

Narrabri Gas Project

NSW Planning Assessment Commission Field Trip to GLNG
June 2017



Contents

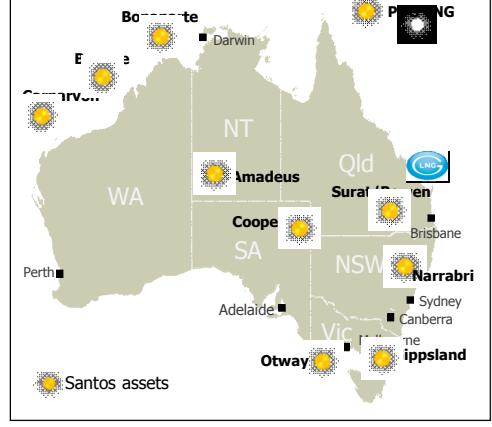
- About Santos
- The role of natural gas
- Natural gas from coal seams
- Hydraulic fracturing
- Overview of Queensland operations in context of Narrabri Gas Project
- Stakeholder engagement
- Western Slopes Pipeline
- Rehabilitation activities Narrabri
- Conclusion



About Santos

- › Leading Australian natural gas company
- › More than 60 years of responsible gas exploration, development and production across the nation
- › Supplying gas to Adelaide since 1969
- › Supplying gas to NSW since 1976
- › Extracting coal seam gas for approximately 20 years in Queensland
- › Employs around 3,000 workers
- › Large proportion of Australian shareholders
- › Drilled over 4,000 onshore wells across Australia

Australian energy company established in 1954



Map excludes Asian operations

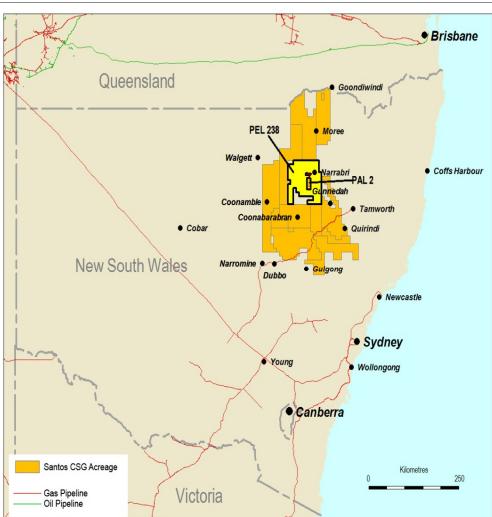
Santos
We have the energy.

3 |

Santos in New South Wales

- › Oil and gas exploration in the area since the mid 1960s
- › Coal seam gas exploration licences cover a large area of north west NSW
- › Exploration in NSW began in 2008
- › Acquired Narrabri operations in November 2011 from ESG
- › Field staff based at Narrabri Operations Centre, shopfronts in both Narrabri and Gunnedah

Focus on exploration around Narrabri



Santos CSG Acreage
Gas Pipeline
Oil Pipeline

4 |

Why do the project?

- › NSW imports >95% of its gas needs
- › AEMO 2016
 - From 2019, as developed 2P [proven and probable] reserves decline, the delivery of new gas reserves from existing fields, and / or the development of fields that are not yet producing gas, will be critical to maintaining sufficient gas supply to meet forecast demand to 2035.'
- › Potential to supply up to 50% of the State's gas needs (200TJ/day) – from certified reserves
- › Natural gas delivers ~50% GHG emission saving compared with the emissions intensity of the existing NSW grid.
- › Designated as a 'Strategic Energy Project'

Eastern Australia supply and demand

Sources: AEMO GSOO 2015 & Core Energy 2014, eastern Australia gas outlook 2035

Santos
We have the energy.

