

MEETING MINUTES

October 16, 2013

Minutes: Santos Community Committee - Narrabri Shire
Wednesday, 16 October 2013
Narrabri Shire Council Chambers

Attendance: David Ross (Chair), Tony Pickard, John Tough, Rod Siler (Santos), Victoria Hamilton, Brendan Warnock, Ian Duffy, Annie Alexander (Santos), Annie Moody (Santos), Ken Flower, Ron Campey, Jon Maree Baker, Terry Hinch

Apologies: Michael Guest.

	Discussion	Action/By Whom
1. Welcome and introductions	The chair opened the meeting at: 5.32pm Chair welcomed committee. Introduced Santos Representatives: Rod Siller	
2. Previous meeting's minutes	<ul style="list-style-type: none">- Changes to previous minutes noted from Santos: MAR in actions should be changed to NAR 7059.- Chair offers committee opportunity to read over meeting action item response list from Santos from last meeting. Meeting Action Item Response (Reference 131001_NCCC) – See attachment 2. <p>Questions/ comments arising from Action response list:</p> <ul style="list-style-type: none">- Item 9: Committee member would like a more precise location of NAR7059_SUR_W GPS reference if available.- Committee would like Santos to present information on baseline monitoring of methane at a meeting. Santos responds that the Environmental and Water Team have agreed to come to a meeting.- Committee member makes request from last meeting of the times the drill rig will be operating doing the shallow aquifer monitoring bores next door to his property. Santos responds that all neighbours will receive a letter. Under the Santos REF conditions we are required to advise adjoining landholders 14 days prior to activity commencing.- Committee member comments that Dewhurst 8 was to be discussed with CCC as part of the REF condition 1 month before the activity begins. Santos responds that the information has	<p>Santos to provide more precise location GPS if available for item 9 NAR7059_SUR_W.</p>

MEETING MINUTES

October 16, 2013

been included in the proposed work activities handout. Committee member says that it is suppose to be discussed. Santos responds that the handout with proposed work activities is considered as a form of communication, it is also advertised in the local paper and any community member is welcome to ask Santos questions regarding this. Committee member responds that it says Santos is going to present about the topic to the Council and discuss with the CCC. The expectation from members of the CCC is that if it is a condition of the REF to discuss proposed work activities then they would like that to happen. Santos responds that this process would not be practical due to meeting time restraints as that is a condition of every REF, Santos will not be briefing on every activity unless it is specifically requested by the CCC based on the update. Chair asks committee if that is a reasonable process and the committee agrees that they now know to respond clearly to any issue they would like discussed on proposed work activities. Once the committee has read the update please notify the Chair about things they would like discussed at the meeting so it can be flagged with Santos and discussed at the meeting.

3. Tri Level Drilling for Narrabri Shire – Presented By Rod Siller

- Previous minutes passed by committee with correction made.
- Chair advises Santos that previously the presentation was agreed to be supplied to the committee one week before the upcoming meeting – Santos agrees.
- See appendix 5 for full presentation.
- See appendix 5.1 for video presentation included.

Santos to send out upcoming presentation for future meetings 1 week in advance.

Questions from presentation:

- How long does it take to drill to join up one vertical shaft to the next? Santos responds that once you have milled the window it shouldn't take longer than a day, its not a hard formation as you are drilling through coal.
- Committee member asks if Santos cement below the casing? Santos responds that the casing is below the level of the Porcupine Formation and that it is solid. For those 60 metres between the top coal seam and where it comes out is left open. Committee member asks if the reason you case it all the way around, is to put the case in the bottom? Santos responds yes we will run the pump down to just above the windows and then run tail pipe down. Committee member asks what is going to stop the coal seam collapsing? Santos responds that the coal is actually quite hard as far as coal is

MEETING MINUTES

October 16, 2013

concerned, the experiences being from the horizontal wells that have been done by Eastern Star Gas (ESG) in the past is that they stay open. Committee member comments that most people have visions that this is lined the whole way along to stop it collapsing. Santos responds if you were shallow you might, but the coal seams we are after are deeper so we don't have to.

- Committee member asks will you be using old drilling techniques like using fluid to drive a drill head through the side? Santos responds that they will be using the Webstocks that were shown on the video presentation (see appendix 5.1). Santos have one of the aluminum skins window where three of them run on the one well, and we will run in with a bite and a motor with a bend on it and drill it out. Once we have milled the window out we will go in with a motor with a bend and then go horizontal and drill a horizontal section. Committee member asks if they then use the fluids to drive it down the curve? Santos responds its got a rotor in-stock with four lobes inside like a corkscrew; so you pump fluid down and it turns inside and the bit will turn without turning the drill pipelines surface, that's how we get the bill.
 - Committee member asks is the sleeve that you go through aluminum? Santos responds no, we will be using steel and milling out steel. We have three pieces where we have pre-milled aluminum skin windows which Santos is trialing to evaluate them as they haven't been used in Australian before, we know they work, we are evaluating on a time situation so we can work out what is the most efficient time. The aluminum is only over the section that will be milled out. It is just on the one side, when we drill through we drill out the complete aluminum piece.
 - Committee member comments that it was mentioned in the presentation that you are going to case it for 1000 metres and cement it back to surface, how do you know when you have reached the 1000 metres with the cement? Santos responds that we pump it down through the inside of the casing, we have a plug, we put in before we pump the cement, and then we calculate the amount of cement we require and add some excess. We pump that into the casing then have another plug, then we push that down. We have excess in our calculations to get the cement to the surface, if we don't get returns to surface we will 'bump the plug', which means we will have that second cement rubber plug will come down and hit the first rubber plug. Committee member
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MEETING MINUTES

October 16, 2013

asks how does the cement dry down there? Santos responds it dries because of a chemical reaction, it uses up the water and sets hard. The reason it is separated with the rubber plugs is so that when we pump it down it doesn't mix with the fluid that is inside the casing and when it flows up the outside it's pumped up and it displaces the mud above it. There is an interface where you have the cement contacting the drilling mud outside the casing but everything else will be cement.

- Committee member asks how does Santos know where the fissures are, and what work have you done to find out if there are any naturally occurring fissures? Santos responds that when we drill exploration wells we run logs down the hole with geophysical measurements and we run imaging logs but it can give us an image of down below of any fractures that are there, ESG did quite a lot of this and they have plots with the fracture orientations on it. Over such a large area as the Gunnedah Basin Santos could not say that there are no naturally occurring fractures. Where we drill we have a sense of where there are fractures in the coal. If there were natural fractures and fissures to surface then down to the bottom of the surface aquifers that all hydrostatic so when we drill a well we measure our mud weight that is used to hold back the formation in pounds per gallon, the weight of sea water is 8.34 pounds per gallon, but deeper down in the formations we increase the mud weight to 9.3 pounds per gallon, to hold the formation pressure back. If there wasn't pressure in the coal that required that mud rate then most of the gas would have leaked out to the surface and we would only have to drill by 8.3 pounds per gallon. Committee member asks when there is methane occurring naturally in shallow water aquifers, is that because there are fissures already there? Santos responds that no, that is because there are shallow coal seams. Another committee member says that once you get down there and draw the water out and then it releases the gas whatever the area you dewatered from we are worried about the fractures that are naturally occurring in the rocks that the gas can just go to the surface. Santos responds that because it is abnormally pressured it means it is sealed; if it wasn't sealed that extra pressure wouldn't be there.
 - Committee member asks if the coal seam is full of water, how did the water get there through the permeable rock? Another committee member comments that the water
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MEETING MINUTES

October 16, 2013

didn't flow down there it started there. Another committee member disagrees saying that is not necessarily the case. Santos responds that in terms of the basin these lower coals on one side are completely sealed and although it might be an extremely long way away some of them might pinch out before they get to surface. That is the model Santos has at the moment, Santos doesn't have wells over the whole basin so cannot give an exact model of the whole area. Committee member comments that they have seen another presentation and understood from this presentation that Whitehaven's coal seam for the underground mine is the same as one of the seams that Santos are extracting coal seam gas from down further and they were saying that there is a good chance that the coal seam they are extracting from was being recharged with rain water at the top end. So is it possible it is getting recharged from a higher level? Santos responds that he is not a hydrologist so cannot answer that. Another committee member says that this means that the permeability is a possible variable. What we are trying to understand is in terms of your practice what are the risks for now and the future, so in the distant future for example if you decide to frack the area what are the risks. Santos responds that we have determined that fracking has offered us very minimal benefit at all. One well that we abandoned earlier this year was a well that ESG fracked which was Wilga Park 5 and we ran geophysical logs over that casing and there was no damage to the integrity to the cement in the casing in that well, part of the reason was that there were very little pressures generated, because we are drilling perpendicular to fractures that are in the coal seams that is why we run the fracture logs what happens is if you try to frack the wells we might break the coal but as soon as you reach a bigger fracture you can pump but you won't get any benefit out of it. And that is why we have stated we don't intend to frack. Committee member responds that in 20 years time there could be another technology so our questions are about what are we looking at is natural occurrences in terms of risk.

- Committee member asks about the polymers; what are they made up of and can we have more information about those in terms of what you are actually using? Santos responds I am not an engineer so I can't give you all the details. I know we are using some Xanthan gum which is used in foods, Santos can provide more information.
 - Committee member asks if by some chance where you are taking the gas from is close
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MEETING MINUTES

October 16, 2013

to where they are underground mining would there ever be any problems? Santos responds that these seams are way too deep for underground coalmines. Committee member asks about the water monitoring bores and if they are monitored all the time? Santos responds that currently you can go onto the Santos website and see the Roma fields monitoring real time and as soon as we finish installing them here they will be live streamed to the web. Committee member comments that they have been advised by Glenn Toogood that it is actually not live data on the web it is data that is being assessed before it goes live.

Santos to provide more information about polymers

- Committee member asks about the intercontinental shelf; if large amounts of gas are being released to the atmosphere where would you find out what percentage is coming out under natural causes? Santos responds that Geosciences Australia might have further information on what is leaking out of the ground naturally. Coal seam outcrops all seams would be oxidized over millions of years and the methane would be dissipated.
- Committee member asks is the casing made of stainless steel? Santos responds no, concrete forms a barrier on the outside of the casing. The casing is centralized. The cement is a special type that produced and ratios calculated by cement companies.

5. General Business

- **Formalising of the CCC** – Santos currently is waiting to hear back from the Department of Resources and Energy (DRE). But Santos General Manager has confirmed that he would like the committee formalized. Santos is hoping to have this process done starting from the new year. Committee members ask if there will be terms of reference drawn up for the new committee? Santos responds that not yet, but there will be. They suspect that the DRE will appoint a chair for the committee and determine the membership, and then the committee will be formalized under their framework.

- Santos has provided the committee with Narrabri Gas Field Groundwater Monitoring and Modelling Plan the Economic Strategy from the Council. Action on all CCC to review the provided material for next
- Santos tells committee that the erosion and sediment control plan is with a delegate at meeting. the moment waiting to be signed off. Once this has occurred, it can be provided to the CCC.

MEETING MINUTES

October 16, 2013

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- Santos will provide Committee with Energy NSW Exploration and Appraisal summary of Program and State Approval Status; this will be included with the monthly update this explains what stages the REFS and EIS are up to.
 - Committee request for water management strategy that was lodged with the REF, committee would like access to the overall plan. Santos responds that this is still an internal document. When the REF or EIS for stage 2 Leewood is submitted that will be a required document and will become publically available (at an estimate this will be about 2 weeks away)
 - Committee asks about list of questions that were submitted at last meeting from the public via the CCC. Santos will have those questions answered in writing by Wednesday the 23rd Oct.
 - Committee member tables an article from Beef Central for Santos to read and comment on. Santos responds they are happy to read the article but as they did not release it are unlikely to comment on it as there are so many of these articles being published in the media.
 - Committee member would like Santos to confirm if the seam they are extracting from is, or is not connected to the underground mine and the same seam that Whitehaven Coal is using. Santos will check the proximity to coal mine and speak with a geologist to see if they can find out.
 - Committee member comments that when the committee is formalised he would like to see that the role of the new committee is to educate the community, could this be inserted in to the terms of reference. (As an example the education of school children.) A second committee member would like to see school children educated in an unbiased manner hearing both side of the story not just Santos. Santos responds that if they are invited to attend a function to present; they present on the basic facts about coal seam gas mining. Committee comments they have an issue with Santos seeking invitations to attend schools. Santos responds that they frequently hold public information sessions that are advertised in local media and all the public are welcome to attend. Some committee members are unhappy with Santos approaching Schools to ask to present.
 - Committee member raises issue that community should be able to attend the CCC meetings as observers, if not for the final meetings of the current committee but in the
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MEETING MINUTES

October 16, 2013

terms of the new committee. Chair responds that at the beginning of the current CCC it was decided that no names be mentioned in the minutes to protect the privacy and views of the individual members, if we have observers it would be a concern that this cannot be controlled. When the CCC gets formalised this can be revisited.

Other Business

Next Meeting Topics: Air quality.

Date of next meeting: Wednesday 13th Nov 2013

Meeting Closed:

7.30pm

Attachment 1. Actions

Action Raised	Date Raised	Progress Made
Action for Santos to provide committee with full soil analysis including analysis of bacteria of the Leewood site next year when it is available. As well as providing regular soil checks to ensure no contamination is occurring.	11th December	Ongoing
Specialist to answer questions on aquifer monitoring research that is being conducted.	11th December	Ongoing.
Santos to give a process to try and resolve committee members issue with his bore	14 th May	Ongoing. CCC will be provided with copy of document when it is finalized
Action for Santos to explore the option of formalising the committee.	18 th June	Ongoing waiting on response from DRE
Santos to raise with their Communications team that the Land Access Brochure has been noted at the CCC meeting to be unclear.	13 th August	Ongoing – Santos will distribute the new version of the Brochure once it has been completed.
Action Santos & Chair to see if Santos can provide the Overall Water Management Strategy to the CCC.	18 th September	Glenn Toogood can provide a technical overview of the water management strategy document at an upcoming meeting.
Ongoing action to revisit the topic of economic impacts. Look into having a Santos expert to come and present on this topic in the future.	18 th September	Manager of Energy NSW commercial or his delegate is

MEETING MINUTES

October 16, 2013

		happy to address the CCC at a suitable time to committee.
Santos to provide further details on the erosion management plan for the flow line project	18 th September.	CCC will be provided a copy of this once it is finalized.
Committee member would like clarification of the location as marked NAR7059_SUR_W.	18 th September	Santos looking into to see if they can provide the GPS location
Santos to provide further information on methane testing. Possibly get a presenter to come and speak at meeting.	18 th September	Manager of Energy NSW or delegate happy to present
Santos to send out upcoming presentation for future meetings 1 week in advanced.	16 th October	
Santos to provide more information about polymers	16 th October	
Action on all CCC to review the provided material (Narrabri Shire Economic Development Strategy and Groundwater monitoring and modeling plan) for next meeting.	16 th October	
Santos will check the proximity of the seam they use to the Whitehaven coal mine and speak with a geologist to see if they can find out more information.	16 th October	

Appendix 1: Proposed Work Activities Santos Update October 2013

Appendix 2: Santos Meeting Action Item Response

Appendix 3: Narrabri Gas Field Ground Water Monitoring and Modeling Plan

Appendix 4: Narrabri Shire Economic Development Strategy July 2011

Appendix 5: Rod Siller Santos Drilling Presentation.

Appendix 5.1: Presentation Video.

Santos Community Consultative Committee – Narrabri Shire Meeting

Wednesday 16th October – 5:30 pm to 7:30 pm

Narrabri Shire Council Chambers

1.	Welcome, apologies and introductions	5:30 – 5:35	All
2.	Previous meeting's minutes	5:35 – 5:55	David Ross
3.	Tri level drilling for Narrabri Shire	5:55 – 6.45	Rod Siller
4.	General Business <ul style="list-style-type: none">• Update• Other Business• Next meeting and issue to discuss	6.45 – 7:30	All

Meeting Action Item Response

Reference:	131001_NCCC
Subject:	Meeting Action Items – September Meeting Narrabri CCC
Request date:	1 October 2013
Requested by:	David Ross Chair Narrabri CCC
Background Request:	<ol style="list-style-type: none"> 1. Provide the CCC with a copy of the new land access brochure and a land access agreement figures. 2. See if Santos can provide the overall water management strategy to the CCC 3. Try and source Council economic analysis 4. Have a Santos person talk on economic analysis at a future meeting 5. Find out what the employee ratio is of employed staff compared to employment agency. 6. Provide further details on the sedimentation / erosion control plan for the flowlines project 7. Find out if Santos has data on the levels of methane released into the tank from the storage produced water. 8. In relation to flowlines, advise what authority Santos have from the Council and if there are any annual payments being made. 9. Committee member would like clarification of the location as marked NAR7059_SUR_W 10. See if the CCC can have a copy of the ground water monitoring and modelling plans. 11. Provide further information on methane testing. Perhaps get someone to present on this at a future meeting 12. Provide information to CCC about compliance plans and who is monitoring 13. Have someone present at next meeting preferably on tri level drilling and methods involved
Response:	<p>Item 1 - <i>Provide the CCC with a copy of the new land access brochure and a land access agreement figures.</i></p> <ul style="list-style-type: none"> • The CCC will be provided with a copy of the document when it is finalised.
	Item 2 - <i>See if Santos can provide the overall water management strategy to the CCC</i>

	<ul style="list-style-type: none"> • The Water Management Strategy is an internal working document which Santos has developed to assist with devising the PEL238 Produced Water Management Plan. • Due to the commercial nature of the document, it is not available to be provided. If required, Glenn Toogood can provide a technical overview of the Water Management Strategy Document at an upcoming CCC.
	<p>Item 3 - Try and source Council economic analysis</p> <ul style="list-style-type: none"> • The report that was referred to at the September meeting is the report by AEC Group published in July 2011 entitled <i>Narrabri Shire Economic Development Strategy</i> • A copy of this report is included as Attachment 1
	<p>Item 4 - Have a Santos person talk on economic analysis at a future meeting</p> <ul style="list-style-type: none"> • The Manager of Energy NSW Commercial or his delegate will be pleased to address the Narrabri CCC at a time suitable to the Committee.
	<p>Item 5 - Find out what the employee ratio is of employed staff compared to employment agency.</p> <ul style="list-style-type: none"> • As at 30 September 2013, there are 131 people working for Santos Energy NSW. Of this total, 36 are contractors. • This does not include staff employed by contractors engaged by Santos for project based activities eg., Daracon
	<p>Item 6 - Provide further details on the sedimentation / erosion control plan for the flowlines project</p> <ul style="list-style-type: none"> • The erosion control plan for the project is being finalised and is with the delegate for approval. • The CCC will be provided with a copy of the document when it is finalised.
	<p>Item 7 - Find out if Santos has data on the levels of methane released into the tank from the storage produced water</p> <ul style="list-style-type: none"> • There is no requirement for Santos to monitor these tanks. • The water has passed through gas separator equipment and the amounts of remaining gas would be minimal.
	<p>Item 8 - In relation to flowlines, advise what authority Santos have from the Council and if there are any annual payments being made.</p> <ul style="list-style-type: none"> • The consent from the relevant road authority is one component of the overall approval process for this program of work. • The proposed activity (Dewhurst Northern Flowline) required assessment and determination under Part 5 of the <i>Environmental Planning and Assessment Act 1979</i> (EP&A Act).

	<ul style="list-style-type: none"> • The Minister for Resources and Energy (Resources Minister) is the determining authority for the proposed activity by virtue of the need to obtain further approval from the Resources Minister under PEL 238 and PAL 2 concerning the proposed activity. • A copy of the REF and approval is available from the DRE website at http://bnsw-search01.squiz.net/search/search.cgi?query=%60REF+Dewhurst+Northern%60&collection=resources • The Narrabri Shire Council provided consent under Section 138 of the <i>Roads Act 1993</i> for roads for which it is the road authority in relation to the Dewhurst Northern Flowline program. • The Narrabri Shire Council is the road authority for Killara Road (part) and Rockdale Road. • An application fee was paid.
	<p>Item 9 - Committee member would like clarification of the location as marked NAR7059_SUR_W</p> <ul style="list-style-type: none"> • The location NAR7059_SUR_W was a large puddle of water located on the Newell Highway. The purpose of monitoring such ponds was to assess the nature and presence of SRB across all aquatic environments.
	<p>Item 10 - See if the CCC can have a copy of the ground water monitoring and modelling plans.</p> <ul style="list-style-type: none"> • The Groundwater Monitoring and Modelling Plan was developed and provided to DTIRIS (as per PEL renewal requirements) following consultation with the NSW Office of Water. • The plan was approved by DTIRIS in December 2012. • A copy of the plan is attached – Attachment 2
	<p>Item 11 - Provide further information on methane testing, perhaps have someone to present on this at a future meeting</p> <ul style="list-style-type: none"> • The methane testing program being undertaken in PEL 238 and the broader Gunnedah Basin area is a voluntary data collection process that Santos is undertaking to inform our baseline data sets. • It is intended that this data will be analysed and reported as part of our ongoing environmental studies. • The University of Adelaide are working with Santos on this project. • Data is being collected in different seasons, during day and the evening • CO₂ and CH₄ concentration and isotope data is being collected using a Picarro 2201i Analyzer. • This equipment is accurate to < 1ppm, data point ~every 1 second • Locations are being logged using Garmin 60 GPS unit. • Analyzer and GPS data is logged continuously while driving. • The Manager of Energy NSW Environment and Water or his delegate will be pleased to address the Narrabri CCC at a time suitable to the Committee to provide more information on this program.
	<p>Item 12 - Provide information to CCC about compliance plans and who is</p>

	<p><i>monitoring</i></p> <ul style="list-style-type: none"> • Santos complies with conditions that apply to approvals, licences and other authorities granted for our activities in NSW. • In relation to Commonwealth approvals, the Department of the Environment is responsible for matters pertaining to the <i>Environment Protection Biodiversity Conservation Act 1999</i>. • CSG activities in New South Wales are principally regulated by the Office of Coal Seam Gas (OCSG), within the Division of Resources and Energy, Department of Trade and Investment. • The OCSG have compliance officers who check on compliance in the area of environmental management, and others with regard to safety. • They OCSG also has personnel responsible for the administration of tenures relevant to petroleum activities. • The legislation the OCSG administers includes the <i>Petroleum Onshore Act 1991</i> and associated Regulations, and all codes of practice relevant to the industry. • They are responsible for assessment and compliance of approvals granted under the legislation that they administer. • The Environment Protection Authority is the responsible entity for Environment Protection Licences associated with our exploration activities. • The Department of Planning regulates Santos activities in relation to the Wilga Park Power Station and the associated gas gathering system. • The NSW Office of Water is the regulator for water licences. • Narrabri Shire Council is the regulator for development approvals they issue, such as the fluid treatment facility. • A variety of other State Government departments have responsibility for compliance activities associated with permits, licences or other authorities that they grant. • For example, Roads and Maritime Services within the Department of Transport monitors permits that they have issued in relation to Traffic Management activities. • Compliance plans are operational documents that Santos uses internally to ensure that regulatory requirements are met.
	<p>Item 13 - <i>Have someone present at next meeting preferably on tri level drilling and methods involved</i></p> <ul style="list-style-type: none"> • Rod Siller, Senior Drilling Engineer, Santos Energy NSW will be presenting to the Narrabri CCC meeting on 16 October 2013.
Briefing Officer:	Annie Moody Team Leader, Community and Land
Date:	14/10/2013

Narrabri Shire Economic Development Strategy

Narrabri Shire Council

Final
July, 2011

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Document Control

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Executive Summary

Narrabri Shire Economy

The Narrabri Shire is located in the north-west of NSW, in the Namoi Valley, with a current population of around 14,000 residents. Covering an area of approximately 13,000km² the Shire includes the key towns of Narrabri, Boggabri and Wee Waa and the villages of Baan Baa, Bellata, Edgeroi, Gwabegar and Pilliga.