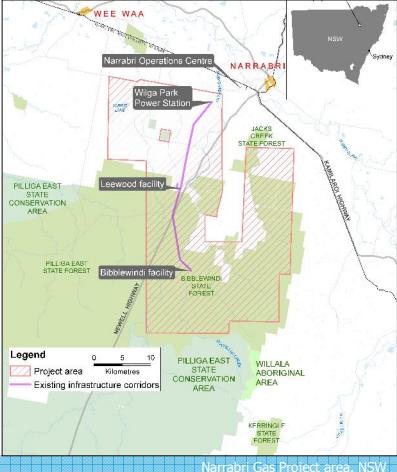
The stakes are high

Restricting coal seam gas development will adversely impact energy supply, affecting all Australians

- › Over 5 million homes and businesses use natural gas
- › 45% of manufacturing relies on natural gas as its prime energy source
- › 21% of the National Electricity Market generation capacity is provided by natural gas power stations
- › Insufficient gas supply will:
 - Push carbon emissions higher as electricity generation goes back to coal
 - Threaten competitiveness of manufacturing, risking ~100,000 jobs
 - Adversely impact our standard of living through higher gas prices

Santos
We have the energy.

Project Location



The Narrabri Gas Project area is located fully within the Petroleum Exploration Licence (PEL) 238 and Petroleum Assessment Lease (PAL) 2

- › Operations located on around 1,000ha or approx. 1% of 95,000ha project area
- › Majority of project area is state forest
- › No areas of national park or nature reserve
- › No mapped Biophysical Strategic Agricultural Land (BSAL) within project area
- › Central gas and water processing facility located outside the Pilliga at the Leewood site
- › Up to 200TJ/day of gas would be made available to the NSW market

Santos
We have the energy.

What is CSG? How is it obtained?



Gas Bubbling From Coal

Releasing pressure off coal releases releases natural gas – chemically CH_4

Created when coal is forming and is buried. Is released when pressure is released.

Target CSG zones are 200-1,000 metres sub surface

CSG does not contain ethane or longer chains (no liquid petroleum).

It can contain inert gas (N_2 and CO_2).

Production process is simply dewatering, inert removal and compression

In Narrabri the coals produce:

Water that is $\frac{1}{3}$ to $\frac{1}{2}$ seawater strength – NaCl and NaHCO_3 , (~ recreational water per guidelines)

Gas which is produced at low pressures and which is an effective and clean-burning energy source

Santos
We have the energy.

In CSG development water handling requires large early investment

Expense of upfront water handling increases the risk to the investor, with ongoing learning after development commences

Coal Seam Well Profile

time

Conventional Well Profile

time

Key take aways:

- Not possible to predict precisely how a coal will give up gas until after drilling and depressurisation data is gathered
- Successive well planning must learn from the immediate past drilling and production history

9 | Santos
We have the energy.

Project Facilities

The project includes wells, an underground gathering pipeline network, gas processing and gas compression

Tintfield Pilot well

- Up to 850 wells on a maximum of 425 sites
- Lateral wells with artificial lift
- Wellhead separation
- Separate gas and water gathering pipelines
- Nodal Compression at Burrendong
- Gas & water trunklines connecting Burrendong to Leewood
- Dehydration, CO₂ removal & gas compression
- Water storage, RO & salt crystallisation, Irrigation
- Electricity generation
- Pipeline tying to Moomba-Sydney pipeline will be constructed by APA Group and subject to a separate approval process

10 | Santos
We have the energy.

What is the Narrabri Gas Project SSDA and EIS?

The SSDA and EIS for the Narrabri Gas Project submitted to the NSW and Commonwealth Governments for assessment

- The EIS is required to:
 - Identify all potential impacts of the Narrabri Gas Project
 - Assess those potential impacts
 - Detail plans and procedures to mitigate and manage potential impacts
- The EIS is a comprehensive document which:
 - Contains almost 7,000 pages and 45 technical studies
 - Draws on data from over 13,000 hours of on-ground ecological surveys, water monitoring activities dating back to 2010, over 1400 hours of background noise monitoring and three months of baseline air quality data collection
 - Contains reports, studies and modelling by scientific and environmental experts on areas including water, flora, fauna, soil, noise, air quality, cultural heritage and social impacts
 - Details around 100 commitments which will assist to minimise the impact of the project
- **The EIS concluded the risks to the environment are minimal and manageable**

The EIS is the major assessment document for the Narrabri Gas Project



Water sampling, Leewood Water Treatment Plant

Santos
We have the energy.

11 | Page

Key findings of the EIS



Bibblewindi Pilot well

The EIS concluded the Project can proceed safely with minimal and manageable risk to the environment

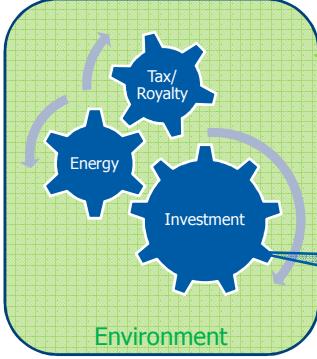
- Water available to farmers and the community will be unaffected
- Drilling can be carried out safely adhering to the *NSW Well Integrity Code of Practice*, which was reviewed by the NSW Chief Scientist and Engineer
- Significant impacts on threatened and endangered flora and fauna will be avoided
- Known Aboriginal cultural heritage sites will be protected
- The Project can coexist with current land uses including agriculture and forestry
- Social impacts can be managed
- Substantial economic benefits will be generated including:
 - 1,300 jobs during construction and 200 ongoing positions during operations
 - Around \$1.2 billion in royalties to NSW
 - A regional benefit fund of up to \$120 million to support local community projects, programs and initiatives

12 | Page

Santos
We have the energy.

Risks must be managed (and understood)

There are environmental, safety, social and economic risks to be managed in a way which enables investment



The EIS quantifies objective criteria for max impact project will have on the whole of the environment. For example, despite uncertainty of well locations, EIS states objective criteria that defines the environmental outcomes

Investors and Treasury (Tax) need objective criteria to assess investment risk. Project approval (if granted) must have conditionality that is **objective, quantitative & clear**

To successfully deliver gas to NSW all elements must work together:

- Environmental footprint and economic benefit
- Government, Local Community and investors (ca. \$3bn needed!)

Santos
We have the energy.

EIS – Chapters

The EIS is a comprehensive assessment of the potential impacts of the Project

Part A: Introduction	Part C - continued
1 Introduction	18 Air quality
2 Location and setting	19 Noise and vibration
3 Strategic context and need	20 Aboriginal heritage
4 Legislation and approvals	21 Historic heritage
5 Commonwealth requirements	22 Traffic and transport
Part B: The Project and Consultation	23 Landscape and visual
6 Project description	24 Greenhouse gas
7 Produced water management	25 Hazard and risk
8 Assessment of alternatives	26 Social and Health
Part C: Environmental Assessment	27 Cumulative impacts
9 Community and stakeholder consultation	28 Waste management
10 Approach to the impact assessment	29 Cumulative impacts
11 Groundwater	
12 Surface water	
13 Hydrology and geomorphology	
14 Soils and land contamination	
15 Ecology	
16 Aquatic ecology	
17 Property and land use	
18	
Part D: Commitments and Conclusion	
30 Environmental management and monitoring	
31 Project commitments	
32 Conclusion	
33 References	

Santos
We have the energy.

EIS – Technical Appendices

The EIS contains detailed reports on a number of key issues prepared by subject matter experts

A	Environmental Assessment Requirements	K	Agricultural Impact Assessment
B	Referral of proposed action	L	Air Quality Impact Assessment
C	Field Development Protocol	M	Noise and Vibration Assessment
D	Stakeholder & community consultation	N1	Aboriginal Cultural Heritage Assessment
E	Drilling waste letter from the EPA	N2	Cultural Heritage Management Plan
F	Groundwater Impact Assessment	O	Historic Heritage Impact Assessment
G1	Managed release study (Bohena Creek)	P	Traffic Impact Assessment
G2	Concept Irrigation Design	Q	Landscape and Visual Impact Assessment
G3	Water Monitoring Plan	R	Greenhouse Gas Assessment
G4	Water Baseline Report	S	Hazard and Risk Assessment
H	Hydrology and Geomorphology	T1	Social Impact Assessment
I1	Interpretive Soils Report	T2	Health Impact Assessment
I2	Biophysical Strategic Agricultural Land Site Verification Certificate	T3	Chemical Risk Assessment
I3	Contaminated Land Assessment	U1	Economic Assessment (Cost Benefit analysis)
J1	Ecological Impact Assessment	U2	Economic Assessment (Macroeconomics analysis)
J2	Biodiversity Assessment Report	V	Rehabilitation Strategy
		W	Decommissioning Report