The Narrabri Shire had an estimated resident population of 13,693 persons in 2009, representing annual growth of around 0.9% from 2008. Despite recording growth during 2009, the Narrabri Shire has generally recorded a declining population since 2001 as a result of the drought (and residents leaving the area in search of employment opportunities). The inflow of residents in 2009 is likely attributable to additional employment opportunities created by the mining boom in the area in recent years. The population decline in the area has had a negative impact on the economy and the recent turnaround in 2009 is an important growth indicator that should not be underestimated. Population projections produced for this report based on recent population data and employment forecasts for major mining projects indicate the Shire's resident population is projected to grow at an average annual rate of 0.5% adding approximately 1,565 residents over the next 20 years.

Agriculture and mining are the key sectors for Narrabri Shire, providing significant value to the economy as well being major employers. Agricultural production includes a variety of crops including cotton, wheat, barley, oilseeds, grapes and peanuts with livestock production comprising sheep, cattle and pigs. Narrabri Shire is also located in the Gunnedah Basin which has one of the largest coal reserves in NSW with numerous coal and gas operations located between Narrabri and Gunnedah. These sectors will continue to play a key role in the economy in the future though the reliance on these sectors underscores the importance of future diversification.

The Narrabri Shire economy is projected to record strong growth over the next five years on the back of the mining sector. The development of new mines and expansion of existing operations will create significant employment opportunities which will drive population growth as well as creating business and investment opportunities for support service providers and suppliers. Business growth will increase demand for industrial and commercial land with population growth driving demand for residential supply, which will increase demand for service provision in the Narrabri Shire.

Opportunities for Growth

There are numerous opportunities to grow and diversify the economy in the Narrabri Shire. Specific opportunities have been broken down into four key areas and inform the development of strategies and activities to facilitate economic development:

- **Target Industry Sectors:** Several industry sectors have been identified to drive economic growth and development in the Narrabri Shire over the next 5 years and represent industry opportunities that contribute high value-adding, knowledge-driven jobs to the region. These industries have been identified to guide investment attraction activities and include:
 - Mining services;
 - Machinery and equipment manufacturing;
 - Agricultural processing and food manufacturing;
 - Professional services;
 - Transport and logistics; and
 - Hospitality and tourism.
- **Labour Attraction and Retention:** The Narrabri Shire records an outflow of younger population between the ages of 20-30 years who leave the Shire in search of better education and employment opportunities, resulting in the loss of potential skilled workers. The significant agricultural sector in the region also means there are

issues with the seasonality of job opportunities that mean local residents are unable to source full time work. Attracting and retaining labour is a key opportunity to promote growth in the region and attract new companies to the area. Opportunities include expanding local tertiary education services, establishing the “Make it Work” program and maintaining a good quality of life and provision of services that will make the region an attractive location for new residents.

- **Climate Change:** While climate change is likely to have some negative impacts on the economy, it is also likely to result in significant opportunities for economic growth and investment globally. There is a greater emphasis on conserving energy, water, recycling and reducing greenhouse gas emissions which is facilitating investment in new technologies and services. In many cases, governments are offering rebates and grants to promote investment in environmentally focused sectors. Potential opportunities for business growth and investment in Narrabri Shire specifically related to climate change include:
 - Coal seam gas;
 - Renewable energy;
 - Water efficiency;
 - Environmental services;
 - Biofuels;
 - Recycling and waste management; and
 - Construction.
- **Infrastructure Provision:** Having access to adequate infrastructure is crucial in facilitating investment by existing businesses and attracting new companies to establish operations in the Narrabri Shire. The following infrastructure is required in the region to facilitate growth and should be the focus of lobbying by Council to the State and Commonwealth Governments and by the economic development unit within Council.
 - Rail infrastructure and services between the Gunnedah Basin and Newcastle;
 - Expansion and upgrades of Narrabri Airport;
 - Release of residential Land; and
 - Provision of social Infrastructure and services: including child care and health services.

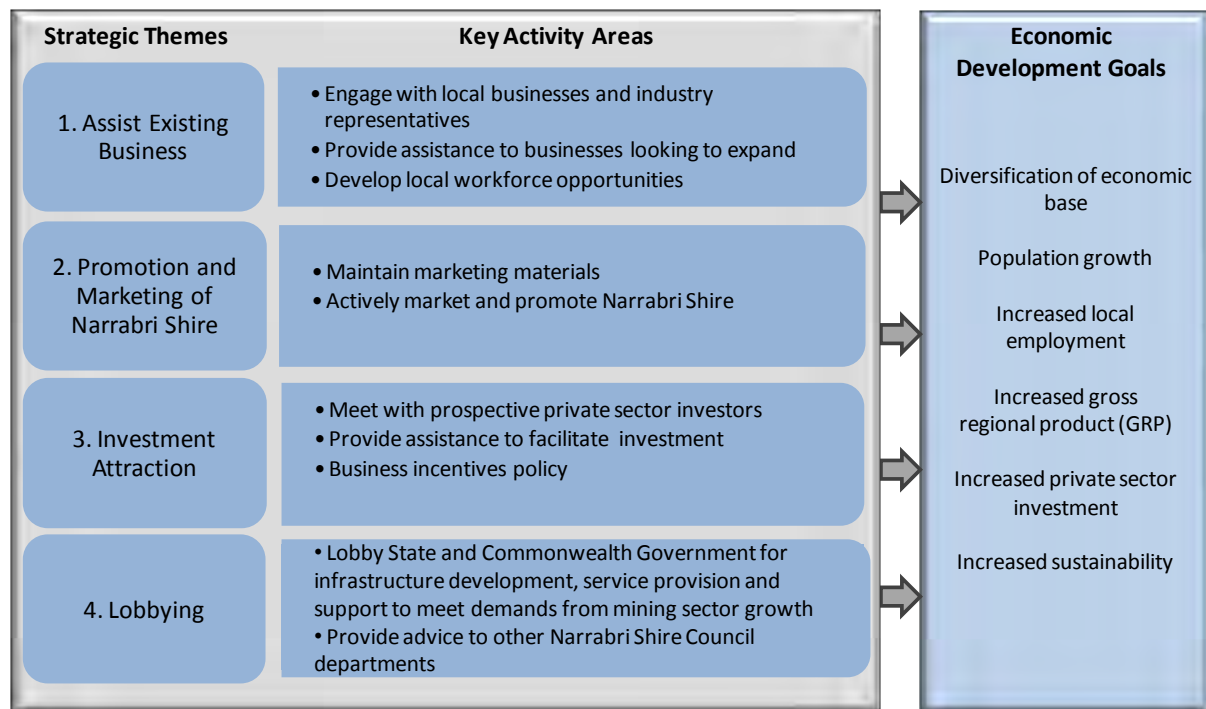
Economic Development Strategy

The vision for the Narrabri Shire Economic Development Strategy was developed through consultation with Narrabri Shire Council, Council staff, key stakeholders as well as with consideration of existing strategies and plans.

To facilitate the growth and development of a vibrant, sustainable and diversified economy that value adds to the region’s resources and provides a quality living environment and prosperous future for all residents and communities.

The Narrabri Shire Economic Development Strategy provides specific and strategic direction for economic development activities to achieve the vision for the local economy. Four strategic themes have been developed to promote the growth and diversification of the economic base of the Narrabri Shire.

Figure E.1: Narrabri Shire Council – Economic Development Strategy Overview



Source: AECgroup

The Economic Development Strategy provides long term guidance and direction for Narrabri Shire Council. It includes practical activities organised across four directives and is geared toward delivering practical outcomes and achieving the economic vision for the future. The Economic Development Program provides specific tasks and activities for Council to carry out in order to achieve the goals and vision of the Economic Development Strategy. The EDP is a 5-year operational plan providing specific activities, key performance indicators, potential partners and proposed budgets as well as offering an annual planning tool for Council for economic development.

Table of Contents

DOCUMENT CONTROL	I
EXECUTIVE SUMMARY	II
TABLE OF CONTENTS	V
1. INTRODUCTION.....	1
1.1 BACKGROUND	1
1.2 PURPOSE OF THE STUDY	1
1.3 PROJECT STRUCTURE AND PROCESSES	1
1.4 ECONOMIC DEVELOPMENT	2
2. PLANNING CONTEXT.....	3
3. OVERVIEW OF NARRABRI SHIRE.....	5
3.1 REGIONAL OVERVIEW.....	5
3.2 HISTORICAL AND PROJECTED POPULATION.....	6
3.3 ECONOMY.....	8
3.3.1 ECONOMIC STRUCTURE AND GROWTH.....	8
3.3.2 LABOUR MARKET	9
3.3.3 MAJOR BUSINESSES	10
3.3.4 KEY INDUSTRIES	11
3.4 ENVIRONMENTAL CONTEXT	12
3.4.1 CLIMATE CHANGE	12
3.5 PROJECTED GROWTH	13
4. SWOT ASSESSMENT.....	15
4.1 STRENGTHS	16
4.2 WEAKNESSES	17
4.3 OPPORTUNITIES.....	18
4.4 THREATS.....	19
5. SPECIFIC GROWTH OPPORTUNITIES.....	21
5.1 TARGET INDUSTRY SECTORS	21
5.2 LABOUR ATTRACTION AND RETENTION	23
5.3 CLIMATE CHANGE.....	23
5.4 INFRASTRUCTURE	24
6. VISION	25
7. ECONOMIC DEVELOPMENT STRATEGY	26
7.1 STRATEGY OVERVIEW	26
7.2 STRATEGIC THEME 1: ASSISTING LOCAL BUSINESS	26
7.3 STRATEGIC THEME 2: PROMOTION AND MARKETING OF NARRABRI SHIRE	28
7.4 STRATEGIC THEME 3: INVESTMENT ATTRACTION.....	28
7.5 STRATEGIC THEME 4: LOBBYING	30
7.6 ECONOMIC DIRECTION FOR COMMUNITIES.....	30
8. IMPLEMENTATION.....	32
8.1 ECONOMIC DEVELOPMENT PROGRAM	32
8.2 MONITORING & MEASURING SUCCESS	32
REFERENCES	34
APPENDIX A: CONSULTATION LIST.....	35
APPENDIX B: POPULATION PROJECTION ASSUMPTIONS	36

1. Introduction

1.1 Background

The Narrabri Shire is located in north-western NSW, and has a current population of around 14,000 residents. The Narrabri Shire has historically been an agricultural economy, with cotton, wheat, sheep and beef cattle providing the backbone of local production.

Recent coal mining and gas exploration developments in the Gunnedah Basin provide an opportunity for diversification and growth in Narrabri Shire but will require planning and collaboration. Climate change, population/demographic changes and other external forces will continue to exert pressures on Narrabri Shire in the future. In order to drive future economic growth, diversification and sustainability, the Council has engaged AECgroup to formulate its Economic Development Strategy (EDS) for the next five years (2011-2016).

1.2 Purpose of the Study

The focus of the Economic Development Strategy will be to strengthen and further diversify the existing economic and industrial base in a balanced and sustainable way, through providing strategic direction as well as specific actions to implement and drive change. An important outcome from this study will be to strengthen the regional economy by reducing the reliance and dependencies on key industries for employment generation and economic activity.

The strategy will **identify Narrabri Shire's competitive advantages, key economic drivers** and potential opportunities for industry diversification and culminate in the preparation of an action plan to implement the outcomes of the EDS.

1.3 Project Structure and Processes

The development of the Narrabri Shire Economic Development Strategy followed a structured approach with the following key processes:

- **Literature Review:** Review of existing strategies and planning documents relating to economic development in the Narrabri Shire to inform the planning context for the project.
- **Economic Research and Analysis:** Comprehensive research and analysis of the existing economic environment in the Narrabri Shire in order to inform the development of future development in the area.
- **Climate Change Impacts:** Assessment of the potential impacts of climate change on the Narrabri Shire economy and the potential economic opportunities resulting from climate change.
- **SWOT Analysis:** Identification of the major strengths, weaknesses, opportunities and threats facing the Narrabri Shire in order to inform economic development initiatives.
- **Stakeholder Consultations:** Consultation was undertaken with key stakeholders in the Narrabri Shire and surrounding region to review the accuracy of existing analysis, identify opportunities and constraints for economic growth and discuss the role of Council in relation to economic development.
- **Strategy Development:** Identification of the key strategies to be implemented by Narrabri Shire Council in order to facilitate the sustainable growth and diversification of the local economy.
- **Economic Development Program:** Following the completion of the Economic Development Strategy, a detailed program will be developed outlining the actions, responsibilities and timeframes in order to implement the identified strategies.

1.4 Economic Development

The International Economic Development Council defines economic development as a

“Program, group of policies, or activity that seeks to improve the economic well-being and quality of life for a community, by creating or retaining jobs that facilitate growth and provide a stable tax base.”

At its core, economic development is about communities and ensuring existing quality of life is increased for future generations. The community at large and residents as individuals are the beneficiaries of economic development. The creation of wealth through economic development includes the increase in business activity, economic output, employment and income within an area that generates benefits for the community. Economic development is generally achieved through the increase in business and economic activity that in turn flows through the economy in the form of greater incomes and wealth to the resident population, thereby influencing their quality of life.

2. Planning Context

Economic development is influenced by many internal and external factors, including existing policy and strategic direction. The table below provides an overview of key planning documents and strategies that influence economic development in the Narrabri Shire.

Figure 2.1: Existing Strategies and Plans

Policy/Plan	Description	Implications for Narrabri Shire
State/Regional		
Regional Development Australia Northern Inland NSW (RDANI) Regional Plan - 2010	It refers to the regional plan developed by RDANI – a regional organisation comprising 13 local government areas (including Narrabri Shire) in northern NSW. The Plan provides an overview of the regional economy, including key strengths, weaknesses, opportunities and threats. The document also provides a vision for the region and outlines priority focus areas for the organisation over the next five years.	It is important that the Strategy recognises and reflects the fact that Narrabri Shire is part of a larger region. The Strategy should aim to address the Shire's position within the region and look to work together with neighbouring Councils and development organisations to promote mutual beneficial opportunities leveraging various strengths of the region.
Municipal		
Narrabri Shire Economic Social Plan - 2010 -2015	It is a socio-economic plan which aims to improve the quality of life of the Shire's local community over the next five years. Some of the key opportunities identified in the Plan include retail business expansion, improvement of major commercial streets, and development of investment and business attraction policies.	It is crucial that the Strategy looks to diversify the economic base including promoting innovation and value adding opportunities in the agriculture sector and investigate opportunities emerging from the growth in new technologies. Climate change is also an important consideration to economic development in the Narrabri Shire and potential impacts on the economy will need to be assessed.
Assessment of Opportunities for Narrabri Shire from Coal Mining & Gas Extraction in the Gunnedah Basin	The document outlines various potential opportunities (for the Shire) associated with the recent coal-seam gas and mining boom in the Gunnedah Basin. Key opportunities identified as part of the Assessment include demand for temporary and permanent accommodation, workforce training and education programs, expansion of retail sector, and attraction of support industries to service mining operations.	The planning document highlights the need for the Strategy to identify ways in which the Narrabri Shire can leverage the mining sector growth within the Gunnedah Basin in a sustainable way.
Boggabri Caravan Park Business Plan - 2008	It is a business plan prepared in 2008 for the 12 powered sites caravan park in Boggabri. The Plan discusses several development concepts including self contained cabin accommodation, short term tourist sites, camping sites, amenity block and other facilities.	The growth in the mining sector generally results in pressure on accommodation including short and long term facilities. The development of additional short term accommodation will be important to support the mining and tourism sectors in the Narrabri Shire.
Retention and Business Survey - 2006	In 2006, businesses located within the towns and villages in the Shire were surveyed with the aim to gather information on the characteristics, expectations and views of the local business community. The survey data formed the basis of a number of reports recommending ways to assist local business community to grow.	It is important that the Strategy provides specific guidelines including identifying opportunities and support programs to grow and develop local businesses in a suitable manner.

Policy/Plan	Description	Implications for Narrabri Shire
Narrabri Shire Growth Management Strategy	<i>The Narrabri Growth Management Strategy</i> aims to develop a clear statement of principles and a map that will be the strategic direction for growth management outcomes for the Shire over the next 20 years.	It is important that the growth and expansion of the Narrabri Shire is done in a sustainable manner - encouraging a diverse and prosperous local economy and offering a range of employment opportunities.
Narrabri Shire Local Environmental Plan (LEP)	Narrabri Shire Council is currently preparing a new LEP to meet the requirements of the NSW LEP template. The new draft LEP is expected to be completed and placed on public exhibition in mid-2011.	As the main planning tool for the Shire, the LEP will provide the planning framework for the future land use and development of the Shire. The LEP will have a tremendous impact on the implementation of the Economic Development Strategy. Equally, the Strategy can provide an economic context for future review of the LEP.
Narrabri Shire Community Economic Development Strategic Plans - 2007	It refers to a series of strategic plans, prepared by the Narrabri Shire Council in 2007, for the towns of Boggabri, Gwabegar, Pilliga and Narrabri. These plans primarily focus on community economic development, outlining actions to promote business growth and sustainable economic development.	There is need for an Economic Development Strategy to address specific economic development opportunities for all of the key towns within the Narrabri Shire considering their respective strengths and weaknesses.
Narrabri Shire Tourism Strategy and Action Plan 2008-12	Narrabri Shire Council prepared a strategy and action plan for the tourism sector in 2008. The action plan has been updated annually in 2009 and 2010 and outlines key actions, tasks and the organisation responsible for each task. Some of the key strategies included in the action plan are improvement and diversification of attraction base, increase visitation to the Shire, and undertake infrastructure improvements.	Tourism represents an opportunity for economic growth in Narrabri Shire with leisure and business visitation likely to drive growth. Growth in the mining sector will create opportunities for investment in accommodation and other hospitality services.
Wee Waa Business Community Marketing Plan	Linda Hailey undertook a review of the Wee Waa business district in order to prepare a marketing plan for the town's business sector . The Marketing Plan identified the need to market Wee Waa to a range of target groups including local and new residents, destination visitors, tourists, business owners and retail staff.	The town centres represent an important component of the Narrabri Shire economy and it is important that the Strategy looks to work with local chambers of commerce to promote growth in the retail, office and hospitality sectors.

Source: AECgroup

3. Overview of Narrabri Shire

3.1 Regional Overview

The Narrabri Shire is located in the north-west of NSW, in the Namoi Valley and covers an area of approximately 13,000km². The Shire is a part of the broader Northern Inland NSW region (as defined by the Northern Statistical Division) and includes the key towns of Narrabri, Boggabri and Wee Waa and the villages of Baan Baa, Bellata, Edgeroi, Gwabegar and Pilliga.

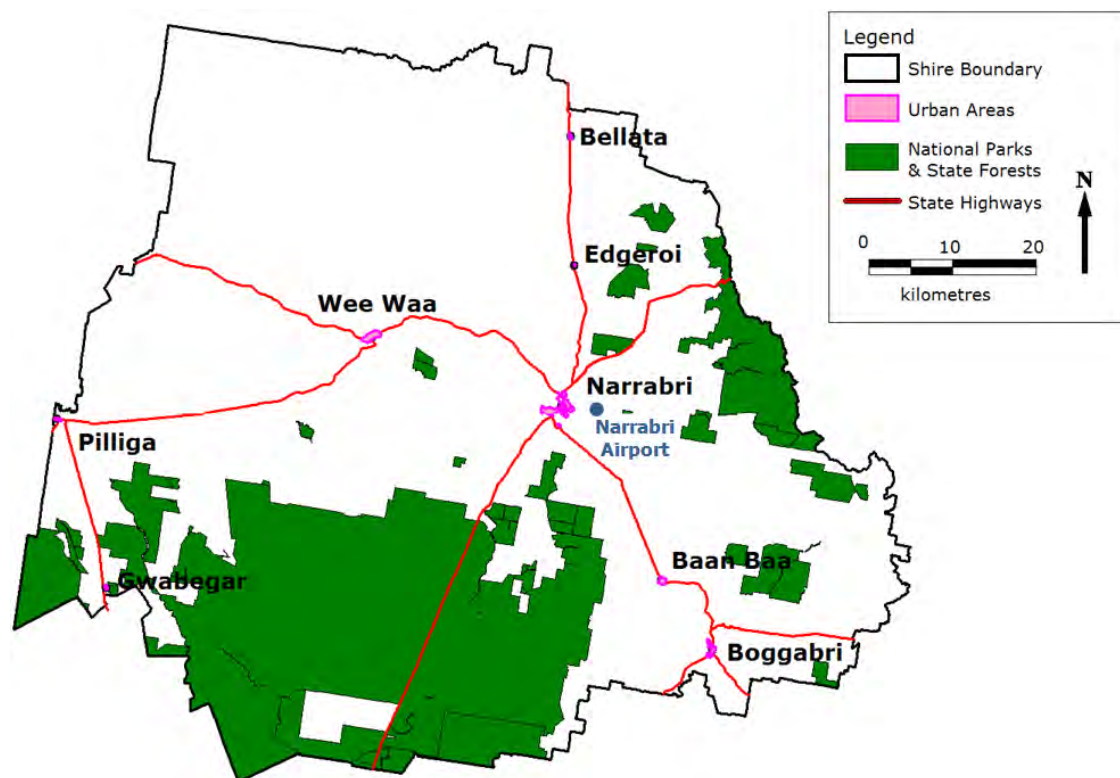
Figure 3.1: Narrabri Shire and Northern Inland NSW



Source: ABS (2003), AECgroup

Located at the intersection of Newell and Kamilaroi Highways, the Shire boasts relatively good provision of road infrastructure. In addition, the Shire is well connected to other parts of the country via the North West railway line and Aeropelican flights operating from the Narrabri Airport.

Figure 3.2: Narrabri Shire



Source: Edge Land Planning (2009)

Narrabri Shire's economy has traditionally been agricultural based and is known for its high-value cotton, wheat, wool, sheep and beef cattle. However, recent coal mining and gas exploration developments in the Gunnedah Basin have provided an opportunity to diversify the Shire's economic base.