15 | Santos
We have the energy.

A pipeline will link the project to the Moomba - Sydney pipeline

The proposed 450km Western Slopes Pipeline will undergo a separate approval process and be constructed and owned by APA Group

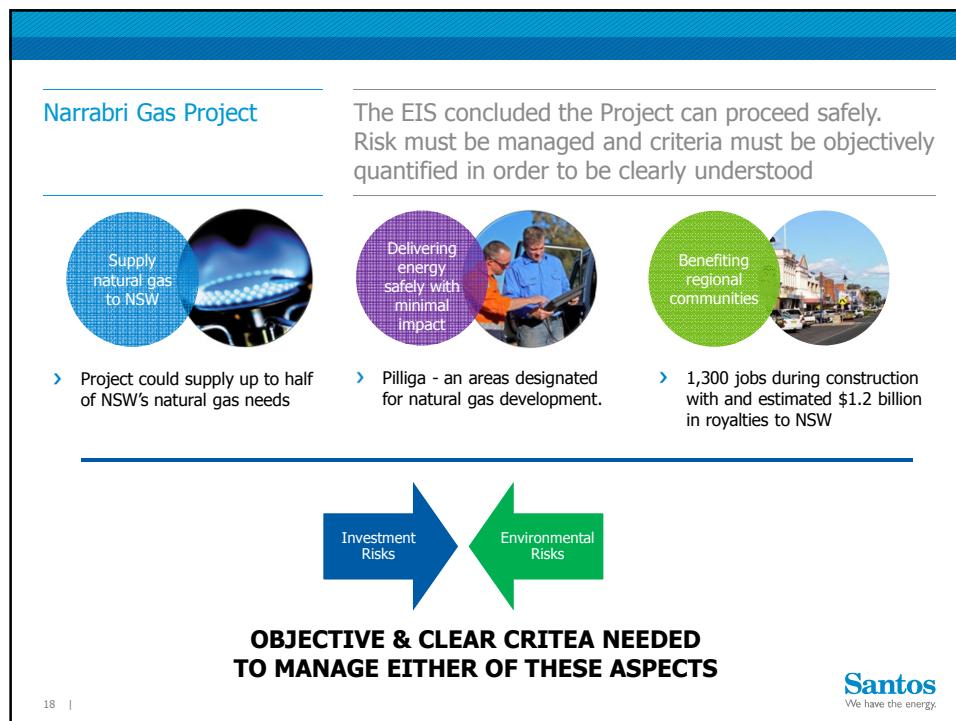
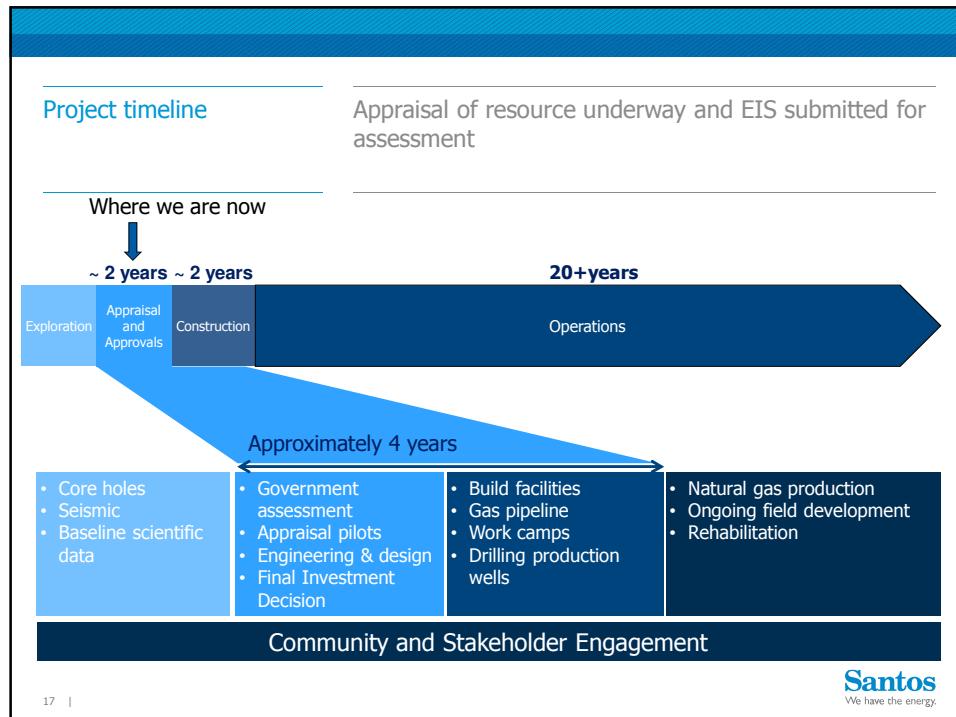
- APA is Australia's largest gas infrastructure business
 - Owns and/or operates 15,000km+ of pipeline infrastructure
 - Transports around half of Australia's natural gas across all mainland states and territories
- APA will soon submit a preliminary Environmental Assessment to the State, commencing the assessment process under Part 5.1 of the Environmental Planning and Assessment Act 1979
- Following construction, land is returned as close as possible to its previous productivity, with topsoil and natural drainage patterns re-established
- As the pipeline is well (generally 900mm) underground, shallow-rooted vegetation can be re-established across the entire pipeline right of way (e.g. cropping)
- No long term impacts would be expected to land uses that rely on cropping and grazing