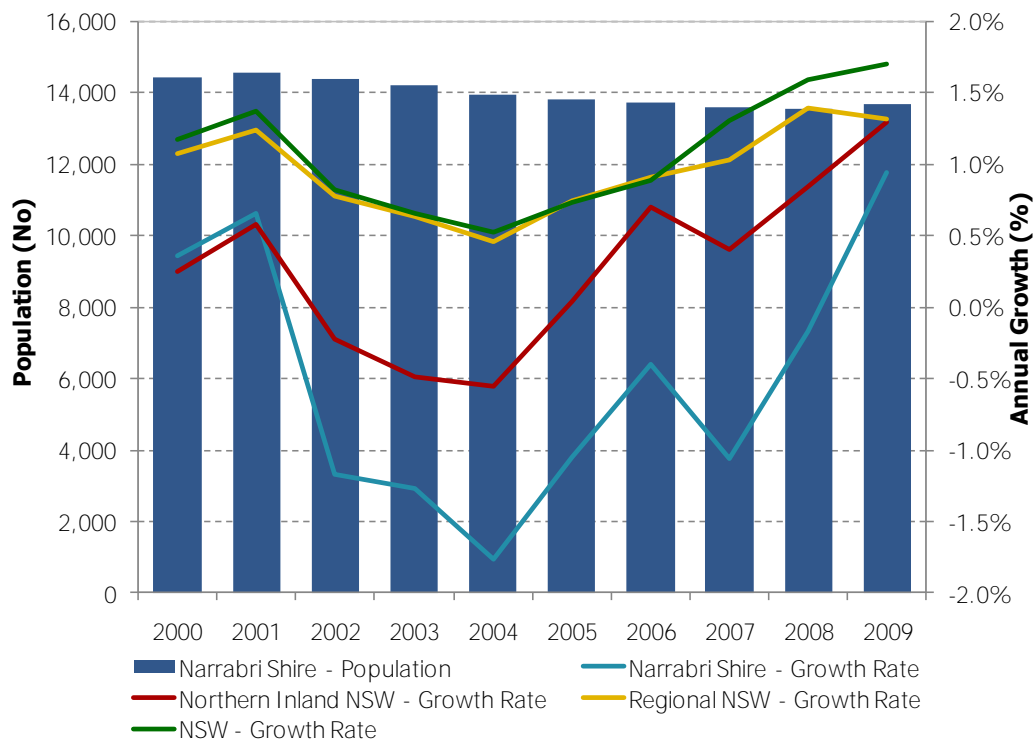
Located within the Gunnedah Basin, the Shire is home to four operating mines including Boggabri, Narrabri North, Rocglen and Tarrawonga. The Gunnedah Basin, which includes Narrabri Shire, Gunnedah and Liverpool Plains, accounts for an estimated 12% of coal reserves available in NSW. With recent increases in the demand and price of coal, the mining activity has increased within the area resulting in new mining and exploration projects being planned for the region in the coming years.

3.2 Historical and Projected Population

The Narrabri Shire had an estimated resident population of 13,693 persons in 2009, representing annual growth of around 0.9% from 2008, which was below Northern Inland NSW, Regional NSW and NSW averages. Over the past decade, the Shire's population declined at an average annual rate of 0.5%. While the population decline in recent years is likely a result of the drought (and residents leaving the area in search of employment opportunities), the inflow of residents in 2009 is likely attributable to additional employment opportunities that may have been created owing to the mining boom in the area.

Population growth is an important source of economic stimulus for local economies, in particular in regional areas as it drives investment through residential development and greater provision of retail, personal, community and recreational services. Population growth also makes a region more attractive to businesses looking to establish operations. Economic development can also impact population growth by creating employment opportunities to attract new residents. While population growth is just one influencing factor of economic growth, a decreasing population can prove to be detrimental to the prosperity of the economy and the local community with employment and spending being removed from the economy, causing on-going economic decline in numerous sectors.

Figure 3.3: Narrabri Shire Population, 2000-09



Source: ABS (2010a)

The NSW Department of Planning's population projections outline that the Narrabri Shire's population is expected to decline between 2006 to 2031. More recent data released by the Australian Bureau of Statistics indicates that the Narrabri Shire's population has actually increased in recent years indicating that the historical decline used as a basis for the Narrabri Shire projections are no longer accurate. The development of major resource projects in the Narrabri Shire planned for the near future are also expected to further drive employment and population growth.

Following the review of recent population trends and the NSW Department of Planning's population projections, AECgroup has prepared alternative population projections for the Narrabri Shire. The projected increase in resident population is based on expected employment generation from major resource projects in the Shire. Assumptions on the proportion of employees that will come from outside the region, reside permanently in the Narrabri Shire and bring partners/families with them are outlined in Appendix B. It has also been assumed that the major resource operations will result in indirect growth in other sectors of the economy that will also result in population growth.

Based on AECgroup projections, Narrabri Shire is expected to have more than 14,500 residents by 2031. The Shire's resident population is projected to grow at an average annual rate of 0.5% adding approximately 1,565 residents over the next 20 years. AECgroup's projections are significantly higher than the NSW Department of Planning's projections (see **Table 3.1**) with more recent data used as part of their development.

Table 3.1: Historical & Projected Population Growth Rates, 2009-2031

Area	Population (No)			Average Annual Growth, 2009-31	
	2009	2021	2031	Persons	%
Narrabri Shire (NSW DoP)	13,693	12,264	10,936	-2,757	-1.0%
Narrabri Shire (AECgroup)	13,693	14,661	15,258	1,565	0.5%
Northern Inland NSW	184,822	184,617	176,809	-8,013	-0.2%
Regional NSW	2,629,952	2,672,038	3,052,266	422,314	0.7%
NSW	7,134,421	7,287,246	8,821,856	1,687,435	1.0%

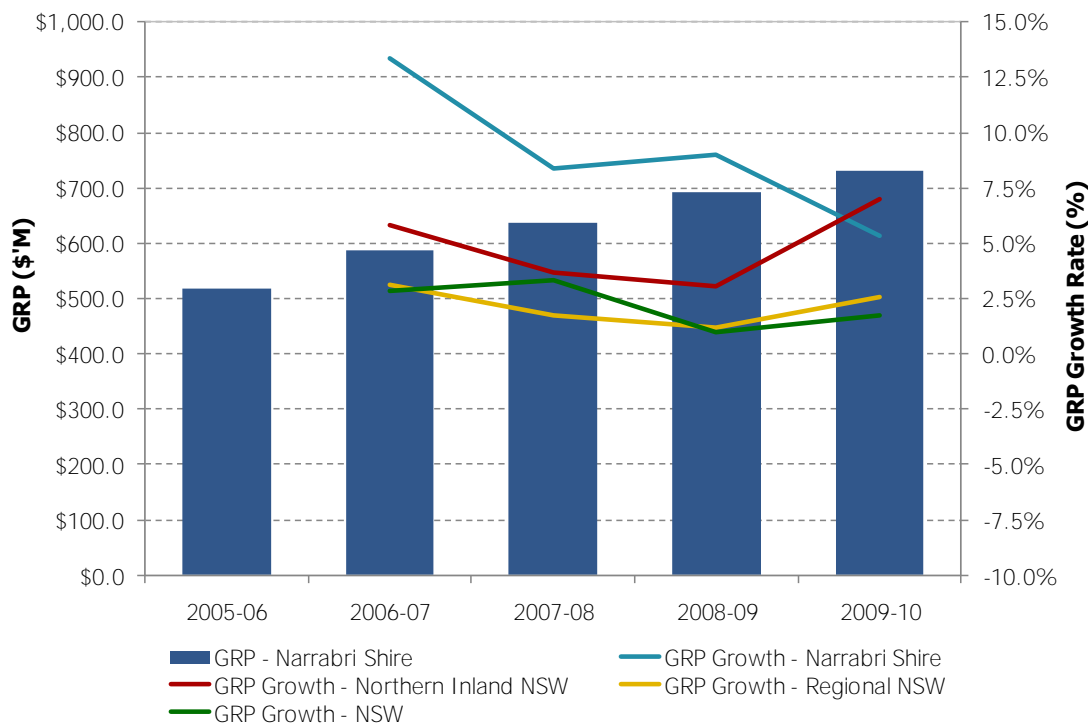
Source: ABS (2010c), NSW Department of Planning (2008), AECgroup

3.3 Economy

3.3.1 Economic Structure and Growth

The Narrabri Shire recorded an estimated Gross Regional Product (GRP) of \$730 million in 2009-10, representing less than 1% of the State's Gross State Product (GSP). Over the past year, the Shire's GRP grew at an annual rate of 5.3%, well above the regional NSW and State averages, however below the Northern Inland NSW average. The Narrabri Shire has recorded high GRP growth in the last four years as a result of new mines commencing operations. Mining growth was not as high in 2009-10 compared to previous years which resulted in growth slowing down slightly below the regional average.

Figure 3.4: Narrabri Shire GRP, 2005-06 to 2009-10

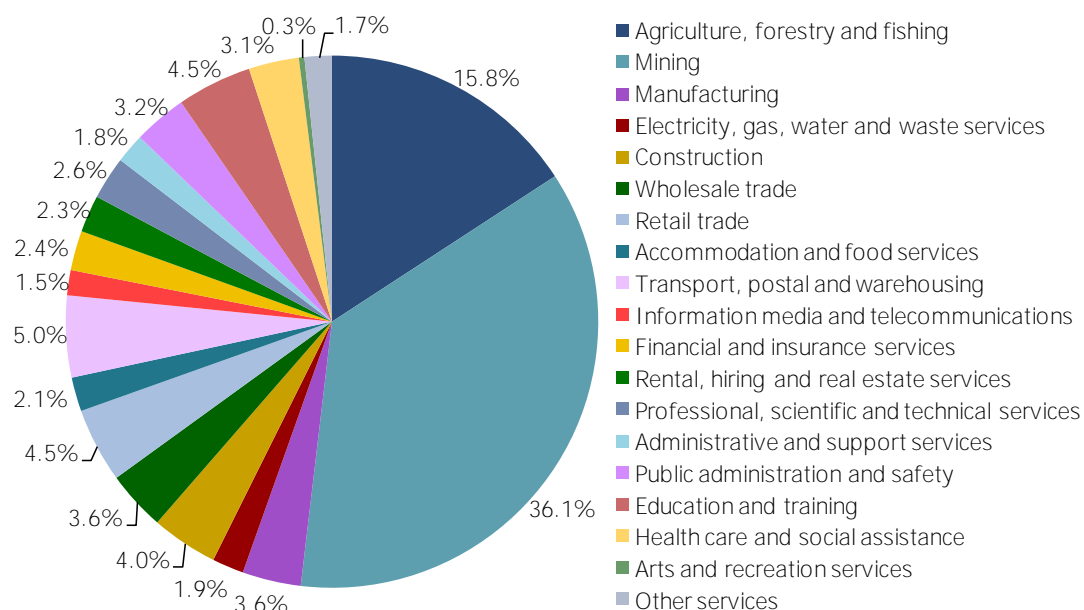


Note: GRP in 2009-10 prices.

Source: AECgroup (2010a)

The Narrabri Shire economy is heavily dependent on the mining and agriculture sectors, jointly contributing more than half of the Shire's GRP in 2009-10. There is a need to diversify the local economy by leveraging the strength in these sectors and other competitive advantages to attract investment in other industries.

Figure 3.5: GRP by Industry, Narrabri Shire, 2009-10



Source: AECgroup (2010)

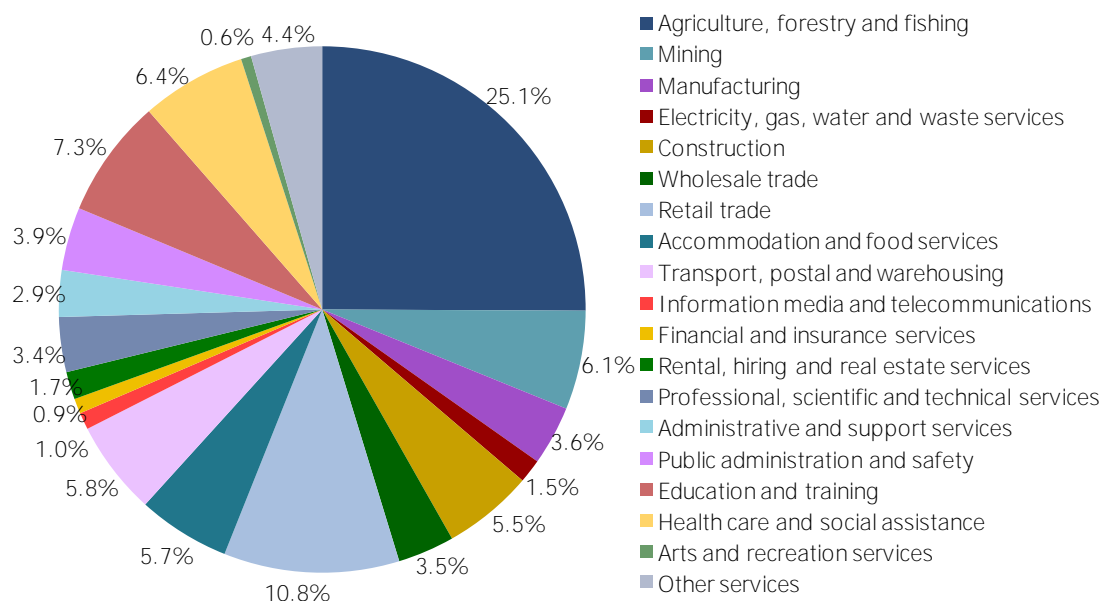
Over the past five years, the Shire's economy grew at an average annual rate of 7.1%, considerably higher than Northern Inland NSW, Regional NSW and State averages. This reflects the significant value add generated by the development and operation of several new coal mines in the Shire and an improvement in agricultural production, including recent strong pricing for cotton.

3.3.2 Labour Market

Recent employment estimates developed by AECgroup indicate that there were an estimated 6,089 employees working within the Shire in 2009-10, over a quarter of which were employed in the agriculture sector. Over the past five years the number of workers employed within the Shire has increased at an average annual rate of 2.6%. This increase is primarily driven by employment growth in the mining, agricultural businesses, construction and retail sectors.

Agriculture (1,527) and retail trade (656) are the largest employment sectors in the Narrabri Shire economy. While these industries are the largest employers, mining and industrial sectors such as manufacturing, wholesale trade and transport and storage are also important employers as they drive growth across the economy.

Figure 3.6: Employment by Industry, Narrabri Shire, 2009-10



Note: Based on place of work.
Source: ABS (2007), ABS (2010b), AECgroup

According to the weekly income estimates developed by **AECgroup**, employed residents within the Shire had an average weekly income of \$803 in 2009-10, relatively higher than Northern Inland NSW (\$696), however below both the Regional NSW (\$852) and the State (\$984) averages.

Increasing average weekly income in the economy will generate greater wealth for residents, which will flow through the economy and contribute to increasing the areas quality of life.

According to the latest labour market estimates developed by the Department of Education, Employment and Workplace Relations (DEEWR), the Narrabri Shire had an unemployment rate of 5.3%, below Northern Inland NSW (6.2%), Regional NSW (5.9%) and the State (5.7%) averages. Since early 2009, the unemployment rate in the Narrabri Shire has been below regional and state averages, reflecting the strong performance of the economy on the back of recent mining activities in the Shire and agricultural productivity, which have driven strong employment throughout the economy.

3.3.3 Major Businesses

The agricultural sector has a strong business presence in the Narrabri Shire, accounting for more than half of its local businesses as at June 2009. Other key business sectors within the Shire include the construction (8.3%), followed by transport, postal and warehousing (7.0%), and rental, hiring and real estate services (5.7%) sectors respectively.

Major businesses and companies located within the Narrabri Shire are listed below:

- **Mining:** Whitehaven Coal, Aston Resources, Idemitsu Boggabri Coal and Eastern Star Gas;
- **Grain Trading:** Louis Dreyfus, Graincorp, Walgett Special One, Canz Commodities and IPS;
- **Manufacturing:** Cargill Australia and Canz Commodities;
- **Agriculture Research:** Cotton Research and Development Corporation, I.A Watson Grain Research Institute (operated by Sydney University); Australian Cotton Research Institute, and Cotton Catchment Communities Cooperative Research Centre; and

- **Retail:** The Shire has a number of large national retail stores and supermarkets including Coles, Woolworths, IGA, Target, Harvey Norman, Retravisson and Home Hardware.

3.3.4 Key Industries

As previously mentioned, the **key industries driving Narrabri's local economy** include mining and agriculture, together representing over half of the Shire GRP and more than 30% of its employment in 2009-10. These two key industry sectors are discussed below.

Mining

The Gunnedah Basin has one of the largest coal reserves in NSW with several coal and gas operations around Gunnedah and Boggabri. There are currently four coal mines located within the Narrabri Shire (Boggabri, Narrabri North, Rocglen and Tarrawonga mines), with two others located south of the Narrabri Shire (Sunnyside and Werris Creek mines).

The mining sector in the Narrabri Shire continues to record strong growth with mine expansions and gas explorations planned over the next four years. Whitehaven Coal purchased the Vickery Project in 2009 from Coal & Allied Industries with the intention of developing both open cut and underground operations. Within the wider Gunnedah Basin, there is also a planned development in Caroona in the Liverpool Plains LGA. The various operational, and proposed mining and exploration projects within the Gunnedah Basin are tabulated below:

Table 3.2: Mining Projects in Gunnedah Basin

Mine/Exploration Area	Owner	Estimated Reserves (Mt)	Estimated Coal (Mt / pa) 2009/10	Estimated Coal Production at Full Operation (Mt / pa)
Operational				
Boggabri	Boggabri Coal (Idemitsu)	567.1	1.5	1.5
Narrabri North – Stage 1	Narrabri Coal (Whitehaven)	102.7	0.0	0.7
Rocglen	Whitehaven	10.8	1.5	1.5
Sunnyside	Namoi Coal (Whitehaven)	N/a	1.0	1.0
Tallawonga	Whitehaven-Idemitsu JV	12.3	1.5	1.5
Werris Creek	Whitehaven-Creek Resources	9.8	1.5	1.5
Proposal – Mine Planning Stage				
Boggabri Expansion	Boggabri Coal (Idemitsu)	567.1	N/a	5.0
Maules Creek	Aston Resources	680.0*	N/a	10.8
Narrabri North – Stage 2	Narrabri Coal (Whitehaven)	102.7a	N/a	5.3
Exploration				
Caroona	BHP Billiton	500+	N/a	20-30

Source: Jenny Rand & Associates (2007), AECgroup

Agriculture

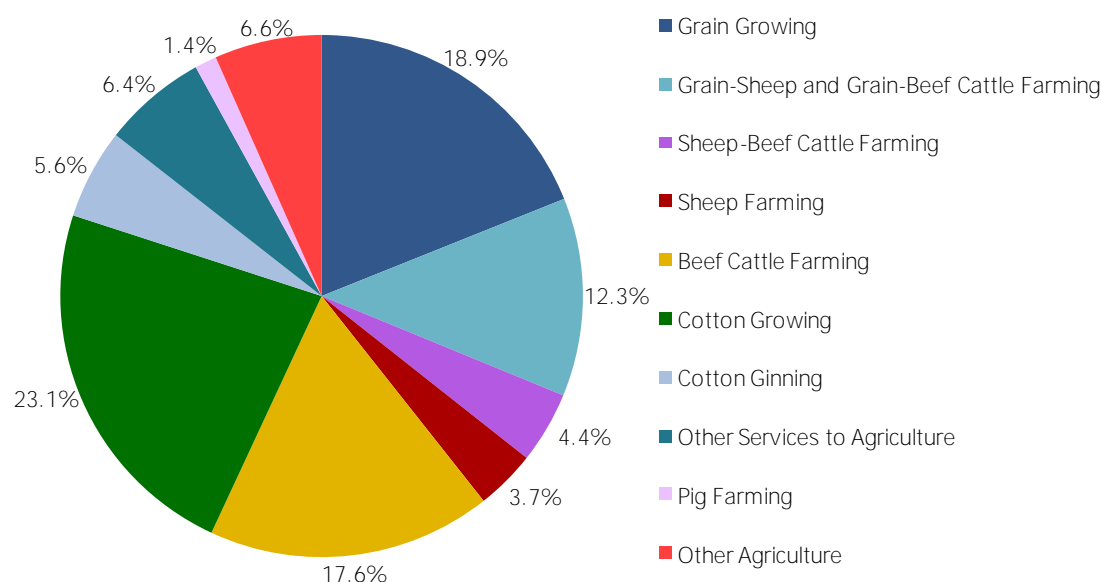
The Narrabri Shire is one of **NSW's major 'food bowls'** due to its rich soil and abundant water resource endowments. Narrabri Shire produces a variety of crops with two largest crops including cotton and wheat with annual production of 916,000t and 256,000t in 2005-06 respectively. Other significant crops include a range of grains, oilseeds, legumes, olives, grapes and peanuts. Livestock grazing is also a large sector including sheep, cattle and pigs. The annual value of agricultural production is estimated to be about \$330 million per year, with more than \$200 million from cotton and about \$60 million from wheat.

There are also several major companies and research institutions located in the Narrabri Shire, supporting the agricultural sector including storage, processing, transporting and wholesaling operations. These include Cotton Research and Development Corporation,

I.A.Watson Grain Institute (operated by Sydney University), Australian Cotton Research Institute and Cotton Catchment Communities Cooperative Research Centre.

The agricultural employment breakdown in the Narrabri Shire is in line with production. Cotton growing and ginning accounts for almost 30% of employment in the agricultural sector, followed by grain growing (18.9%), beef cattle farming (17.6%) and people working on a mix of grain, sheep and cattle farming.

Figure 3.7: Agricultural Employment, Narrabri Shire, 2009-10



Note: By place of work.

Source: ABS (2007), ABS (2010b), AECgroup

Agriculture and mining are key sectors for Narrabri Shire, providing significant value to the economy as well being major employers. These sectors will continue to play a key role in the economy in the future though the reliance on these sectors underscores the importance of future diversification.

3.4 Environmental Context

3.4.1 Climate Change

The NSW Climate Impact Profile assesses the biophysical changes projected for the state as a result of climate change over the next 40 years. A profile of the New England/North West Region found that the climate is almost certain to be hotter in all seasons, with the greatest warming in spring. Average daily maximum and minimum temperatures are very likely to increase by between 1 and 3°C. Rainfall is likely to increase in spring, summer and autumn, but decrease moderately in winter.

Table 3.3: Summary of Temperature and Rainfall Changes in North West Region to 2050

Season	Minimum temperature	Maximum temperatures	Precipitation	Evaporation
Spring	1.5-2.0°C warmer	2.0-3.0°C warmer	10-20% increase	20-50% increase
Summer	1.0-1.5°C warmer	1.5-2.0°C warmer	10-20% increase	10-20% increase
Autumn	1.0-1.5°C warmer	2.0-3.0°C warmer	5-10% increase	10-20% increase
Winter	1.0-1.5°C warmer	2.0-3.0°C warmer	10-20% decrease	10-20% increase

Source: NSW DECC (2009)

The current average daily maximum temperature in the Narrabri Shire in summer is 33.6°C, with average rainfall of 227 mm. During winter however, the Shire experiences

relatively lower rainfall averaging 134 mm. The climate change projections for the Shire over the next 40 years indicate:

- Average daily maximum temperature will increase to between 35.1°C and 35.6°C in summer;
- Average rainfall over summer will increase to between 250 mm and 273 mm; and
- Current average rainfall over winter will decrease to between 107 mm and 121 mm.

3.4.1.1 Impacts

Climate change is a major issue facing the world economy and likely to have a significant influence on the future of the Narrabri Shire. Key climate change issues include rising temperatures, growing need for green house gas emission reduction, and possible decline in water entitlements.