Western Slopes Pipeline – Proposed Route Map

Key

- existing transmission pipeline
- existing lateral pipeline
- proposed pipeline

16 | Santos
We have the energy.



Interest Group Issue: Queensland operations vs. Narrabri Proposal

Santos
We have the energy.



Santos
We have the energy.

What's in a question?

It depends

For example: How safe is road transport ?



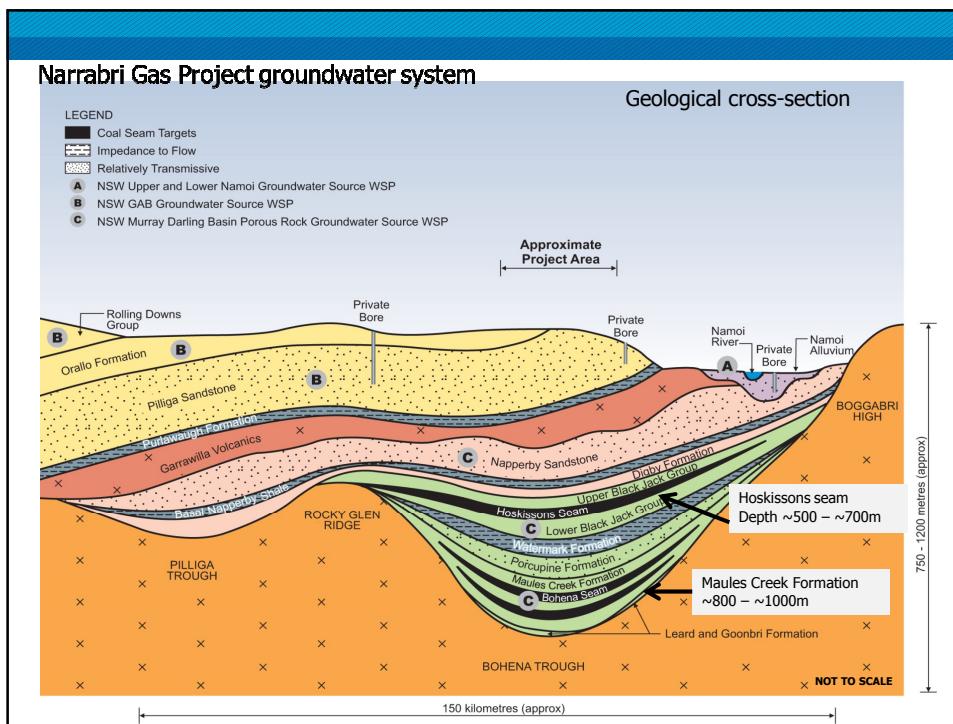
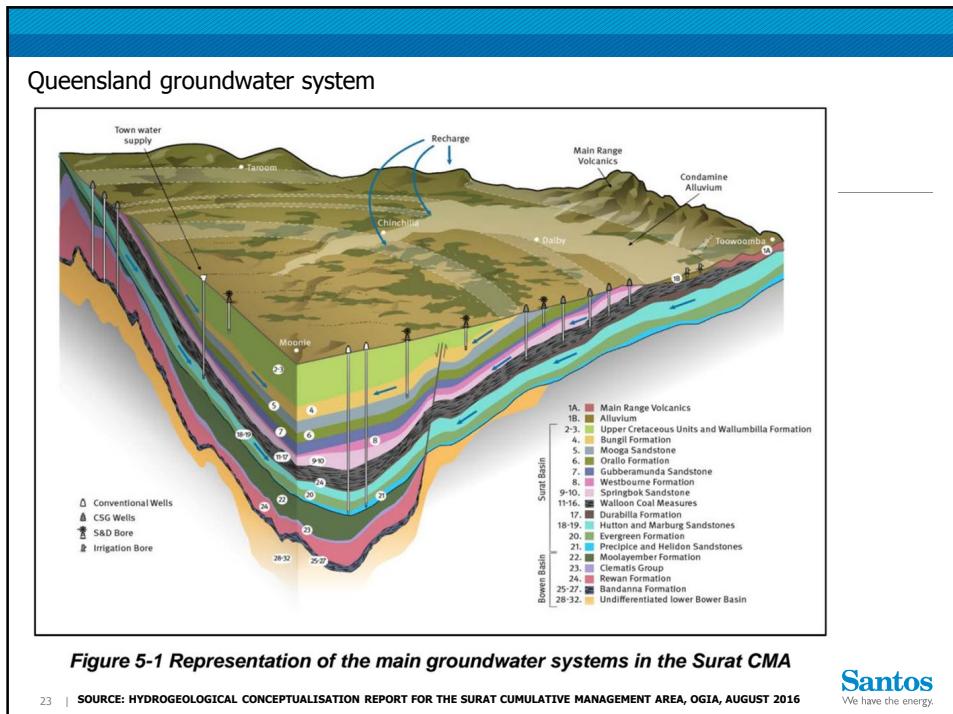
Santos
We have the energy.

Overview of QLD operations and proposed NSW project		
Aspect	Queensland operations	Proposed NGP
Number of wells	Surat Cumulative Management Area (CMA) 6,500 currently, 17,900 total proposed.	850 new wells
Number of wells per pad	Up to 4 on 1.5 hectare pad.	Up to 3 on max. 1 hectare pad
Production well spacing	Minimum ~780m	Minimum 750m
Well designs	Vertical and deviated	Vertical, lateral and deviated
Depth to target coal seams	500-1200m (in some cases ~150m)	500-1200m
Need for hydraulic fracturing	Yes (historically~10%, future 50-100%)	No
Landholder water sources	Over 2000 landholder bores access water from same Walloon target coal seams in Surat CMA (75% of affected bores above triggers are in Walloon coals)	Most landholders bores <150m deep, none within target coal seams
Right to extract groundwater	Statutory right under the petroleum tenure	WAL required from sustainable allocation within LTAAE limit.
Annual water volumes extracted (GL/year)	Surat Basin CMA total:(OGIA, 2016) <ul style="list-style-type: none"> • Current CSG: 65GL • Current non-CSG: 203GL • Peak expected CSG: 110GL 	Average 1.5GL Peak expected 3.65GL (years 2-4)