Aforementioned issues could have a range of impacts on the Narrabri Shire economy including:

- **Agricultural production:** Agricultural production is heavily reliant on climate and water availability and any reductions in the availability of water will negatively impact productivity and output.
- **Mining:** The high greenhouse emissions associated with coal mining could result in the implementation of carbon tax schemes to limit emissions. The implementation of a scheme to tax carbon emissions could have a significant impact on the viability of coal mines in the Narrabri Shire and result in mine closures and job losses in the region.
- **Electricity costs:** Electricity prices in NSW have increased over time with the NSW Independent Pricing and Regulatory Tribunal (IPART) announcing in July 2010 that electricity prices will rise by a cumulative total of up to 64% by 2013. The introduction of an emissions trading scheme will potentially further increase electricity costs as coal fired power is the major source of electricity in NSW.
- **Water availability:** Climate change is likely to have an impact on water availability in inland NSW with the Murray Darling Basin Plan currently being prepared. The Plan will outline strategies to guide the management of water resources in the Murray-Darling Basin and set environmentally sustainable limits on the amount of surface water and groundwater that can be taken from the Basin. As previously discussed, a reduction in the availability of water will have adverse impacts on agricultural production and energy generation, which are both major water users.
- **Lifestyle changes:** Everyday living will change over time as a result of climate change and investment in environmentally sustainable technologies. Building standards are changing with a greater focus on 'green buildings' which are more water and energy efficient and constructed out of more environmentally sustainable materials. This includes the incorporation of water and energy saving technologies and products into home design. Water availability will also have impacts on household water usage with the potential enactment of water restrictions.

3.5 Projected Growth

The resource sector is projected to be the primary driver of the Narrabri Shire economy over the next five years with an additional mine and two mine expansions planned for the Narrabri Shire comprising:

- **Boggabri Mine Expansion:** An expansion of Idemitsu's Boggabri mine which would triple coal output to more than four million tonnes by 2013 and is expected to generate another 150 jobs.
- **Maules Creek Project:** Development of a large coal mine at Maules Creek by Aston Resources, which Aston expects to start producing in 2012, ramping up to full production of 10.8 million tonnes a year in 2014. The project is estimated to have a peak construction workforce of 400 and an operational workforce of between 450-500.

- **Narrabri North Mine – Stage 2:** Development of longwall mining at the mine with capital expenditure of approximately \$300 million. Full time employment at the mine is expected to total approximately 200 as the mine moves into full production of approximately 6 Mtpa.

Additional employment in the Narrabri Shire as a result of the operation of the new mines is expected to be approximately 750. It is expected that a significant proportion of workers will live temporarily in the Narrabri Shire (especially during the construction phase) with workers accommodated in The MAC Services village in Narrabri and the potential for a similar facility in Boggabri. The permanent residential population is also projected to increase with a proportion of workers expected to move to Narrabri Shire with their families and an increase in population due to more employment opportunities as a result of the mining growth. AECgroup population projections conservatively estimate that the population of the Narrabri Shire will increase by approximately 490 residents between 2011-2016.

The increase in the temporary and permanent population and the growth in disposable income from the highly paid mining workers will drive growth in the commercial centres of Narrabri and Boggabri in the retail and hospitality sectors. Increased demand and disposable income will facilitate the establishment of new retail operations, personal services, restaurants and cafes.

The construction and operation of the new mines is projected to result in the attraction of businesses involved in providing support services and supplies to the mining companies. These operations will include industrial operations such as machinery and equipment manufacturers and suppliers which will increase demand for industrial land in Narrabri and Boggabri. Other service providers such as engineers, consultants and technology providers will also be attracted increasing demand for commercial office space in the town centres.

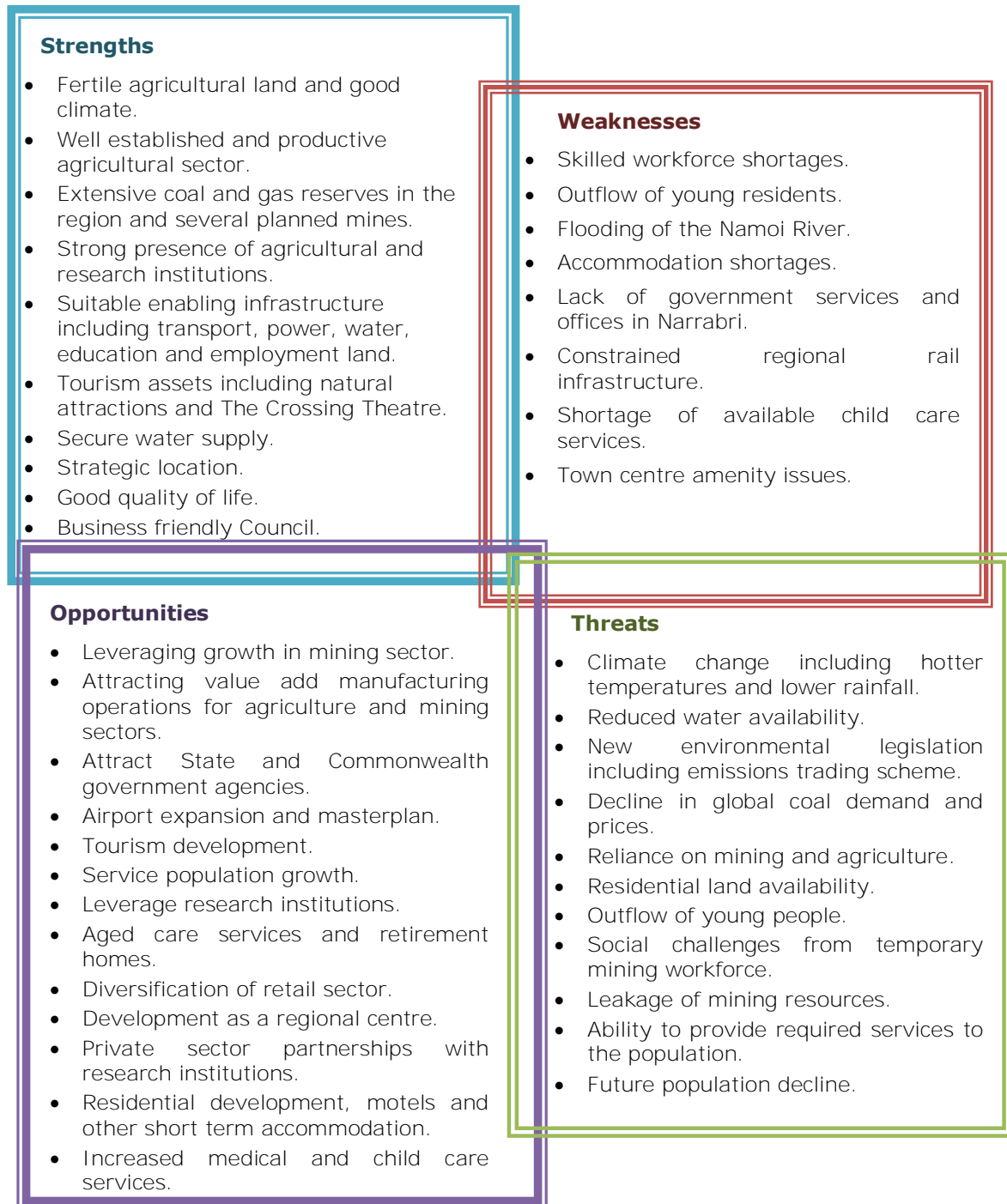
The Narrabri Shire economy is projected to record strong growth over the next five years on the back of the mining sector. The development of new mines and expansion of existing operations will create significant employment opportunities which will drive population growth as well as creating business and investment opportunities for support service providers and suppliers. Business growth will increase demand for industrial and commercial land with population growth driving demand for residential supply, which will increase demand for service provision in the Narrabri Shire.

4. SWOT Assessment

The SWOT (strengths, weaknesses, opportunities and threats) analysis is a tool that is **used to assess a region's competitiveness**. The analysis identifies 'internal' (strengths and weaknesses) and 'external' (opportunities and threats) factors for a local environment. The SWOT analysis is commonly used in strategic planning exercises and can identify how a region is presently placed and what opportunities and threats it may face in the future. The results of the SWOT analysis can be used for future decision-making.

The figure below summaries the key findings of the SWOT analysis.

Figure 4.1: Narrabri Shire SWOT Analysis



Source: AECgroup

4.1 Strengths

The Narrabri Shire boasts numerous strengths that support the existing economy and have the ability to act as catalysts for future growth including:

- **Fertile Agricultural Land and Climate:** The Shire forms part of the Lower Namoi Valley and is well endowed with fertile soil that underpins the strong agriculture sector. The local climate (including adequate rainfall, sunlight and warm temperatures) is also excellent for agriculture.
- **Agricultural Sector:** The region boasts a well established and resilient agricultural sector including production of cotton, wheat, barley, oilseeds, grapes and peanuts as well as livestock production comprising sheep, cattle and pigs. Irrigation farmers are some of the most innovative in the country and cotton production is widely accepted to be among the most water efficient in the world.
- **Mining Resources:** The Gunnedah Basin has extensive coal and gas deposits with several deposits located south of Narrabri. Strong global demand and high prices have resulted in the development and operation of several mines in the last five years.
- **Research Institutions:** The Shire also has a strong presence of several agriculture-based research institutes including, Cotton Research and Development Corporation, I.A Watson Grain Research Institute; Australian Cotton Research Institute, and Cotton Catchment Communities Cooperative Research Centre. The CSIRO's Australia Telescope Compact Array is also located in Narrabri Shire and involved in research in radio astronomy.
- **Land Availability:** The Shire has a significant supply of industrial land with two large estates located in Narrabri and an estate in Boggabri. The industrial estate in Narrabri west is zoned for general industrial (with land uses such as grain storage and logistics facilities), the industrial land towards the north is zoned for light industry (including manufacturing wholesale and bulky retail goods) with the Boggabri estate including light and general industry zoned land.
- **Enabling Infrastructure:** The Narrabri Shire boasts extensive infrastructure provision required to facilitate business and investment including:
 - **Transport Infrastructure:** Narrabri Shire is well serviced by major arterial roads (the Newell and Kamilaroi Highways), Aeropelican flights operating from Narrabri Airport, and Xplorer rail motors services operating offering both passenger and freight services to and from Narrabri Shire.
 - **Power Infrastructure:** The Wilga Park Power Station, located near Narrabri, provides electricity that is significantly lower greenhouse intensity than electricity generated from coal. The power station has a capacity of 12MW that could be increased to 40MW as coal seam gas production in the region is increased.
 - **Water Availability:** Compared to other areas in inland NSW, the Narrabri Shire has good access to water. The Shire is serviced by three independent water bores, resulting in surplus water capacity for water-intensive industries such as power generation and agriculture.
 - **Education Infrastructure:** The Shire is well served by numerous primary and secondary schools. Narrabri TAFE is an integral part of the community providing courses across a range of disciplines such as business, community services, engineering and visual arts. The campus also offers tailored traineeships and general education programs to support local industry and business demand by offering highly skilled workforce.
 - **Health Infrastructure:** The Narrabri Shire has adequate provision of health infrastructure including a number of public hospitals located in town centres of Narrabri, Wee Waa and Boggabri and providing for a range of medical services such as general and orthopaedic surgery, emergency department, hospice care unit, obstetrics and outpatient services. **The Shire's health infrastructure is being upgraded with major redevelopment of the Narrabri Public Hospital estimated to be completed in 2012.**

- **Commercial Centre:** Narrabri has a strong town centre anchored by major retailers and employers including Coles, Woolworths, Target Country and Narrabri Shire Council. Narrabri is an important commercial and administrative centre for the surrounding region.
- **Quality of Life:** The Narrabri Shire offers a good quality of life to residents with an uncomplicated lifestyle and access to sport, recreational and other services. Crime is low in the area and there are reasonably good employment opportunities.
- **Coal and Gas Resources:** The region is well endowed with extensive coal and natural gas deposits, the Shire is home to four major coal mines, attracting resource intensive businesses and investment to the Shire.
- **Location:** Strategically located at the intersection of the Newell and Kamilaroi Highways and is situated relatively equidistant from the major cities of Sydney and Brisbane.
- **Airport:** Narrabri Airport is serviced by Aeropelican that operates daily services to Sydney, Brisbane and Newcastle that improves access to and from the major cities.
- **Business Friendly Council:** The Narrabri Shire has attracted several new businesses in recent years and the supportive nature of Council, led by Council's economic development staff, was identified as a key factor that facilitated the investment.
- **Tourism Assets:** The Shire boasts several tourism attractions including Yarrie Lake, Mount Kaputar National Park, Australia Telescope, Dripping Rock, Waa Gorge and Sawn Rocks. Narrabri is one of the only towns in regional NSW with a major modern entertainment and conference venue. The Crossing Theatre is a modern facility including an auditorium, two cinemas and several smaller rooms and is suitable for functions, events, conferences and conventions.

The Narrabri Shire boasts numerous strengths and assets that have the potential to support economic development. The implementation of strategies to leverage these strengths will create opportunities to attract investment, create employment and diversify the economic base of the Shire.

4.2 Weaknesses

The Narrabri Shire is also negatively impacted by a variety of issues that have constrained economic growth in recent years.

- **Skilled Workforce Shortages:** Regional Australia often struggles with skill shortages and the ability to attract qualified workers. The Narrabri Shire has also experienced this issue in several industries and is linked with the outflow of young residents and the inability to attract them back once they have completed their education.
- **Workforce Seasonality:** Many agricultural producers only need workers during the harvest period which lasts less than a month. This causes labour issues as people are unwilling to only work for these short periods.
- **Outflow of Young Residents:** The Narrabri Shire records an outflow of younger people between the ages of 20-30 years. There are relatively fewer tertiary education opportunities in Narrabri in comparison to bigger towns/cities such as Tamworth, Armidale and Newcastle.
- **Population Decline:** Narrabri Shire has recorded a population decline over the last decade which halted in 2009 as a result of the mining growth. Population decline has significant detrimental economic impacts and the Shire needs to avoid the population going back into decline. Economic and employment growth as a result of the mining sector growth is likely to drive population in the short to medium term.
- **Flooding:** One of the key constraints for Narrabri's development is the flooding of Naomi River. Significant areas of land are flood prone which constrains their potential to be developed for employment generating uses such as industrial land.

- **Accommodation Availability:** The majority of tourism accommodation establishments in the Narrabri Shire are operating at close to full occupancy due to the strong demand from contractors working in the resource sector. The lack of available rooms is constraining the tourism sector with people driving through the Shire and staying in neighbouring towns.
- **Government Services:** Narrabri is relatively under-serviced in relation to State and Australian Government agencies with neighbouring towns such as Moree and Tamworth boasting relatively more offices.
- **Visual Amenity:** Narrabri's commercial town centre, located along Maitland Street, does not offer adequate visual appeal to its local residents and visitors. The amenity of the Narrabri town centre could be improved to make it more attractive. There is currently limited signage indicating the presence of the Boggabri and Wee Waa town centres when entering the towns along the highways.
- **Rail Infrastructure:** The expansion of mining operations in the region is placing pressure on rail infrastructure and resulting in more freight (particularly agriculture) been forced onto the road.
- **Child Care:** Shortage of child care availability throughout the Narrabri Shire, particularly in the 0-2 year age group. Child care service providers are also experiencing difficulties in attracting skilled staff due to the relatively more attractive work opportunities in primary education.

The weaknesses outlined above are constraining economic development and by improving and eliminating these issues, Narrabri Shire will create opportunities for future growth and investment.

4.3 Opportunities

By leveraging the strengths of the Shire and addressing the weaknesses, Narrabri Shire has numerous opportunities to facilitate economic growth. The following section provides an overview of economic opportunities with a more in depth analysis of growth opportunities provided in the following chapter.

- **Leveraging the Mining Sector:** The growth in the mining sector offers the opportunity to attract businesses and service providers. The development of the MAC Services mining village is an example of investment flowing through from the mining growth. Opportunities identified for the Narrabri Shire include the development of residential, motel and other accommodation, attraction of companies servicing the mine operations, workforce training and education and attracting footloose industries that need access to both rail transport and natural gas.
- **Value Add Manufacturing:** The region's strong agriculture and mining sectors create opportunities for value adding manufacturing operations. Agricultural processing operations such as flour mills and ethanol production have potential. Manufacturers producing mining equipment could also leverage off the strong mining sector.
- **Attract State and Commonwealth Government Agencies:** The strong economic growth in the Shire over the last few years could provide a strong argument to attract State and Commonwealth Government agencies to establish offices in Narrabri. Attracting government services will provide good employment opportunities for residents and strengthen the town centre.
- **Airport Expansion:** The Narrabri airport is a key asset to the Shire and there is the potential to expand the airport to include a longer runway to attract larger aircraft and the provision of industrial land to create opportunities for transport, logistics and aviation businesses.
- **Tourism:** Greater promotion of the Shire's tourism assets and attractions could boost the number of visitors to the area with opportunities including attracting more conferences and events to the Crossing Theatre and the development of additional tourism accommodation.
- **Service Population Growth:** The Narrabri Shire recorded population growth during 2009, following several years of negative growth. The strong growth in the mining

sector is projected to drive population growth over the next five years. Maintaining positive population growth will create opportunities to service the growing population including increased demand for retail, personal services, construction and other services.

- **Leverage Research Assets:** Opportunity to leverage the numerous innovative research institutions that are located in the Narrabri Shire. Opportunities include building relationships with universities throughout the country to attract a larger student population and facilitating partnerships with industry.
- **Aged Care and Retirement Homes:** The ageing population within Australia is creating opportunities for the provision of accommodation and services for retirees and older residents. Narrabri offers a good quality of life with a relatively low cost of living making it attractive to retirees.
- **Diversification of Retail Sector:** Opportunity for the retail sector in the Narrabri Shire to expand and diversify with an increase in retail spending in the area. Diversification would include a broader range of retailers in the clothing, recreation and hospitality areas.
- **Development as a Regional Centre:** The growth in the mining sector and population could lead to Narrabri developing as a regional centre including the location of more State and Australian Government agencies as well as the increase in commercial, recreational and administrative service provision.
- **Research Institutions:** Strong presence of research institutes within the Shire creates opportunities to build university ties to retain and attract students and facilitate industry partnerships. This could include private sector investment to commercialise new technology or products.
- **Logistics:** Opportunities to attract more transport and logistics companies to the region to leverage resource sectors and take advantage of the Shire's strategic location. Include more agricultural storage companies to increase competition in the market.
- **Property Development:** Considerable property development opportunities, including residential, industrial and tourism, exist within the Narrabri Shire.
- **Education Services:** A strong agriculture research sector, coupled with limited tertiary education facilities creates potential opportunities to expand services such as the development of an agricultural college, additional TAFE courses and attraction of a university campus.
- **Medical Services:** Leveraging the redevelopment of the Narrabri Hospital and attracting medical professionals to the Shire including GPs, specialists and nurses.
- **Gas:** Leveraging the existing coal seam gas operations by utilising the gas locally for energy generation and potentially reducing electricity costs.
- **Hospitality:** Attraction of more restaurants to Narrabri Shire to increase the variety of dining options.

The opportunities listed above represent the key prospects for economic development in the Narrabri Shire and should represent the focus of strategies to grow and diversify the local economy.

4.4 Threats

There are a range of local and external issues that have the potential to adversely impact the future economic development of the Narrabri Shire.

- **Climate Change:** It is generally accepted that the climate is going to get hotter in Australia over the next 50 years. While rainfall is not projected to decline in the Narrabri Shire, should rainfall in the Narrabri Shire decline over time, the overall productivity and output of the agricultural sector could decline.
- **Environmental Legislation:** There has been a push by the Australian Government to introduce new legislation to limit greenhouse gas emissions in the economy. Should new legislation be enacted, it could negatively impact the viability of the coal mining sector.

- **Water Availability:** The Narrabri Shire is located on the Namoi River, part of the Murray Darling Basin, with planning underway to manage the future sustainability of water resources. There is potential for water entitlements in the area to be reduced if rainfall declines, which would have adverse impacts on water intensive activities such as agriculture production and power generation.
- **Global Coal Demand:** The mining industry has historically been relatively volatile and is heavily reliant on global demand and commodity prices. The strong growth in the price of coal has improved the viability of several mines and resulted in their construction and/or expansion. A downturn in world demand and commodity prices could possibly result in the closure or downsizing of mines.
- **Reliance on Mining and Agriculture:** The Narrabri Shire economy is heavily reliant on the mining and agriculture sectors with any future downturns in these industries likely to have major impacts on the local economy. Diversification of the economic base is needed to reduce the risks associated with the reliance on these industries.
- **Residential Land Availability:** There is a shortage of residential land within in the Shire that is going to be amplified by the expansion of mining operations in the area. Rental and house prices are likely to continue to increase placing pressure on housing affordability.
- **Infrastructure Provision:** The expansion of the mining sector is likely to place significant pressure on the provision of rail, road, utility and social infrastructure within the Shire. The Shire has three major towns which places pressure on infrastructure provision as most LGAs have majority of population in one centre.
- **Rail Infrastructure:** Transport is an important component of the primary sectors including agriculture and mining. The increase in coal production is resulting in increased competition for rail access to transport produce and resources to market and the Port of Newcastle for export. The significant value of mineral resources is likely to see agriculture lose access unless additional rail infrastructure is developed in the region.
- **Youth Drain:** The Shire records an outflow of younger population between the ages of 20-30 years who leave the Shire in search of better education and employment opportunities, resulting in youth drain and subsequent loss of potential skilled workers.
- **Social Challenges:** The growth in the mining sector could cause social issues with a large number of workers moving to the area on the back of the mining boom earning relatively high incomes. The inflow of workers could increase the demand for housing, child care and other services which could create affordability issues.
- **Leakage of Mining Resources:** Gunnedah is considered among some people to be a more attractive business investment destination for mining related businesses in comparison to Narrabri primarily due to proximity to port and being geographically positioned in the middle of the Gunnedah Basin, having Narrabri to its north and Liverpool Plains to its south. This perception may restrict economic growth and investment in Narrabri and is a challenge that needs to be overcome.
- **Population Decline:** A declining population represents a threat to the future development of the Narrabri Shire economy. A decreasing population can prove to be detrimental to the prosperity of the economy and the local community with employment and spending being removed from the economy, causing on-going economic decline in numerous sectors.
- **Services:** The availability of services such as child care, health and education has an impact on the ability to attract families to live in the Narrabri Shire. Creating more child care spaces is a big challenge though very important in helping to facilitate the attraction of families to the area. Attracting general practitioners and other medical specialists to the region also continues to be a challenge for Narrabri Shire.

The economic development strategy needs to manage and address these threats in order to minimise the potential negative impacts on the future growth and sustainability of the Narrabri Shire economy.

5. Specific Growth Opportunities

The specific growth opportunities identified for the Narrabri Shire have been based on the detailed research and analysis of the social, economic, business and industry drivers (as detailed in the Background Research Report) and confirmed through consultation with local businesses and project stakeholders. The specific opportunities to facilitate economic growth include:

- Target industry sectors for economic growth;
- Opportunities to attract and retain labour in the Narrabri Shire;
- Addressing climate change opportunities; and
- Required infrastructure to facilitate growth.

5.1 Target Industry Sectors

The following industry sectors have been identified to drive economic growth and development in the Narrabri Shire over the next 5 years and represent industry opportunities that contribute high value-adding, knowledge-driven jobs to the region. Additionally, growth in these sectors will stimulate other parts of the economy and encourage further job growth. For example, if the opportunities in mining services can be realised, then these companies will require greater services (from the local region) and employ more people. The additional services will mean more activity for other local businesses and the greater number of jobs means that there is more disposable income to be spent at cafes, restaurants, retail outlets and other services in the local economy.

AECgroup provides these opportunities in order to give detailed and clear direction to the economic development efforts in the region and to guide investment attraction activities. At the same time, economic growth can come from other areas and these options should not be excluded. In fact, market conditions can change quickly and Narrabri Shire Council should reconsider these opportunities on an on-going basis.

By focusing efforts on these opportunities that can drive economic growth in the region, the Narrabri Shire will receive the greatest amount of benefit from economic development.

The opportunities for growth in the table below demonstrate opportunities which generate valuable, full-time employment for local residents and diversify the economic base of the local economy.

Additional opportunities resulting from climate change are outlined in Section 5.1.3.

Table 5.1: Specific Industry Opportunities for Narrabri Shire

Growth Sector	High Value-Adding Activity	Why Narrabri Shire?
Mining Services	<ul style="list-style-type: none"> • Equipment providers (clothing, safety equipment) • Vehicle hire (cars, trucks for mining personnel) • Contractors (engineers, consultants, mechanics) 	<ul style="list-style-type: none"> • Projected growth in demand with the construction and operation of major mining projects • Proximity to mining projects improving ability to service mines in comparison to other regional centres • Available industrial land in Narrabri and Boggabri
Machinery and Equipment (M&E) Manufacturing	<ul style="list-style-type: none"> • Industrial M&E manufacturing (food processing equipment, specialty pumps / compressors / components, other high-tech industrial equipment) • Mining equipment (pumps, drilling, valves, excavators, components) • Agriculture machinery and equipment manufacturing (tractors, harvesters) 	<ul style="list-style-type: none"> • Available industrial land in Narrabri and Boggabri <ul style="list-style-type: none"> o Large lot sizes o Able to accommodate heavy industrial operations o Land more cost effective than in other major markets • Significant agricultural sector in the Shire open to the use of innovative technology and machinery • Projected growth in demand with the construction and operation of major mining projects
Agricultural Processing and Food Manufacturing	<ul style="list-style-type: none"> • Wheat product manufacturing (cereals, pasta manufacturing) • Cotton seed processing (oil production) • Baked goods (breads, biscuits, etc.) • Processed foods (packaged foods, frozen foods, ingredients, snack foods, etc.) 	<ul style="list-style-type: none"> • Proximity to the significant agricultural production in the wider region which reduces transport costs • Strategic location with access to key capital city markets
Professional Services	<ul style="list-style-type: none"> • Professional services (accounting, banking, legal, property) 	<ul style="list-style-type: none"> • Demand driven by population growth projected in the Narrabri Shire • Opportunities to leverage strong business growth projected for the area
Transport and Logistics	<ul style="list-style-type: none"> • Storage (grain and cotton storage) • Logistics operations (warehousing and distribution operations servicing a variety of clients and customers for both import and export) 	<ul style="list-style-type: none"> • Proximity to the significant agricultural production in the wider region • Direct access to rail and road networks for receiving inputs and distribution of products • Strategic location with access to key capital city markets
Hospitality and Tourism	<ul style="list-style-type: none"> • Accommodation (motels and short term accommodation) • Hospitality (restaurants, cafes and takeaway shops) 	<ul style="list-style-type: none"> • Significant demand for short term accommodation as a result of mining workforce and contractors • Weekday occupancy rates of nearly 100% in Narrabri • Demand growth as a result of population growth projected in the Narrabri Shire • Increased wealth in the community from inflow of well paid mining employees and strong projected agricultural production

Source: AECgroup

5.2 Labour Attraction and Retention

The Narrabri Shire records an outflow of younger population between the ages of 20-30 years who leave the Shire in search of better education and employment opportunities, resulting in youth drain and subsequent loss of potential skilled workers. Access to a skilled workforce is an important consideration for prospective companies looking to establish an operation in an area. Specific opportunities to attract and retain labour include:

- **Work with TAFE:** Narrabri Shire Council should continue to work closely with the New England Institute to TAFE to develop training programs that provide opportunities for local residents to study and transition into local job opportunities. Council should continue to liaise with major businesses and mining companies to identify future labour requirements and discuss opportunities and options with TAFE to provide these courses in Narrabri and other local campuses.
- **Make it Work:** Narrabri Shire Council is pioneering a new employment concept that should help to develop and retain labour in the Shire and help alleviate problems with the seasonality of employment opportunities in the agricultural sector. Council is looking to stage a 12 month full traineeship program for up to 10 people. Council will employ the trainees and will have the trainees in a number of different workplaces around the Shire on seasonal work. When certain work is no longer in season, the trainees will work for Council, study or take annual leave meaning they will not have to leave the area when there is a gap in seasonal work.
- **Quality of Life:** The strong growth in the mining and agricultural sectors is likely to create numerous job opportunities for skilled workers in these sectors and people able to provide support services. These opportunities will provide the necessary catalyst for attracting labour to the area though the Narrabri Shire also needs to be seen as a desirable place to live and raise a family. If people are not attracted to Narrabri Shire as a place to live, the likelihood is they will pursue employment opportunities elsewhere. Key issues affecting the desirability of the Narrabri Shire as a place to live include access to quality and affordable housing, recreational and cultural facilities, retail and commercial services, health, child care and education services. By ensuring the availability of quality services and facilities in these areas, Narrabri Shire will increase its ability to attract new labour and residents.

5.3 Climate Change

While climate change is likely to have some negative impacts on the economy, it is also likely to result in significant opportunities for economic growth and investment globally. There is a greater emphasis on conserving energy, water, recycling and reducing greenhouse gas emissions which is facilitating investment in new technologies and services. In many cases, governments are offering rebates and grants to promote investment in environmentally focused sectors. Potential opportunities for business growth and investment in Narrabri Shire specifically related to climate change are outlined below. Other economic opportunities identified based on preliminary analysis of the economy are discussed in the following chapter.

- **Coal Seam Gas:** Approximately 90% of NSW's electricity is sourced from coal though there is a push to move away from this form of electricity generation. Gas-fired power stations emit up to 70% less greenhouse gas emissions than existing coal-burning plants and could be the future of electricity generation in NSW. The Narrabri Shire sits on significant coal seam gas reserves and increased demand for gas in Australia could have significant positive economic impacts for Narrabri Shire.
- **Renewable Energy:** Commonwealth legislation is in place to ensure that 20% of Australia's electricity comes from renewable sources by 2020, with the NSW Government supporting this target. Australia is a sunny place, with over 90% of the continent absorbing solar radiation of over 1,950 kilowatt hours per square meter per year. As part of the NSW Government's renewable energy agenda, six renewable energy precincts have been identified including the New England Tablelands region (comprising Narrabri Shire and 12 other LGAs in the Northern Inland region). The precincts are a community partnership initiative in areas where significant future

renewable energy development is expected. Narrabri Shire has potential to explore opportunities in solar power generation and wind.

- **Water Efficiency:** Water efficiency will be important should rainfall decline in the future. There will be opportunities for the development and installation of irrigation systems for the agricultural sector and water efficiency fittings for buildings.
- **Environmental services:** Opportunity for service providers to improve the environmental sustainability of businesses and homes including undertaking of energy audits, installation of water saving devices and installation of solar power.
- **Biofuels:** There is an ongoing trend towards producing energy sources that have a lower environmental impact. Biofuels including ethanol and biodiesel are becoming more efficient and financially viable. Grain production has positive links to biofuel development and the Narrabri Shire could leverage its strong agricultural sector to attract investment in this area.
- **Recycling and Waste Management:** Opportunities for environmental and waste management services to improve recycling.
- **Construction:** There has been a trend in Australia for buildings to be 'greener' with improved water and energy efficiency. There will also be opportunities for retro-fitting existing buildings with more efficient materials and technology.

5.4 Infrastructure

Having access to adequate infrastructure is crucial in facilitating investment by existing businesses and attracting new companies to establish operations in the Narrabri Shire. The following infrastructure is required in the region to facilitate growth and should be the focus of lobbying by Council to the State and Commonwealth Governments and by the economic development unit within Council.

- **Rail:** The expansion of mining operations in the region is placing significant pressure on rail infrastructure between the Gunnedah Basin and Newcastle with very limited capacity. The increase in coal production is forcing other freight (particularly agriculture) onto the road at a significantly higher cost that is impacting the viability of local businesses. The Australian Rail Track Corporation has announced its preferred option of duplicating the track across the Liverpool Range near Murrurundi which would increase coal movements from the Gunnedah Basin to the Port of Newcastle to 50 million tonnes by 2020.
- **Airport:** The Narrabri Airport is a key asset to Narrabri Shire as it allows for relatively quick and easy access from Brisbane, Sydney and Newcastle and makes operating a business in the Shire considerably easier. Narrabri Shire Council is currently preparing a masterplan for the Narrabri Airport which will outline the required upgrades to aviation infrastructure. These upgrades will be required to facilitate the growth in airline services to the Narrabri Shire.
- **Residential Land:** The construction and operation of several large mines will put significant pressure on the ability of the Shire to accommodate the increased residential population. In order to attract these people to live in Narrabri (rather than in temporary accommodation) Council needs to facilitate the release of attractive residential land for development. This land will need to be serviced by the necessary utilities such as electricity, water, gas and sewerage.
- **Social Infrastructure and Services:** The strong growth in the mining and agricultural sectors is likely to create numerous job opportunities for skilled workers associated with these sectors and will drive population growth. In order to adequately service the needs of the growing population, additional services will be required across the child care and health services sectors.

6. Vision

To facilitate the growth and development of a vibrant, sustainable and diversified economy that value adds to the region's resources and provides a quality living environment and prosperous future for all residents and communities.

The vision for the Narrabri Shire Economic Development Strategy was developed through consultation with Narrabri Shire Council, Council staff and key stakeholders as well as with consideration of existing strategies and plans.

The Narrabri Shire economy will record strong growth and leverage the significant investment in the region with the attraction of business investment that creates valuable employment opportunities for local residents and attracts new residents to the Narrabri Shire.

Economic growth within the Narrabri Shire economy will be economically, environmentally and socially sustainable and take into consideration the changing environmental and climate issues facing the region such as water availability, temperature and greenhouse gases.

The Narrabri Shire will continue to boast an economy underpinned by the major industries and dual economic drivers of agriculture and mining, though will continue to diversify the economic base through promoting the growth of sectors that value add to the significant primary production and resources. The economy will also react to the changing economic environment and foster growth in emerging industries such as renewable energy and technology.

The strong economy will be the catalyst for maintaining a high quality of life for local residents including the provision of an adequate level of facilities and services. All communities within the Narrabri Shire will have a thriving local economy, with job opportunities and vibrant community spirit.

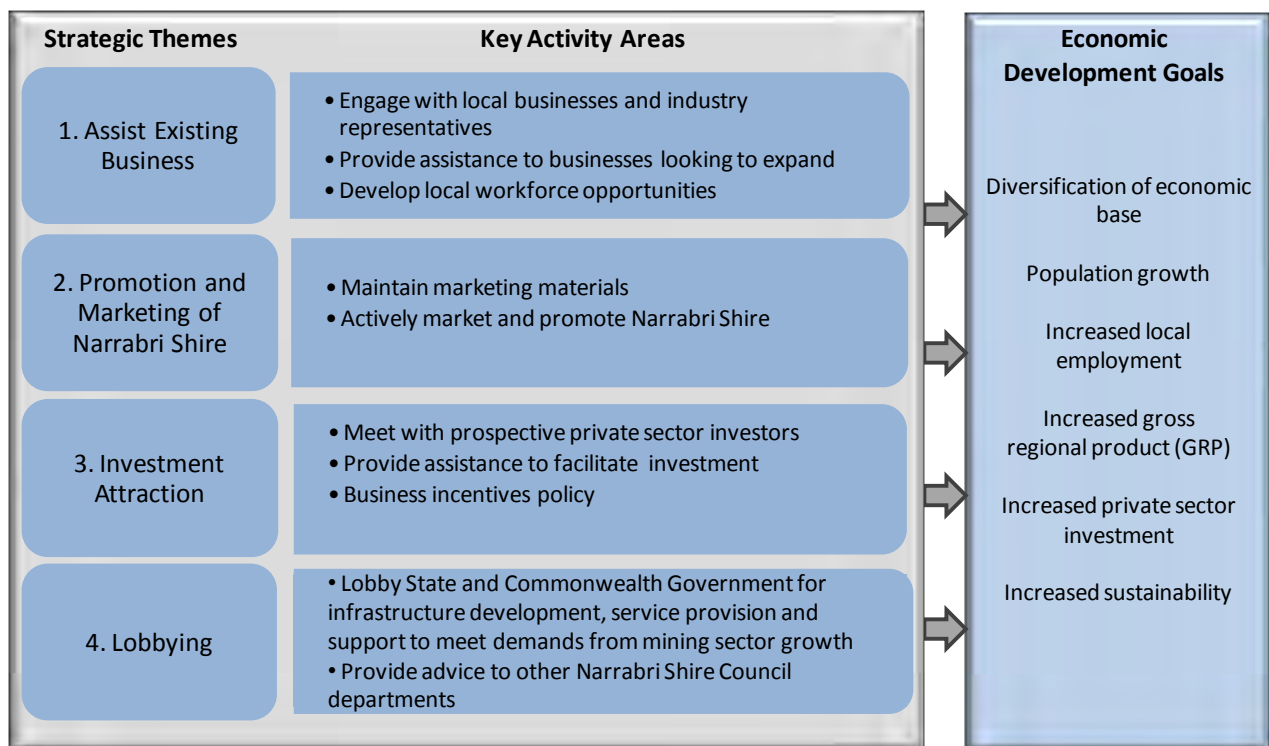
7. Economic Development Strategy

7.1 Strategy Overview

The Narrabri Shire Economic Development Strategy provides specific and strategic direction for economic development activities to achieve the vision for the local economy. The Strategy was developed after careful review and analysis of economic and business data (contained in the Background Report) and consultation with Narrabri Shire Council, Council staff and key stakeholders.

The Economic Development Strategy is highlighted below in Figure 7.1 below.

Figure 7.1: Narrabri Shire Council – Economic Development Strategy Overview



Source: AECgroup

7.2 Strategic Theme 1: Assisting Local Business

Objective: To assist local businesses expand operations and flourish.

Rationale: Existing businesses tend to be responsible for 60%-80% of private sector investment and job growth in most advanced economies. As such, supporting local businesses to expand their operations will create local job opportunities, increase local production as well as helping to raise the level of innovation in the region.

Key Activities:

In order to assist existing businesses, key activities areas will include:

- Executing an Existing Business Expansion and Retention Program, which will focus on:
 - Engaging with existing businesses and industry representatives; and
 - Providing assistance to local businesses including organising events and seminars for the business community.
- Developing local workforce opportunities.

Companies will always be directly responsible for the growth of their business though it is important that Council is engaged with local businesses and positioned to provide services and assistance when needed that will support the business and have positive outcomes for the local economy.

The first step is to provide for regular engagement with local businesses, which should occur through individual meetings with the management of the larger businesses in the community and through networking events and seminars to engage with small businesses. Individual meetings with local business organisations should also take place to build relationships with the business community throughout the Shire. During this engagement process, strong relationships with local businesses can be formed and numerous benefits can be realised, including:

- Better understanding of specific industries and their trends;
- Specific understanding of challenges and issues faced by individual businesses;
- Identification of areas where Council can proactively assist businesses;
- On-going feedback as to the economic well being of the business specifically and the community collectively; and
- Identification of future business opportunities and connecting local businesses.

Currently, there are a range of various valuable business assistance programs offered by the State and Commonwealth Government. These programs are extensive and have been proven to assist local companies to grow. Council is well placed to stay abreast of the available programs, through maintaining strong relationships with various State and Commonwealth partners, and to help facilitate the delivery of these programs to local businesses. These programs could form part of the on-going discussions with existing businesses through the engagement process and links to the relevant agency and contact person can be facilitated.

At the same time, Narrabri Shire Council can work with partners to deliver business seminars and information programs. These programs can provide valuable and helpful information to businesses, including export assistance, process improvement, systems efficiency and other facets of business management. During consultation, the need to promote succession planning in the agriculture sector was also highlighted as an important issue with an increase in the number of younger people unwilling to take over the operation of multiple generation farms.

Local businesses have expressed difficulties in attracting suitable staff and Council can assist the local business community by developing the local workforce. Workforce development includes supporting the training of existing residents, retaining these residents and attracting additional skilled workers to the Shire. Opportunities that should be addressed by Council include:

- Continuing to work closely with the New England Institute to TAFE to develop training programs that provide opportunities for local residents to study and transition into local job opportunities. Council should continue to liaise with schools and major businesses (such as mining companies and manufacturers) to identify future labour requirements and discuss opportunities and options with TAFE to provide these courses in Narrabri and other local campuses.
- Council should continue to pioneer the Make It Work program to provide a traineeship program for local residents and employment in seasonal work. Should the project be successful, opportunities for the expansion should be considered.
- The major mining companies are keen to have their employees live locally. Suitably skilled workers cannot always be sourced locally and have to be attracted from outside the region. Council staff are working with local mining companies to show potential staff around the area to provide them with an insight into the community to help them decide if they want to live in the area. Council should continue with these activities and review results to see whether they have been successful.

Through the successful implementation of the Existing Business Expansion and Retention Program, businesses may look to invest in larger and more modern facilities which is discussed in Strategic Theme 3.

7.3 Strategic Theme 2: Promotion and Marketing of Narrabri Shire

Objective: To promote the Narrabri Shire as a desirable business and investment destination.

Rationale: It is important to promote the Narrabri Shire as a business investment destination in order to attract investment. Promoting the region by highlighting the strengths, assets and potential opportunities for growth can create interest from potential investors.

Key Activities:

In order to promote and market the Narrabri Shire, key activities will include:

- Branding the Narrabri Shire;
- Development and maintenance of marketing material; and
- Proactively promote and market the Narrabri Shire.

In order to encourage future business investment, it is critical for Council to brand and market the region as a business destination. Consultation with local businesses confirmed that promoting the area is a major role for Council.

It is important to brand and position the Narrabri Shire so that it highlights the key competitive advantages it possesses in comparison to other areas in regional NSW. The strengths and competitive advantages of the Narrabri Shire are outlined in Section 4.1 with the major economic strengths comprising the agriculture sector and availability of mining resources.

In order to market the region, various promotional materials are required, including a regional business location profile, industry specific materials and other information that highlights the opportunities in the region for investment. These materials should be professionally presented and provide succinct information to encourage further investigation of the region by companies. This material should contain the latest business information and data and be updated regularly, which will support their usefulness to businesses.

Narrabri Shire needs to undertake promotional activities to raise the profile of the area for investment and growth. The development of an economic development website would provide a platform to host the marketing materials and promote the local economy. Press releases and newsletters should be developed and send to a database of business contacts and stakeholders to highlight recent success of local businesses, new investment in the region and investment opportunities.

More targeted promotion and marketing should also be undertaken with a focus on prospective investors. Targeted promotion involves attending events that potential business investors may also attend and promote the Narrabri Shire as a business destination. Potential events include National Manufacturing Week, Australia–New Zealand Climate Change & Business Conference, AustralAsian Cleantech Forum, Australia's National Water Conference and Exhibition (OzWater) and Asia Pacific International Mining Exhibition. Once interest is received from prospective investors, investment attraction activities should be undertaken as discussed in the next section.

7.4 Strategic Theme 3: Investment Attraction

Objective: To proactively recruit new businesses, local business expansion, investment and jobs to the Narrabri Shire.

Rationale: Businesses (both existing and new) are an important source of investment in communities. Attracting new business to the area generates employment, increases GRP and increases the diversity of the local economy, contributing new skills and potentially increasing innovation in the region. The attraction of new investment to the region will also allow for the diversification of the economy away from the reliance on mining and agriculture. Expansion of existing businesses is also an important generator of employment and GRP growth.

Key Activities:

In order to attract investment to the Narrabri Shire, key activities will include:

- Development and execution of a proactive business development program;
- Network with business and partners to identify investors;
- Engage with prospective investors;
- Consider investment incentives; and
- Facilitating private sector investments.

As discussed in Strategic Theme 2, the promotion and marketing of the Narrabri Shire as a leading business destination is critical to encourage future business investment. Promotion and marketing builds awareness and interest in the Narrabri Shire and can create opportunities for more targeted investment attraction.

The development and execution of a proactive business development program will entail market research into industries and companies (prospective investors), engaging regularly with companies (prospective investors) and other business services providers (i.e. bankers, real estate professionals, consultants, Industry Capability Network and Industry and Investment NSW representatives in Tamworth and Sydney), who are regularly in contact with businesses regarding geographic relocation and expansion.

The Business Expansion and Retention Program can also be used as a business development tool and larger businesses in the region should be asked about potential suppliers or customers that would provide value to the local business by locating to the region. Consultation with major mining companies already located within the Narrabri Shire and in the process of developing new mines highlighted a number of potential suppliers and service providers that are needed in the region to meet their requirements.

There are a range of partners important for the investment attraction process, including Industry and Investment NSW, the State Government investment attraction branch, and Austrade, the Commonwealth agency responsible for investment attraction. Additionally, many of the business service providers can support broader marketing and business development activities.

Companies decide where they expand and/or relocate to and often they have great variety and choice of location. It is extremely important to proactively recruit investment through a business development program in order to drive economic growth. With a large number of prospective locations, proactively engaging with businesses helps the region stand out as a growth area. At the same time, the business development program provides support and assistance to existing businesses looking to expand which creates employment opportunities.

Business development activities should identify prospective investors. After these investors are identified, a process to facilitate and recruit these investments must occur. This process involves providing detailed information regarding the region, which often includes specific available properties/estates within the region, business case information, statistics and business costs information.

Having the support of a progressive Council and the likelihood of a quick and efficient approval and planning process is often a key factor **in a company's investment decision**. Project delays can prove very costly to businesses as they lose potential revenue so companies are generally very keen to locate in LGAs where they feel like they have the support of Council. Consultation with new businesses in the Narrabri Shire indicates that **Council is generally seen to be 'open for business'**. **In order to maintain this perception**, the economic development staff should continue to facilitate meetings with the Narrabri Shire Council planning department in order to ensure that the permitting and processing times of development applications are as efficient as possible.

As discussed in Strategic Theme 1, the successful implementation of the Existing Business Expansion and Retention Program can identify opportunities for local businesses to expand, which could provide the opportunity to attract further investment from existing businesses. Council should provide the same assistance to local businesses to facilitate this new investment.

It is important to highlight that the business development process often takes time to develop with initial discussions and the development of a project taking up to 12-24 months. Businesses need to undertake significant due diligence and planning before final investment signoff is given. Investment attraction is a long-term process that provides long-term benefits. Once the program begins in earnest, it could take 12-24 months before results begin to emerge on a regular basis.

7.5 Strategic Theme 4: Lobbying

Objective: To lobby for infrastructure and service provision on behalf of local businesses and the wider community.

Rationale: Building a stronger business environment will assist the economy to grow. Significant future growth is projected to occur in the Narrabri Shire as a result of the development of major resource projects which will place significant pressure on infrastructure and require significant investment to avoid problems. The Economic Development Unit can advocate on behalf of business to support major infrastructure improvements and other government policies both internal to Narrabri Shire Council and external (State and Commonwealth Government).

Key Activities:

In order to lobby for businesses and the wider community, key activities will include:

- Lobby for infrastructure and support from State and Commonwealth Governments; and
- Provide advice to other Narrabri Shire Council departments.

The State and Commonwealth Governments invest significantly in major infrastructure, which has an impact on the competitiveness of the Narrabri Shire. Narrabri Shire has virtually no input into the approval process for mining projects with the State Government undertaking the process. However, the impacts of these mining projects on the local area are significant with the major operations and influx of workers placing pressure on local service provision and transport infrastructure. Narrabri Shire Council should proactively engage with State and Commonwealth Government agencies regarding the future provision of key strategic infrastructure and service provision (such as rail infrastructure, road upgrades, education and health) to alleviate the impact of the mines.

At the same time, through the Business Expansion and Retention Program and the Business Development Program, the Economic Development Unit will be in constant dialogue with existing and prospective future businesses. This interaction with businesses builds an incredibly strong knowledge base, which can inform many Narrabri Shire Council decisions. In such a way, the Economic Development Unit can provide advice to Narrabri Shire Council regarding the needs and requirements of businesses, providing further support and enabling business to grow. This advice would be valuable in many planning discussions.

7.6 Economic Direction for Communities

The Narrabri Shire is made up of unique communities that all face a different set of challenges and which have distinct characteristics. While the economic development strategy seeks to increase the economy across the Shire, it is also important to consider the unique characteristics of each community and provide future guidance for development.

Narrabri

Narrabri is the commercial and administrative centre of the Narrabri Shire and has the potential to consolidate this position. Narrabri is well placed to support the growth of the mining sector in the region through the attraction of value-adding operations and support services. Narrabri is also well placed to attract new residents and house the new mine employees and their families. As a result of the projected population growth and increase in wealth, Narrabri has the potential to attract additional commercial and retail businesses and government agencies. Value adding to the agriculture sector is also a

growth opportunity for the town with the potential to attract manufacturers and suppliers to the sector.

Wee Waa

The Wee Waa community has been traditionally underpinned by the production of cotton and other agriculture and there is potential to leverage this strength by attracting value adding operations to the area. Supporting existing businesses in the town is an important requirement with a need to create education and employment pathways and opportunities for the local youth in order to retain them in the area. Opportunities include the development of a tertiary education such as an agricultural college and assisting with the development of apprenticeship and traineeship programs. Local farmers should also be supported with a need to educate some farmers in relation to succession planning.

Boggabri

Boggabri is the closest large town to the majority of the new mines planned for the Narrabri Shire and the economic direction for the town should focus on servicing the significant demand for housing and other services, particularly for these new mines. Economic development needs to work closely with planning to facilitate the release of new residential development to accommodate the demand for new housing from mining employees. The existing business community should also be supported to facilitate their development to take advantage of significant growth opportunities. Boggabri has the potential to capture more visitor and tourism expenditure and better signage is required to inform passing travelers of attractions and the town centre.

Gwabegar

Gwabegar is a small town with agriculture representing the major industry since the closure of the once thriving timber industry. Economic development initiatives should include assistance to local businesses to market and expand their operations. The town is very picturesque and there are opportunities to increase visitation to the town through marketing and promotion.

Pilliga

Pilliga is a small town with agriculture representing the major industry underpinning the town. Economic development initiatives should include assistance to local businesses to market and expand their operations, as well as opportunities to increase visitation to the town by leveraging attractions like the hot artesian bore baths. Local farmers should also be supported with information provided to help improve their operations and guide succession planning.

Bellata

Bellata is a town renowned for the fertile soils and its durum wheat production which results in significant economic activity during planting and harvest times. A key consideration for guiding economic development in Bellata is diversifying the economy to ensure year round vibrancy. Workforce development within the Shire is needed to create employment opportunities for workers outside the peak times. The town is located on the Newell Highway with opportunities to increase the number of travellers that stop in the town.

While each of the towns within the Narrabri Shire have different opportunities for growth, facilitating growth within the entire Narrabri Shire should benefit all communities and residents.

8. Implementation

8.1 Economic Development Program

The Economic Development Strategy provides long term guidance and direction for Narrabri Shire Council. It includes practical activities organised across four directives and is geared toward delivering practical outcomes and achieving the economic vision for the future. However, the strategy will only succeed if it can be successfully implemented. The Economic Development Program will be this implementation tool.

The Economic Development Program provides specific tasks and activities for Council to carry out in order to achieve the goals and vision of the Economic Development Strategy. The Economic Development Program is a 5-year operational plan providing specific activities, key performance indicators (KPIs), potential partners and proposed budgets as well as offering an annual planning tool for Council for economic development. Being an annual program, it will be flexible to adjust to the changing market dynamics and as well as new opportunities that may present themselves. At the same time, it ensures that any future activities align to the longer term strategic objectives and goals of the strategy. In such a manner, the Economic Development Strategy remains flexible but focused on delivering the future vision for the Narrabri Shire.

8.2 Monitoring & Measuring Success

It will be important for Narrabri Shire Council to monitor and track progress towards achieving the vision. In order to do this, the Economic Development Unit will need a variety of tools.

In order to track the future development of the economy, there are indicators to demonstrate change over time in the economy:

- Employment;
- Gross Regional Product (GRP);
- Incomes and wages; and
- Skills.

Additionally, population trends, private sector investment as well as the level of R&D conducted within the region can be used to understand the changing dynamics of the regional economy.

Table 8.1: Economic Indicators

Indicator	What it tracks
Employment	
Total Employment Growth	Overall employment creation (overall job growth)
Unemployment Rate	Overall employment creation (employment rate of residents)
Self Containment	Ratio of local jobs to local resident workforce
Gross Regional Product (GRP)	
GRP Growth	Overall growth of economy and by industry sector
Incomes and wages	
Average Wage for Jobs	Higher average wages indicate high value jobs are being created
Average Income	Indicates personal wealth growth among residents
Skills	
Resident occupation and skills	Capability of residents and contribution to economy

Source: AECgroup

Narrabri Shire Council does not have any control over the economic indicators listed above. However, these indicators do track the economic development of the Narrabri Shire and can demonstrate positive growth towards the goals and realising the economic vision of the Economic Development Strategy.

Council's performance (and that of the Economic Development Unit) needs to have a separate set of key performance indicators (KPIs) that it can control and that it can achieve. These KPIs will be the outcomes of the Economic Development Program and if achieved, these outcomes should contribute towards achieving the economic vision for the future.

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Appendix A: Consultation List

The following organisations were consulted with during the consultation phase:

- Narrabri Shire Economic Advisory Committee;
- Narrabri Chamber of Commerce;
- Boggabri & District Promotions Group;
- Wee Waa Chamber of Commerce;
- Cotton Australia;
- Cotton CRC;
- Lower Namoi Cotton Growers Association;
- I.A. Watson Wheat Research;
- Priag Marketing/AWB;
- Graincorp;
- Canz Commodities;
- Cargill;
- Whitehaven Coal;
- Idemitsu (Boggabri Coal);
- Aston Resources;
- The Mac Services Group;
- Aeropelican;
- Property Developers;
- Namoi Water;
- Gunnedah Shire Council Economic Development Unit;
- Moree Plains Shire Council Economic Development Unit;
- Investment & Industry NSW;
- Council Tourism Manager;
- Why Leave Town Promotions;
- Rehbein Airport Consultants;
- NSW TAFE;
- The Crossing Theatre;
- Landmark (Narrabri Real Estate);
- Tamworth Building Supplies;
- Cotton Seed Distributors;
- Nurruby Childcare Centre & Preschool Inc;
- Neighbourhood Early Learning Centre; and
- National Parks and Wildlife Service.

Appendix B: Population Projection Assumptions

A comparison of actual recent population estimates with the NSW Department of Planning projections indicates some potential inconsistencies. AECgroup has reviewed the recent **population trends and the NSW Department of Planning's population projections and prepared alternative population projections for the Narrabri Shire.** Assumptions used by AECgroup include:

- Population growth will be driven by major resource projects including:
 - Eastern Star Gas Expansion: Additional 30 operational employees by 2014.
 - Maules Creek: 400 operational employees by 2014.
 - Narrabri North Expansion: Additional 200 operational employees by 2012.
 - Boggabri Mine Expansion: Additional 150 operational employees by 2013.
- 90% of new operational employees will be sourced from outside Narrabri Shire.
- 20% of new operational employees sourced from outside Narrabri Shire will live permanently in Narrabri Shire with the remainder living in temporary accommodation or outside the Shire.
- Operational employees moving permanently to Narrabri Shire will bring two family members with them on average.
- Economic growth and indirect employment opportunities generated by resource growth will result in additional population growth of 0.4% per annum (direct growth from resource projects is assumed to be in addition to this underlying growth).

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NARRABRI GAS FIELD

GROUNDWATER MONITORING AND MODELLING PLAN

ENERGY NEW SOUTH WALES

Narrabri Gas Field (PEL-238, PAL-2, PPL-3)

Revision History

Revision	Date	Description	Prepared	Endorsed	Approved
A		Work in Progress			
B		For Comment			
0	12/12/2012	For Submittal and Uses	Santos	Santos	Santos

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Table of Contents

1	INTRODUCTION.....	2
1.1	Relationship to Water Strategy.....	2
1.2	Purpose of Work	3
1.3	Overview of Narrabri Gas Field CSG Development Activities.....	3
2	ENVIRONMENTAL SETTING	3
2.1	Geology.....	3
2.2	Hydrogeology.....	4
2.3	Topography and Drainage.....	4
2.4	Land Use.....	5
3	RATIONALE AND OBJECTIVES	5
3.1	Shallow Aquifer Monitoring Bore (SAMB) Network	6
3.2	Deep Aquifer Monitoring Bore (DAMB) Network.....	7
4	APPROACH.....	8
4.1	Excavation of Mud Pits.....	9
4.2	Bore Drilling and Geophysics	9
4.3	Packer Testing	9
4.4	Piezometer Installation.....	10
5	GROUNDWATER MODELLING	10
5.1	Conceptual Hydrogeological Model	10
5.2	Numerical Groundwater Flow Modelling	10
	5.2.1 Model Parameters.....	10
5.3	Model Calibration	11
6	DATA MANAGEMENT AND REPORTING.....	11
7	ACRONYMS AND DEFINITIONS	11
8	REFERENCES.....	12

List of Figures:

Figure 1	Narrabri Gas Field Area
Figure 2	Narrabri Gas Field Geologic Cross Section
Figure 3	Narrabri Gas Field Proposed SAMB Locations
Figure 4	Narrabri Gas Field Proposed DAMB Locations
Figure 5	Typical Well Construction Schematic

List of Tables:

Table 1	Proposed SAMB Locations and Rationale
Table 2	Proposed DAMB Locations and Rationale

1 Introduction

This groundwater monitoring and modelling plan (Plan) has been prepared for the proposed exploration and appraisal activities that will be conducted in the Narrabri Gas Field Area (Field Area). This Plan describes the purpose, objectives, rationale and approach for collecting and evaluating groundwater data within the Field Area. Additionally, this Plan discusses how the proposed monitoring activities fit into the broader purpose and objectives outlined in the Water Monitoring Strategy.

Currently this Plan relates to assessment and investigation activities related to coal seam gas (CSG) development activities in the petroleum exploration licence (PEL) 238, petroleum assessment lease (PAL) 2 and petroleum production lease (PPL) 3 areas (Figure 1). Specifically, the scope of work discussed in this Plan describes the installation and monitoring of shallow aquifer monitoring bores (SAMBs) and deep aquifer monitoring bores (DAMBs) within the area of proposed activities. This groundwater monitoring data will be used to supplement the existing regional dataset. A broader Water Monitoring Plan is currently under development which will detail regional monitoring requirements as they relate to the goals and objectives of monitoring described in the Water Monitoring Strategy.

As development progresses in the Field Area, this Plan will be expanded (or merged into the broader Water Monitoring Plan) and will cover supplemental investigation activities needed to complete assessment of the hydrogeologic setting and sensitive receptors. Additionally, collected data will be used to calibrate the regional groundwater model which is currently in development for the Field Area. The current modelling effort is discussed in Section 5.

1.1 Relationship to Water Strategy

The Water Monitoring Strategy has been developed to provide a framework for monitoring and reporting on the existing and proposed CSG activities in the Field Area. The objectives of the Strategy are defined as follows:

- Present the regulatory framework, community concerns and environmental characteristics of the Field Area;
- Describe the proposed CSG activities, identify potential risks and specify how the monitoring strategy provides for development of monitoring and response actions to demonstrate how risks may be managed or mitigated; and
- Establish a framework for monitoring and reporting consistent with the regulatory requirements and framework applicable to the Field Area.

The Water Monitoring Strategy provides the basis for the development of this Plan and the broader Water Monitoring Plan (currently in development). This Plan and the Water Monitoring Plan focus on the implementation of the Strategy and provide specifics on what, where and when environmental and operational monitoring will be undertaken. The Strategy, therefore, is a companion (and parent) document to this Plan and should be reviewed for additional detail on:

- Regulatory framework;
- Stakeholder considerations;
- Record keeping and data management;
- Staging and workflow;
- Response actions; and

- Reporting requirements.

1.2 Purpose of Work

The purpose of the well installation and monitoring activities described in this Plan is to serve as the initial phase of an iterative data collection process to supplement the existing regional baseline data set. This data will be used to support current and future CSG development plans and activities and serve as key input data into the groundwater modelling that is being conducted. Additionally this data will be used to develop rationale for reference and targeted monitoring (discussed in the Strategy) which will be undertaken as the CSG development and operational activities progress.

1.3 Overview of Narrabri Gas Field CSG Development Activities

The Narrabri Gas Field is located within PEL 238. The field development activities involves extraction of natural gas and CSG water from deep-seated coals within the Bohenia sub-basin.

During the life of the Narrabri Gas Field, extending from 2012 to approximately 2055, preliminary estimates indicate that a total of 49 Giga Litres (GL) of CSG water could be produced, with a peak production of around 7.6 Mega Litres per day (ML/day).

The Narrabri Gas Field is currently at the early concept stage, with planned activities focused on exploration and appraisal. Key attributes of the ultimate field development plan will likely include:

- A centralised Water Treatment Plant (WTP) into which a series of gathering lines will feed CSG water;
- Water treatment facilities (e.g., Reverse Osmosis (RO) plant, CSG water collection ponds and brine management ponds), enabling the gathered CSG water to be desalinated and amended as required and used for local beneficial uses (managed aquifer recharge, irrigation and provision to third parties for use, etc); and
- Production wells distributed uniformly across the field.

An overview of the lifecycle of CSG water and associated management options are discussed in further detail in the Water Monitoring Strategy.

2 Environmental Setting

2.1 Geology

Geological and stratigraphical data in the vicinity of the site have mainly been sourced from geological and geophysical logging undertaken by Santos to determine potential CSG resources in the Narrabri area (Halcrow, 2012a). Further regional information has been sourced from published reports and datasets.

The local geology of the Narrabri Gas Field Area is characterised by unconsolidated alluvial and colluvial deposits overlying Jurassic Surat Basinal strata which in turn unconformably overlie indurated Permo-Triassic Gunnedah Basin sediments of the Bohenia Trough, resting on early Permian and older meta-volcanic basement rocks (Figure 2).

The Surat Basinal strata present in the vicinity of the Field Area include the Keelindi Beds, Pilliga Sandstone, Purlawaugh Formation and basal Garrawilla Volcanics. The Gunnedah Basin strata locally present beneath the Surat sediments include the Triassic Deriah, Napperby and Digby Formations unconformably overlying the Late Permian Black Jack Group, Middle Permian Millie Group and the Early Permian Bellata Group.

The local geology consists of Jurassic or Early Cretaceous sedimentary strata overlain in places by alluvium and colluvium/piedmont deposits. Underlying the Field Area is the Pilliga Sandstone of the Surat Basin, considered to comprise the lowest (and most easterly) intake beds of the Great Artesian Basin (GAB). The Pilliga Sandstone ranges from 0-250 metres (m) in thickness with a general westerly dip. Underlying the Pilliga Sandstone is the Purlawaugh Formation comprising mudstones, shales and siltstones and beneath these, the Garrawilla Volcanics consisting of flows and intrusions of dolerite, basalt, trachyte, tuff, and breccia. Overlying the Pilliga Sandstone in the north western half of the Field Area are interbedded mudstone and sandstone strata of the Keelindi Beds, the lateral equivalents to the west of the Early Cretaceous Orallo Formation. Alluvial deposits are present in the valleys of ephemeral watercourses (Bohena Creek Alluvium (BCA)), whilst the Upper and Lower Namoi Alluvial formations are present upstream (south east) and downstream (north west) of Narrabri township respectively. Colluvium and sand plain deposits occupy much of the remaining area (Figure 2).

A detailed discussion of the geology is available in the Draft Narrabri Groundwater Impact Assessment (Halcrow, 2012a).

2.2 Hydrogeology

Currently, groundwater is abstracted largely for irrigation and stock-watering under licence in the Field Area predominantly from the Namoi Alluvium, although a lesser number of bores are completed within the underlying Pilliga Sandstone. From inspection of the NSW Office of Water (NOW) Pineena Database, no bores are known to extend beyond the Pilliga Sandstone or to abstract water from deeper strata in the NGP area. It remains possible that some bores exist that do tap strata beneath the Pilliga Sandstone but it is unlikely given the superior aquifer characteristics of the Pilliga Sandstone over deeper strata.

Groundwater in the Pilliga Sandstone flows primarily from outcrop in the east towards the north west and then west. The Purlawaugh Formation and Keelindi Beds are understood to comprise aquitards, impeding the vertical flow of groundwater. Hence groundwater infiltrating the Pilliga Sandstone outcrop in the east and south east of the Field Area is prevented from percolating into the Purlawaugh and may be confined in the north west by the Keelindi Beds. Locally, groundwater in the Pilliga Sandstone in the northern part of the NGP area may flow northwards, drawn by hydraulic gradients in the Namoi Alluvials (Gunnedah & Narrabri Formations).

Groundwater level monitoring from adjacent areas in the Namoi Catchment indicates a declining trend of groundwater levels in the alluvial deposits and Pilliga Sandstone as a consequence of intense agricultural abstraction. CSG abstraction operations are not expected to impact significantly on groundwater levels in the Pilliga Sandstone or overlying Namoi Alluvium. However, minimal groundwater level monitoring is carried out currently and hence monitoring of groundwater levels or pressures in these "shallow" aquifers is required. This will help to establish the baseline conditions prevailing before the commencement of pilot trials.

2.3 Topography and Drainage

The Narrabri CSG Field area falls within the Namoi catchment, which represents some 3.8% of the total Murray-Darling Basin (MDB). It is bounded to the east by the Great Dividing Range, to the north by the Gwydir catchment, to the south by the Castlereagh, Macquarie and Hunter catchments and to the west by the Barwon Darling catchment.

The Field area is located predominately in the Lower Namoi sub-catchment on gentle north-northwest facing valley slopes. The flat open floodplain of the Namoi River is located to the north and west of the Field, with steep to undulating, mostly vegetated, land to the east and south. The Warrumbungle Ranges are located to the south and the Mount Kaputar National Park occurs to the north-east. Elevations within the Field Area range from approximately 400 m AHD in the south-east down to approximately 250 m AHD in the north-west.

The Lower Namoi sub-catchment commences at Narrabri with this location considered to be the start of the true riverine zone of the Namoi catchment due to the increased frequency of lagoons, the low gradient of the channel and the development of several anabranches and effluent channels (NSW Office of Water, 2011).

The lower Namoi is regulated by two major weirs downstream of Narrabri – Mollee Weir and Gunidgera Weir.

2.4 Land Use

The Field Area is predominantly woodland vegetation associated with the Pilliga East and Bibblewindi State Forests. This area is generalised as Eucalyptus Crebra dry open forest.

3 Rationale and Objectives

The CSG-related groundwater abstractions in the NGP area will be focused at great depth (~700-1100m depth) and hence the potential for impact in the shallow aquifers (extending to approximately ~300 m depth) is likely to be negligible. Notwithstanding the likely scale of, and delay in, any potential impact, monitoring of groundwater is required to confirm the absence or onset (and magnitude) of any impact and hence the shallow aquifers require routine long-term level monitoring over the duration of the CSG operations.

The particular hydrogeology of the Field Area lends itself to differentiating between shallow and deep groundwater monitoring systems. The Purlawaugh Formation represents an effective aquitard limiting groundwater leakage between the overlying GAB Surat Pilliga Sandstone (shallow system) and the sandstones of the underlying Napperby or Deriah Formations of the Gunnedah Basin (deep system).

Consequently, the design of monitoring infrastructure has been split between a SAMB network in which strata are, or are expected to be, normally pressured, and a DAMB network in which pressurised strata may be encountered.

The specific objectives of the SAMB and DAMB programmes are described below and discussed in detail in the SAMB and DAMB design reports (Halcrow, 2012b and 2012c). Summary tables detailing the rationale of the each location proposed in this initial phase of work are provided as Table 1 and Table 2 for the SAMB and DAMB programmes, respectively. The rationale for the network design proposes monitoring bores both within, and within the vicinity of, the Field Area. Each bore is likely to incorporate multi-level groundwater pressure monitoring capabilities to elaborate fluctuations and trends in various key hydrostratigraphic units. The current proposed SAMB and DAMB networks are illustrated on Figure 3 and Figure 4, respectively.

3.1 Shallow Aquifer Monitoring Bore (SAMB) Network

SAMB groundwater monitoring is required to collect baseline groundwater quality, pressure, and flow direction within the Pilliga Sandstone, confirm the groundwater pressure in the low permeability Purlawaugh Formation and Keelindi Beds as well as a range of data collection needs described in Table 1. It is not envisaged that groundwater is perennially present in the overlying superficial deposits (alluvium and colluvium) within the Field Area.

The depth of individual SAMBs will be dictated by the depth of the target monitoring zone, although the maximum depth of SAMBs is governed generally by the depth of the first regional seal. Given the targets are the Keelindi Beds, Pilliga Sandstone and the Purlawaugh Formation, the maximum depth of any SAMB in the NGP area will likely be dictated by the depth of the Purlawaugh Formation. The SAMBs will be arranged to maximise the acquisition of beneficial data and hence four criteria have been considered to determine the lateral distribution of the SAMBs. These include constructing an array of monitoring locations which (i) can demonstrate the absence of impact to the regional GAB aquifers; (ii) act as sentinel monitoring locations between the Field Area and groundwater abstractions; (iii) act as sentinel monitoring locations between the Field Area and GDEs; and (iv) yield essential hydrogeological data comprising additional stratigraphic data, remote head data and cores for laboratory testing of hydraulic parameters.

The SAMB network has been developed by Halcrow on behalf of Santos (Halcrow, 2012c) in order to:

- Establish baseline groundwater level and pressure conditions in the Pilliga Sandstone and overlying Namoi Alluvium prior to the commencement of CSG activities;
- Undertake long-term groundwater level monitoring over the duration of the CSG activities in order to confirm the absence or onset (and magnitude) of any impact to the Pilliga Sandstone and Namoi Alluvium associated with the CSG activities;
- Collect additional hydrogeological data to confirm the presence of aquitards impeding the vertical flow of groundwater between the Pilliga Sandstone and underlying or overlying formations; and
- Collect water quality samples at select locations. It is proposed that water sampling capabilities be designed (open boreholes) at several of the SAMB sites (Leewood in the upper Pilliga Sandstone, at Jacks Creek in the upper Pilliga Sandstone and at Turrawan in the Namoi Alluvium, if present) to supplemental current regional bore assessment activities currently underway.

Specifically, the SAMB network has been designed to allow for the following outcomes:

- Demonstration of the baseline groundwater levels and the background flow pattern within the Pilliga Sandstone;
- Confirmation of the groundwater pressure in the Purlawaugh Formation; and
- Verification of the confining characteristics of the Keelindi Beds overlying the Pilliga Sandstone and hence the hydraulic segregation of the Pilliga Sandstone from the GAB Alluvials to the west of the Field Area.

The SAMB network has been arranged to maximise the acquisition of beneficial data which:

- Can inform the absence or otherwise of impact to the regional GAB aquifers;

- Act as sentinel monitoring locations between the Narrabri Gas Field Area and groundwater abstractions from shallow aquifers;
- Act as sentinel monitoring locations between the Narrabri Gas Field Area and groundwater dependent ecological (GDEs); and
- Yield essential hydrogeological data comprising additional stratigraphic data, remote head data and cores for laboratory testing of hydraulic parameters.

3.2 Deep Aquifer Monitoring Bore (DAMB) Network

DAMB groundwater monitoring and the collection of ancillary data (lithological and permeability characteristics) are required to describe the baseline conditions prior to the commencement of pilot/appraisal and/or field development CSG water abstractions. These baseline conditions will assist in identifying the distribution/variations in groundwater pressures both laterally within hydrostratigraphic units and vertically between units.

The depth of individual DAMBs will be dictated by the depth of the target monitoring zone. Given the primary CSG target is the Maules Creek Group (principally the Bohena seam) and the secondary CSG target is the Black Jack Group (principally the Hoskinson Seam), the likely minimum depth of any DAMB in the Field Area will be dictated by the depth of the primary target or the basement strata beneath - where these are likely to be transmissive, or immediately overlying strata – where the deeper strata are pinched out (onlap) against the basement. It is likely that each DAMB will be equipped with at least one gauge in the Triassic sequence and one in the Permian strata in which the CSG targets lie. A third gauge may be sited within the Napperby Formation above the basal Napperby Shale to monitor the impedance of depressurisation from below. Alternatively, beyond the Field Area, a gauge may be sited in the target seam(s) to assess the lateral migration of the depressurisation front. This will help assess the depressurisation impact outside of the Field Area.

The DAMB network has been developed by Halcrow on behalf of Santos (Halcrow, 2012b) in order to:

- Establish baseline groundwater level and pressure conditions in the strata belonging to the Gunnedah Basin prior to the commencement of significant CSG activities;
- Undertake long-term groundwater level monitoring over the duration of the CSG activities in order to assess the migration of de-pressurisation effects within the Permo-Triassic strata and the hydraulic continuity present between different hydrostratigraphic units; and
- Collect additional hydrogeological data including conducting field tests and wireline geophysical logging and collecting core samples for laboratory hydraulic analysis to elaborate the hydraulic properties of the deep strata (hydraulic conductivity, specific storage, fracturing).

Co-designing water quality sampling and long-term water level/pressure monitoring in dedicated DAMBs is not recommended. Therefore it is recommended that various former CSG wells due for abandonment are converted to enable water sampling. Given that each of the former CSG wells are either perforated in a target seam or open hole below the target seam, conversion may require partial plugging and/or the installation of a liner or perforation in a stratigraphically higher unit. The selection of former CSG wells for conversion to water quality monitoring bores, and the conversion required to enable samples to be acquired from the appropriate hydrostratigraphic units, is beyond the scope of the current phase of work discussed herein.

Specifically, the DAMB network has been designed to allow for the following outcomes:

- Demonstration of the baseline groundwater pressures and the background flow patterns / existing hydraulic gradients within the hydrostratigraphic units of the Gunnedah Basin;
- Illustration of the absence or otherwise of vertical hydraulic continuity within the Gunnedah Basin strata; and
- Elaboration of the migration of groundwater depressurisation both laterally in the target seam and vertically above and below the target seam, following the commencement of CSG water abstraction.

The DAMB network has been arranged to maximise the acquisition of beneficial data which:

- Can inform the absence or otherwise of potential impact to the regional GAB aquifers;
- Act as sentinel monitoring locations between the Narrabri Gas Field Area and groundwater abstractions in the Gunnedah Basin domain; and
- Yield essential hydrogeological data comprising additional stratigraphic data, remote head and field testing data and cores for laboratory testing of hydraulic parameters.

4 Approach

The following section describes the general approach and investigation and data collection techniques that are proposed to achieve the objectives of the SAMB and DAMB programmes discussed above. Table 1 and Table 2 provide additional detail for the proposed intervals and test methods to be performed at specific SAMB and DAMB locations. Detailed field implementation plans will be developed to describe specific methodologies for installation, measurement and sampling procedures that will be undertaken. Ultimately, target installation and data acquisition depths will be determined based on field conditions to optimise characterisation of target aquifers. Although the current scope of work is focused on collection of geologic and hydrogeologic data to support conceptual and numerical model development, collection of additional water quality data will be evaluated following completion of this initial phase of investigation.

The potential scope of drilling work for installation of the SAMB and DAMB wells include:

- Excavation of mud pits at each drill site.
- Drilling of monitoring bores using mud rotary methods and/or rotary air percussion.
- Logging of cuttings and laboratory analysis of core runs.
- Drill Stem Testing including collection of groundwater samples from select depth intervals.
- Geophysical logging using calliper, gamma and density wireline logs.
- Packer testing to measure the hydraulic conductivity in both high and low permeability zones.
- Installation of vibrating wire piezometers (quartz gauge) or pressure transducers to provide long term, regular measurement of water levels within target aquifer units.
- Installation of open hole monitoring wells (at select SAMB locations) to facilitate groundwater quality sample collection.

- Appropriate surface completion at all sites and cattle fencing and/or high-visibility protective metal bollards as needed.

4.1 Excavation of Mud Pits

Excavation of mud pits will be required at each location. Once pits are excavated, bunting will be installed around the perimeter to ensure the safety of workers and the public. Additionally, material excavated from the pit will be used to build bunds around the pits for further safety, and to minimise the potential of any surface run-off occurring. The pits will be lined with an impermeable liner in accordance with regulatory requirements.

When the pits are no longer required, the fluid remaining in the pits will be analysed and classified then removed to a licenced waste management facility or transported to another Santos site for re-use, as appropriate. The cuttings remaining in the pits will be removed by Santos. Drilling mud and associated water will not be pumped on to the ground. Backfilling and rehabilitation of mud pits will be arranged by Santos for drilling completions.

4.2 Bore Drilling and Geophysics

The general approach for bore drilling, logging, coring and wire-line geophysical testing includes the following primary steps:

- Drill through the overburden into more competent bedrock to allow for the installation of poly vinyl chloride (PVC) conductor casing. This is intended to provide stability to the upper portion of the bore and to facilitate drill chip returns. Where no alluvium exists, the base of starter casing to be sealed with a 5% bentonite / cement mix, ensuring cement fills the entire length of the annulus. Where alluvium exists, to be monitored by installation of a gauge, the PVC will not be cemented to allow removal of the casing prior to installation.
- Re-commence drilling through the outer casing using mud rotary and/or air hammer methodology until target depth reached, as determined by examination of the drill cuttings and consultation with existing borehole data and regional literature resources.
- Perform gas monitoring in the work zone of the drillers.
- Take photos of cuttings and other work activities throughout each day to assist documentation and interpretation of data.
- Log drill cuttings for geologic characterisation of the strata.
- Core select intervals for characterisation and laboratory analysis. Recovered core samples will be analysed to determine hydraulic conductivity and moisture content. Details of proposed core run sections are given in Table 1 (SAMB network) and Table 2 (DAMB network).
- Collect water samples during Drill Stem Tests for laboratory analysis from core holes that are completed as DAMBs to provide indicative water qualities at those locations.
- Conduct geophysical logging of the borehole using calliper, gamma and density wireline logs.

4.3 Packer Testing

Packer tests consist of isolating specific sections of a bedrock borehole with inflatable packers (bladders), at each end of the target zone. The double or straddle packer test method will be used.

Packer testing may be completed across sections picked from the wireline geophysics with a relatively smooth borehole wall as determined from the calliper log.

4.4 Piezometer Installation

Bores will be completed with either quartz gauge pressure transducers or groundwater monitoring wells (equipped with dedicated pressure transducers) based on drill cutting, packer testing and geophysical results. In addition groundwater monitoring wells may be used to facilitate groundwater sample collection (at select SAMB locations). The specific procedures for installation of the pressure transducers and monitoring wells will be described in the scope of work and coordinated with the selected contractor. Typical well construction schematics are provided as Figure 5.

5 Groundwater Modelling

A calibrated groundwater model will be utilised to further develop the conceptual model for the Field Area and aid in achieving the Purpose and Objectives outlined in the Water Monitoring Strategy.

5.1 Conceptual Hydrogeological Model

In the context of the size of the Gunnedah Basin, very little published information is available to describe the range and spatial distribution of hydrogeological properties of the indurated strata. Only limited data describing the hydraulic parameters of the strata in the vicinity of the site are available, with the dominant focus having been on coal seam geology and reserve quantification. Drill stem tests have been undertaken within the Field Area previously, although almost exclusively on coal seam sections with virtually no information being gathered on the hydraulic parameters of the non-coal strata. However, a number of detailed studies have been carried out in relation to planning applications for collieries within the Gunnedah Basin. These include groundwater impact assessments for mining in the Maules Creek sub-basin (Boggabri, Maules Creek and Rocglen mines) and Mullaley sub-basin (Narrabri, Sunnyside and Werris Creek mines).

These studies were utilised by Halcrow in development of a conceptual hydrogeological model detailed in the Draft Groundwater Impact Assessment (Halcrow, 2012a).

5.2 Numerical Groundwater Flow Modelling

A numerical groundwater model was developed by Golder Associates (Golder, 2011) to assess the potential impact on groundwater levels and groundwater flows from the proposed Narrabri Gas Field. Additional developments to the model were completed by Halcrow in 2012 and it will be further refined based on data collected during this monitoring phase.

The numerical groundwater model was constructed using MODFLOW-2005 and Groundwater Vistas interface V6.07 Build 18. MODFLOW is a three-dimensional finite-difference continuous-layer numerical model developed by USGS. Groundwater Vistas was used to undertake pre- and post-processing of the input and output from MODFLOW. Further model refinement and development was undertaken by Halcrow using Groundwater Vistas V6.22 Build 2.

5.2.1 Model Parameters

Hydraulic parameters were assigned to each hydrostratigraphic unit (HSU) in the model based on available site data and literature values and were then adjusted during model calibration. Hydraulic parameters required in MODFLOW include:

- Horizontal (Kh) and vertical (Kz) hydraulic conductivity;
- specific yield (Sy) and specific storage (Ss) (transient only);
- recharge (q); and
- conductance (used in MODFLOW River (RIV) and Drain (DRN) Modules).

These values will be further adjusted based on sampling results and field activities detailed above. This will allow for greater accuracy and understanding of HSUs within the Field Area.

5.3 Model Calibration

A steady state calibration was undertaken by Halcrow which is capable of reproducing observed long-term average groundwater levels as closely as possible, given the limitations of the input dataset and model design. Steady state calibration involves comparison of model-simulated groundwater levels against measured groundwater levels, assuming the groundwater system is in equilibrium.

The groundwater model was calibrated using long-term average groundwater levels from fifty observation wells in the Field Area (Halcrow, 2012a). The current groundwater monitoring data set is not considered sufficient to complete the transient model calibration and sensitivity database. Further groundwater modelling calibration will be completed following additional monitoring and collection of data during the aforementioned field activities. Following additional groundwater monitoring, the model will be calibrated for both steady state and transient mode in order to accurately model pumping conditions associated with proposed CSG activities.

6 Data Management and Reporting

Data management and reporting will be conducted in accordance with applicable regulatory and stakeholder requirements as discussed in the Water Monitoring Strategy.

7 Acronyms and Definitions

BCA	Bohena Creek Alluvium
CSG	Coal Seam Gas
DAMBS	Deep Aquifer Monitoring Bores
GAB	Great Artesian Basin
GDE	Groundwater Dependent Ecosystems
GL	Giga Litres
HSU	Hydrostratigraphic Unit
m	metre
MDB	Murray Darling Basin
ML/yr	Mega Litres per year
PAL	Petroleum Assessment Lease
PEL	Petroleum Exploration Licence
PPL	Petroleum Production Lease
the Plan	Groundwater Monitoring and Modelling Plan
Field Area	Narrabri Gas Field Area
PVC	Polyvinyl Chloride

RO	Reverse Osmosis
SAMBs	Shallow Aquifer Monitoring Bores
WTP	Water Treatment Plant

8 References

- EHS Support, Inc (2012). *Water Monitoring Strategy*, November 2012.
- Golder & Associates (2011). *Groundwater Impact Assessment for the Narrabri Gas Project* [prepared for Eastern Star Gas], 2011.
- Halcrow Pacific Pty Limited (2012a). *Draft Groundwater Impact Assessment: Narrabri Gas Project*, September 2012.
- Halcrow Pacific Pty Limited (2012b). *Narrabri Deep Aquifer Monitoring Bores (DAMBs): SAMB and DAMB Networks Design*, September 2012.
- Halcrow Pacific Pty Limited (2012c). *Narrabri SAMBs: Rationales for Location and Design*, July 2012.
- New South Wales Office of Water (NOW, 2011). *Water Resources and Management Overview – Namoi Catchment*, 2011.
- URS Corporation (2011). *Field Briefing Report: Santos Gunnedah Shallow Aquifer Monitoring Bore Program*, March 2011.

Tables

Table 1. Proposed SAMB Locations and Rationale

SAMB target site	Correlation	Target depth (m)	Field test intervals	Core targets	Gauge target		Rationale (SAMB site; coring and gauge targets)
					Fms	Depths (m)	
Kiandool	Culgoora 1a & Wilga Park 5	200 *1	UPS, LPS	K, UPS, LPS	LNA K UPS	<40 45 150	Within area of intense lower Namoi Alluvium abstractions, north of all NGP activities, co-location with DAMB/corehole, area of sparse hydrogeological property data
Turrawan	TBA		UPS, LPS, PU	UPS, LPS, PU	UNA K UPS		Within area of intense upper Namoi Alluvium abstractions, north east of all NGP activities, co-location with LT future corehole, area of sparse hydrogeological property data
Jacks Creek (Dewhurst Lateral)	Dewhurst 8	270	-	(K); UPS; LPS; PU	UPS LPS PU	95 180 265	Within area of dispersed PS abstractions, at NE of NGP activities, co-location with pilot/potential corehole/DAMB, area of sparse hydrogeological property data and upgradient of the GDE: Mayfield Spring
Tullamullen	TBA		GV, N, (D)	GV; N, (Di)	GV N (D)		Within area of dispersed hardrock abstractions, at E of NGP activities, area of sparse hydrogeological property data;
Dewhurst 3	Dewhurst 3	180	UPS, MPS, LPS, PU	UPS, LPS, PU	UPS LPS	40 140	Within area of dispersed PS abstractions, towards the E of NGP area, co-location with potential DAMB, area of sparse hydrogeological property data, along strike from Dewhurst Lateral Pilot and upgradient of the GDEs: Eather & Hardys Springs
Willala	TBA		GV, N, (D)	GV, N, (D)	GV N (D)		Within area of dispersed hardrock abstractions, at SE of NGP activities, area of sparse hydrogeological property data
Dewhurst 21	Dewhurst 21 prognosis	200	-	LPS, PU	LPS PU	150 195	At Southern end of NGP activities, area of sparse hydrogeological property data
Borah Creek	Galloway 1 & Tunmalalee	145	MPS, LPS, PU	UPS, LPS, PU	UPS LPS	? 110	Within an area of very dispersed PS abstractions, area of sparse hydrogeological property data, south of all NGP activities but between NGP and Dandry Springs
Biblewindi Lateral 27	Biblewindi 11C,12 & 17	230	UPS, LPS, PU	K, UPS, LPS, PU	UPS LPS PU	60 120 225	Within centre of NGP area – greatest depressurisation at depth, area of sparse hydrogeological property data, initially identified according to Kahlua Protocol, aligned with MDBC 2000GAB model groundwater flow


Table 1. Proposed SAMB Locations and Rationale

SAMB target site	Correlation	Target depth (m)	Field test intervals	Core targets	Gauge target		Rationale (SAMB site; coring and gauge targets)
					Fms	Depths (m)	
Bibblewindi Lateral 28	Bibblewindi 11C,12 & 17	290	MPS, PU	K, UPS, LPS, PU	K UPS LPS	70 140	directions
Bibblewindi West Tri-lat'1	Bibblewindi 30 prognosis	240	-	UPS, LPS, PU	UPS LPS	50 ~150	Monitoring of MAR to BCA, area of sparse hydrogeological property data, directly west of all NGP activities but close to creek recharge
Coghill Creek	TBA		TBA	TBA	K UPS		Potentially similar to Dewhurst 21
Leewood	Bohena 12C	550	K UPS, LPS, PU, N, BNS	K; UPS, LPS, PU, N, BNS	K UPS LPS N	? 110 300 420	Proposed target area for MAR; directly N of NGP activities in zone of thick Surat strata, Naperby Shale may be 1 st reg seal hence depth and extent of monitoring
Lynwood	Lynwood 1 & Bohena 14	200	-	K, UPS	K UPS	100 195	Within area of dispersed PS abstractions, at NW of NGP activities & SW of Tintsville, area of sparse hydrogeological property data, especially Orallo
Nyori	Wee Waa 1 & Nyori 1	340	UPS, LPS, GV	K, UPS, LPS, GV	K*2 (UPS) LPS GV	110-160? 195-220? [340]	Within area of dispersed PS abstractions and up gradient of intense NA abstractions, north west of all NGP activities, area of sparse hydrogeological property data, Pw potentially absent

Notes

*1: Target depths based on assumed surface elevation of 222.7mAHD

*2: described in Wee Waa 1 as Cretaceous Blythesdale Formation (top 40' blue heavy plastic clay, argillaceous sandstones beneath) & in Nyori 1 as Orallo Fm. Former reported PU but latter proved PS directly on GV.

Items in  indicate absence of borehole correlations at the time of preparation of this note.

Abbreviations: LNA – Lower Namoi Alluvium; UNA – Upper Namoi Alluvium; K – Keelindi Beds (Orallo Fm); UPS – Upper Pilliga Sandstone; MPS – Middle Pilliga Sandstone; LPS - Lower Pilliga Sandstone; PU – Purlawaugh Fm; GV – Garrawilla Volcanics; BCA – Bohena Creek Alluvium; N – Napperby; BNS – basal Napperby Shale; MAR – Managed Aquifer Recharge (permeate re-injection). TBA – To be advised.

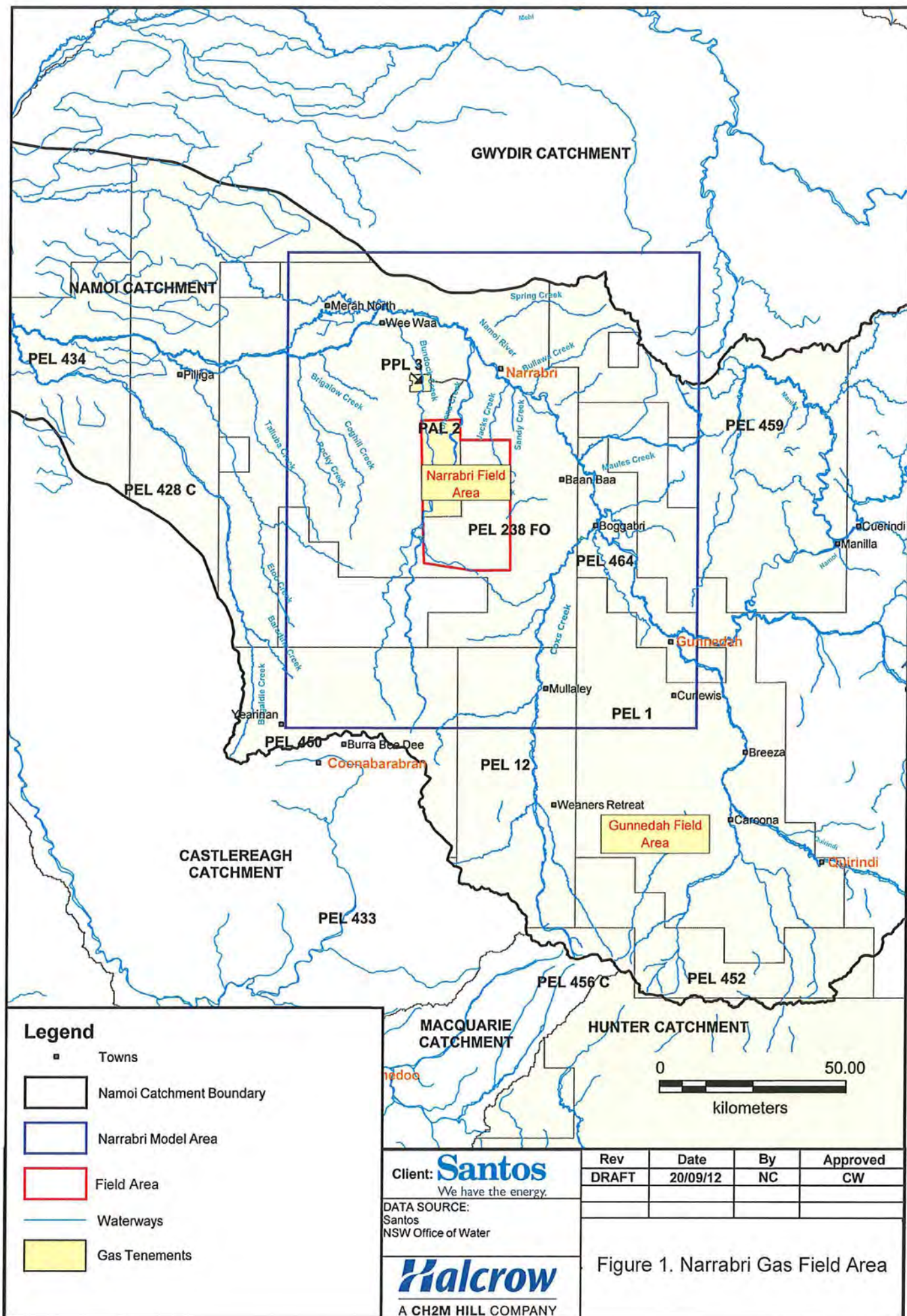
NOTE: All indicated depths are approximate and subject to revision based on detailed appraisal of local geological data and well prognoses.

Supporting information used in the preparation of this note and referred to in Table 3 ("Correlation") is reproduced in separate attachment.

Table 2. Proposed DAMB Locations and Rationale

DAMB		Target	Coring		DSTs		Lab testing (core sections to be preserved & shipped)		Proposed monitoring devices & rationales		Additional rationale
No.	Name	depth	Scheduled	Additional	Scheduled	Additional	Depth	Formation	Depth	Target	
1	Kiandool I	859	440-650 722-865	695-722	Hoskissons seam Maules Ck coal (x2)	695-722: Lwr Porcupine 825-835: Weath'd basem't 845-855: Fresh basement	445-455 465-475 480-490 510-520 540-550 570-580 635-645	Mid Napperby Shale Lwr Napperby Shale Upr Digby Sandstone Lwr Digby conglomerate Upr Black Jack overburden (Trinkeey) Upr BJ overburden Upr Watermark Fm	360 485 595 710	Napperby Formation (seal effectiveness of Napp Shale) Upr Digby (upward depressurisation) Hoskissons seam (lateral in-seam depressurisation) Lwr Porcupine (interseam depressurisation)	Northerly location to act as sentinel monitoring bore between CSG field and River Namoi alluvial systems. Similar location to proposed SAMB of same name, for pressure head change comparison Additional coring to capture some Watermark
2	Dewhurst 8A	1023	436-680 870-1024	None	Hoskissons seam Maules Ck seams (x2) Bohena seam	683-690: Lwr Watermark 730-736: Upr Porcupine 820-826: Lwr Porcupine 985: Leard Fm	453-456 480-483 495-498 520-526 555-561 567-570 579-585 677-683 873-879 885-888 982-985	Mid Napperby Shale Lwr Napperby Shale Digby Fm Trinkeey Fm Walala Fm Clare Sst Benelebri Fm Mid Watermark Fm Lwr Porcupine Fm Upr Maules Ck Fm Leard Fm	495 570 735 985	Upper Digby Formation (upward depressurisation) Clare Sandstone (upward depressurisation) Upper/Middle Porcupine (upward depressurisation) Leard Fm (basement response if hydraulic continuity with basement)	Easterly location to act as sentinel monitoring bore between CSG field and easterly Permo-Triassic strata and between CSG field and Narrabri coal mine. Similar location to proposed Jacks Creek SAMB, for pressure head change comparison
3	Goolhi	660	-	320-420	-	532 Hoskissons Seam 650: Basement	320-326 336-342 360-366 400-406	Napperby Formation Napperby Shale Digby Formation Digby Formation	400 500 532	Digby Formation (upward depressurisation) Clare Sandstone (upward depressurisation) Hoskissons seam (lateral in-seam depressurisation)	Located to the immediate east of land classified as Nature Reserve and outside of the extent of any National Park or State Forest Southerly location to act as sentinel monitoring bore between CSG field and south easterly Permo-Triassic strata.
4	Biblewindi 9	-	-	-	-	-	-	-	475 550 850	Napperby Formation (seal effectiveness of Napperby Shale) Digby Formation (upward depressurisation) Porcupine Formation (interseam depressurisation)	Bore already drilled - actual depth is 1030m Located in central CSG field location to illustrate maximum vertical depressurisation migration
5	Lanes Mill	600	-	360-440	-	-	363-369 390-396 420-426	Napperby Formation Napperby Shale Digby Formation	425 527	Digby Formation (upward depressurisation) Hoskissons seam (lateral in-seam depressurisation)	Westerly location to act as sentinel to monitor impact of westward depressurisation of confined Permo-Triassic aquifers on (confined) GAB aquifers west of the (unconfined) GAB intake zone. At fringes of Bohena Trough but outside of likely influence of block faulting identified by seismics around Biblewindi-30 proposed core hole location.

Figures



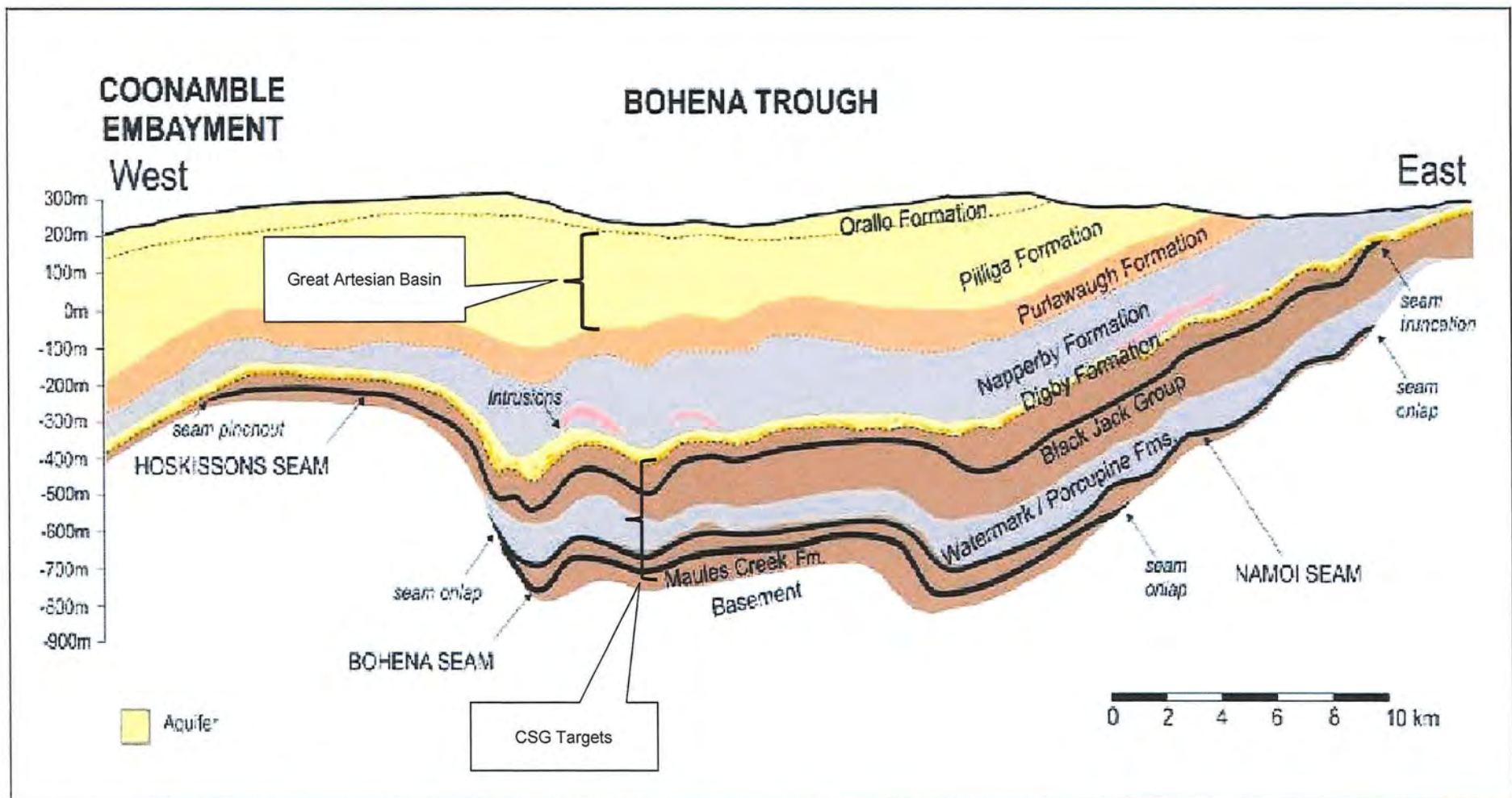


Figure 2. Narrabri Gas Field Geologic Cross Section

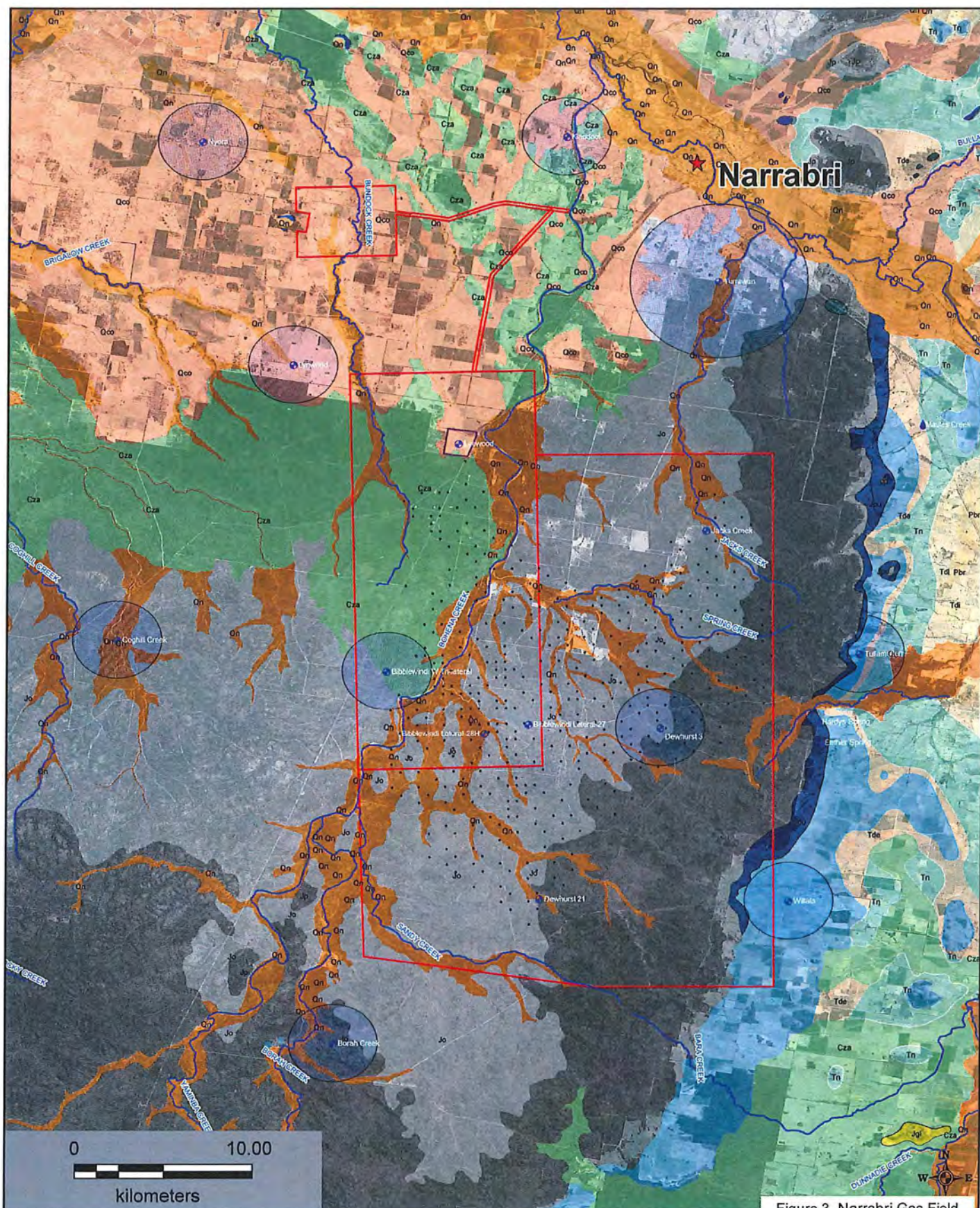


Figure 3. Narrabri Gas Field
Proposed SAMB Locations

Geology Legend

Quaternary - alluvium	Deriah Formation	Maules Creek Formation
Quaternary - colluvium	Digby Formation	Pilliga Sandstone
Quaternary - fan / floodout	Garrawilla Volcanics	Porcupine Formation
Cainozoic - sand plain	Glenrowan Intrusives	Purlawaugh Formation
Brothers Subgroup	Keelindi beds	Watermark Formation
Boggabri Volcanics	Napperby Formation	Werrie Basalt

	SAMB Location
	GDEs
	Bore Locations
	Major Rivers
	Region of SAMB sites
	Narrabri Field Area
	Leewood

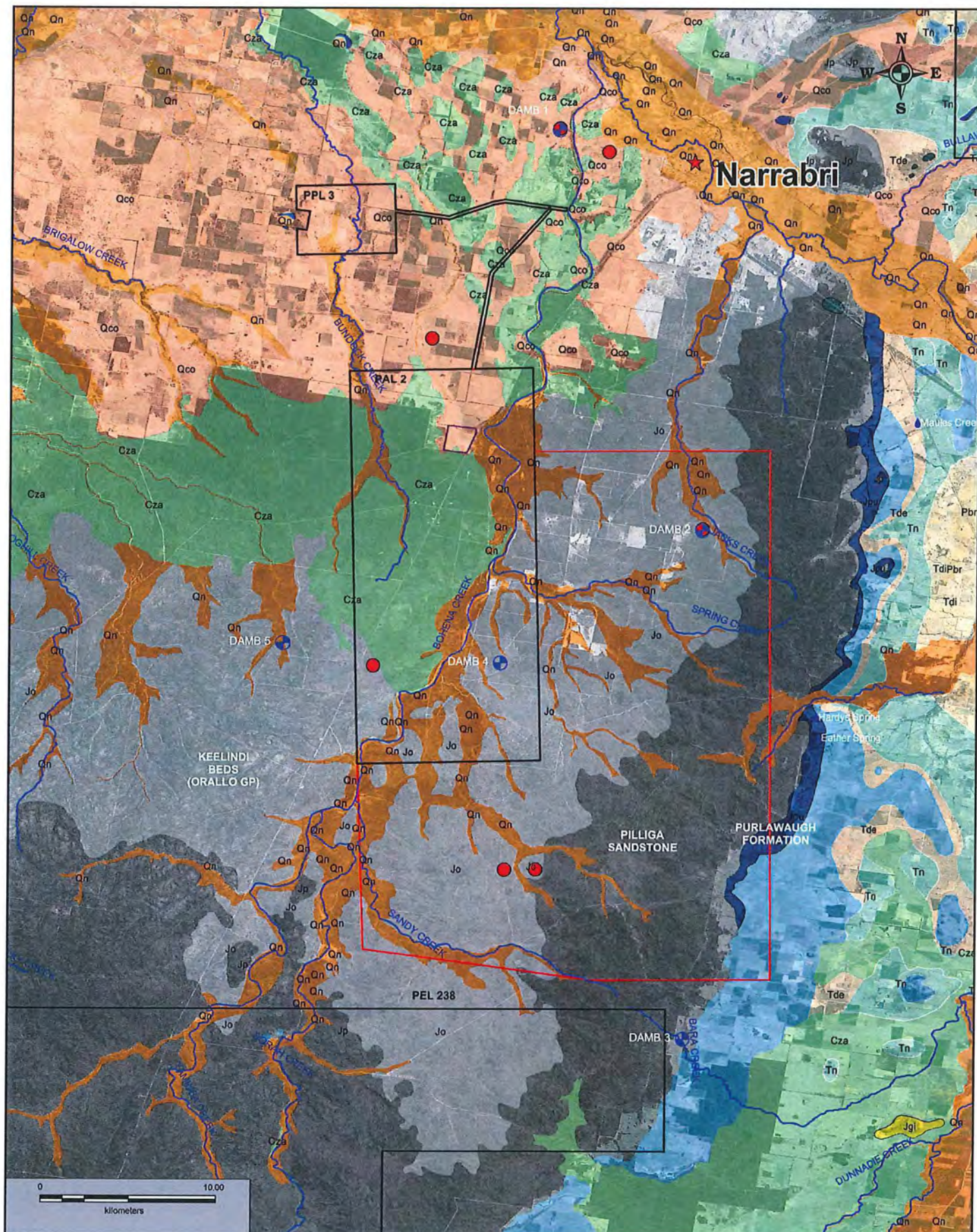
Data Source: Santos, Dpt. of Natural Resources

Client:

Santos
We have the energy.

Revision	Date	By	Approved
A	05/07/12	NC	TN

Halcrow



Legend

- Proposed Deep Aquifer Monitoring Bore (DAMB)
- Proposed Corehole
- GDE
- Major Waterways
- Tenement Boundary
- Narrabri Field Area
- Leewood

Source: Santos, Dpt. of Natural Resources

Halcrow
A CH2M HILL COMPANY

Client: **Santos**
We have the energy.

Revision	Date	By	Approved
A	22/08/12	NC	TN
B	09/10/12	NC	TN

Figure 4. Narrabri Gas Field
Proposed DAMB Locations

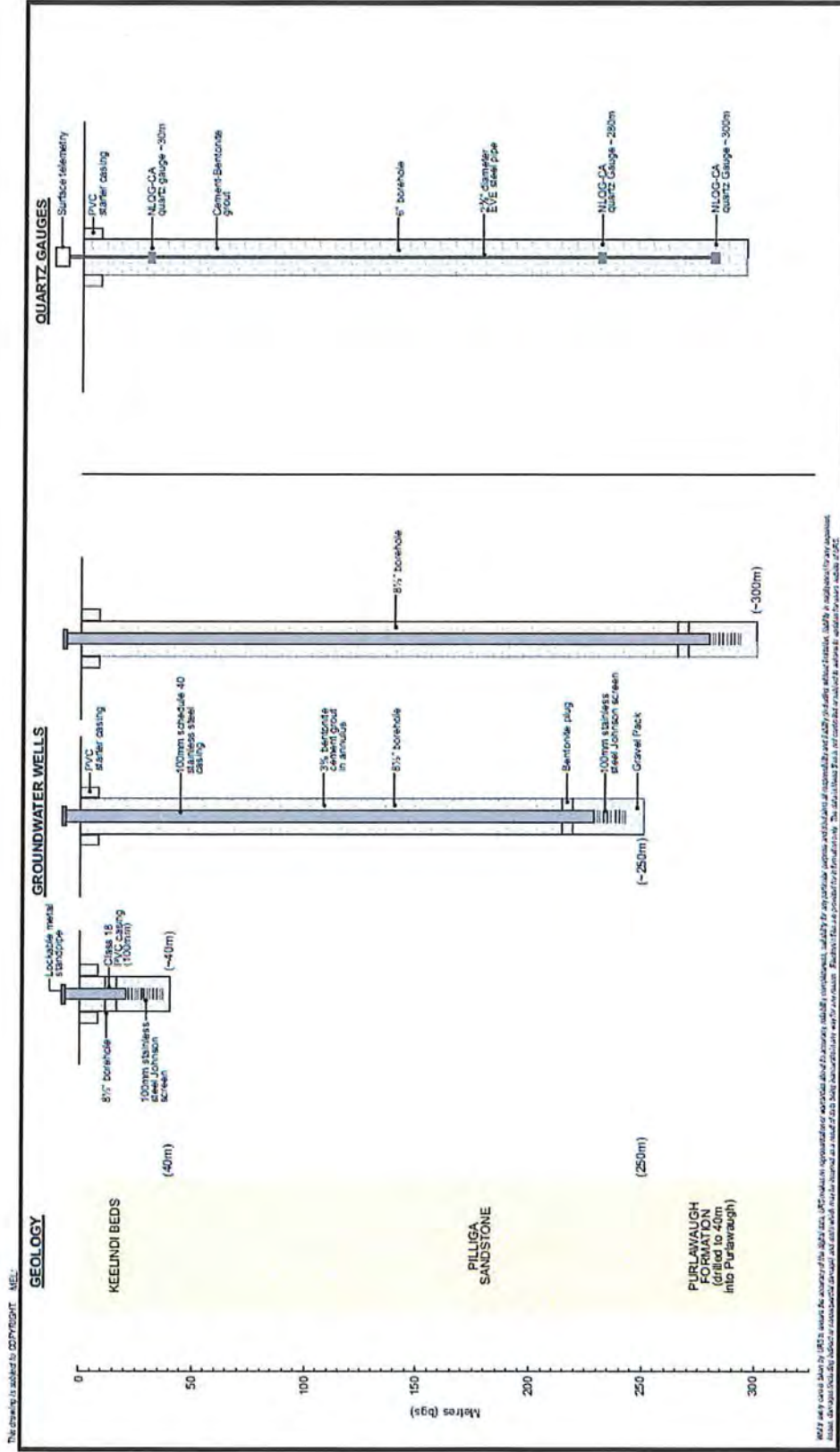


Figure 5. Typical Well Construction Schematic

SANTOS UPDATE – October 2013

Proposed upcoming work program – Narrabri Area

Time frames are indicative as schedules are dependent on factors such as approval times, weather and rig availability.

Decommissioning of wells:

- No plug and abandon activities planned for October

Workovers:

- Workover of Bibblewindi 14 will occur mid-October.

Drilling of exploration core holes:

- Drilling of core hole at Dewhurst 8A scheduled for October. When the core material has been extracted, the hole will be fitted with aqua monitoring equipment to provide baseline deep groundwater information and the core hole sealed.

Pilot wells:

- Installation of pilot wells at Dewhurst 22-25 scheduled for November 2013.

Other work:

- Leewood - construction of the first stage of the Leewood water storage facility is continuing with material conditioning in Brine Pond 1; ripping and conditioning of material in southern sedimentation pond and installation of erosion and sedimentation controls around perimeter of earthworks. Traffic Management continues on the Newell highway and Old Mill Road and RMS has issued a revised Road Occupancy License (ROL) for Newell Highway and a new traffic management plan has been developed for the southbound project traffic. Replacement of existing Leewood perimeter fence with security fence in liaison with neighbouring landholders. Commenced installation of security fence on eastern boundary.
- Installation of shallow aqua monitoring bore Nyora scheduled for late October 2013
- Installation of shallow aqua monitoring bore Bohena 14 scheduled for early November 2013.
- Installation of deep aqua monitoring bore Dewhurst 8A scheduled for October 2013.
- Dewhurst Southern Flowline on-ground works expected to commence late October 2013.
- Ecological surveys – ongoing for current program through to December 2013.
- Methane testing - The next round of testing has also been rescheduled and is expected to take place in November 2013.

Pilliga rehabilitation:

- Irrigation is continuing as part of the rehabilitation of the Bohena and Bibblewindi sites in the Pilliga.

Site visits:

- Next community site visit to the Pilliga will be held on October 17.

Community:

- The Campervan and Motorhome Club of Australia's (CMCA) 28th National Rally is being held at Narrabri from 21 - 27 October 2013. Narrabri Shire Council are partnering with CMCA for the Rally and Santos are providing sponsorship for volunteer t shirts and attendee site tours.
- As part of a suite of activities happening across the local area during this period, the Crossing Theatre is hosting the inaugural *Interior Sounds* concert on Saturday 19 October 2013. David Campbell, Kate Ceberano and Daryl Braithwaite are amongst the artists participating in the concert. Santos is a major sponsor for the event.

Other:

- Santos' Development Application to Narrabri Shire Council for a Fluid Treatment Facility located at the Narrabri Operations Centre was passed by Council on 2 October 2013.
- In late June, Santos chose to refer the proposed exploration and appraisal program to the Commonwealth Government for assessment under the Environment Protection Biodiversity Conservation Act (EPBC). In early October 2013, the Department of the Environment determined that the program will not significantly impact water resources or other Matters of National Environmental Significance. The referred program involves the drilling of 15 new appraisal wells, recommencement of existing pilot wells, construction of associated flowlines and operation of approved water storage facilities, in the Narrabri area in northwest NSW. Santos asked that the impact of all historic operations, activities and clearing carried out by previous operators in the Pilliga also be assessed as part of the cumulative impact of the program. A copy of the referral decision is available at <http://www.environment.gov.au/epbc/notices/assessments/2013/6918/2013-6918-referral-decision.pdf>
- The Bibblewindi Exploration Pilot Expansion EIS is on public exhibition until 7 November 2013. Copies are available for viewing at the Santos Office, the Narrabri Shire Council office or available on the Department of Planning and Infrastructure website at http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=5934
- The Narrabri Shire Council has released their draft Mining and Extractive Industries Policy for public comment. A copy of the policy is available from Narrabri Shire Council website. Submissions close on 5 November 2013. http://www.narrabri.nsw.gov.au/index.cfm?page_id=1285&page_name=Public%20Exhibition%20and%20Notifications