21 | NOTE: Information in table is indicative and generalised for purpose of comparison

Overview of QLD operations and proposed NSW project		
Aspect	Queensland operations	Proposed NGP
Water Management Framework	Baseline assessment, monitoring, recording and 'Make Good' provision. OGIA has statutory role in CMAs to coordinate and assigns Make Good requirements to tenure holders.	Baseline assessment, monitoring, recording and 'Make Good' provisions in accordance with the Aquifer Interference Policy.
Water reuse activities undertaken	Irrigation, stock watering, construction, dust suppression, managed release & reinjection.	Irrigation, stock watering, construction, dust suppression and managed release (when existing flows in creek >100ML)
Underground gas storage	Yes	No
Field design and infrastructure placement	Field Development Protocol, consistent with conditions of approval.	Field Development Protocol and conditions of any approval
Cumulative impacts	Surat Basin CMA managed by OGIA. Its 2016 Report found: <ul style="list-style-type: none"> • Less water extraction than expected • CSG takes <2% of volume extracted for irrigation from Condamine Alluvium • No change from background trends in water pressure of non-target formations 	Assessed. 17 other existing and proposed projects considered. Cumulative groundwater effects with Narrabri North Coal Mine dominated by impacts of mine, NGP's contribution indiscernible

22 | NOTE: Information in table is indicative and generalised for purpose of comparison



Narrabri Gas Project

The EIS found water available to farmers and the community will be unaffected



- As part of the EIS, a Groundwater Impact Assessment (GIA) was developed to determine what impact the Project would have on local water
- The GIA incorporated the findings of a regional groundwater model developed by specialist groundwater scientists
- The model simulated water pressure and included data from more than 100 locations in the Narrabri region
- The model was peer-reviewed by the CSIRO and described as "state of the art" and suited to assess the potential impacts
- The GIA found that impacts to the good quality shallow groundwater sources would be negligible

Santos
We have the energy.

Narrabri Gas Project

Water extraction in context

- The water extracted is not the same water source accessed by farmers and the community
- It is not from the Great Artesian Basin, but from coal seams much deeper, generally 500 - 1,200m underground.
- Underground rock formations isolate coal seams from the water used by farmers and the community
- The maximum drawdown from the Project would be less than 0.5m in the Namoi Alluvium and Pilliga Sandstone. Predicted to occur in Pilliga Sst around 350 years after project commencement.
- Indiscernible from existing variations in groundwater pressures and storage volumes caused by existing uses and replenishment with seasonal fluctuations

Santos
We have the energy.

Narrabri Gas Project

Water extraction in context: Long Term Assigned Groundwater rights in Groundwater Resources in the Project Area

Long term average annual extraction
limits (ML/yr)
Share component of local water utility access licences (ML/yr)
Project component
Share component of aquifer access licences (ML/yr)^{1,2}

Source: DPI Water - 2015/16 NSW Water Register
Excludes basic entitlement rights
Includes licence categories Aquifer, aquifer (high security), aquifer (medium security) and surface water management
Assume 1ML per unit share

Category	Long term average annual extraction limits (ML/yr)	Share component of local water utility access licences (ML/yr)	Project component	Share component of aquifer access licences (ML/yr) ^{1,2}
Upper Narrabri Groundwater source	~100,000	~10,000	~10,000	~10,000
Lower Narrabri Groundwater source	~80,000	~0	~0	~0
NSW GAB - Sustainable recharge groundwater source	~20,000	~0	~0	~0
NSW MGB - Gunnedah Owyee groundwater source	~200,000	~0	~0	~0

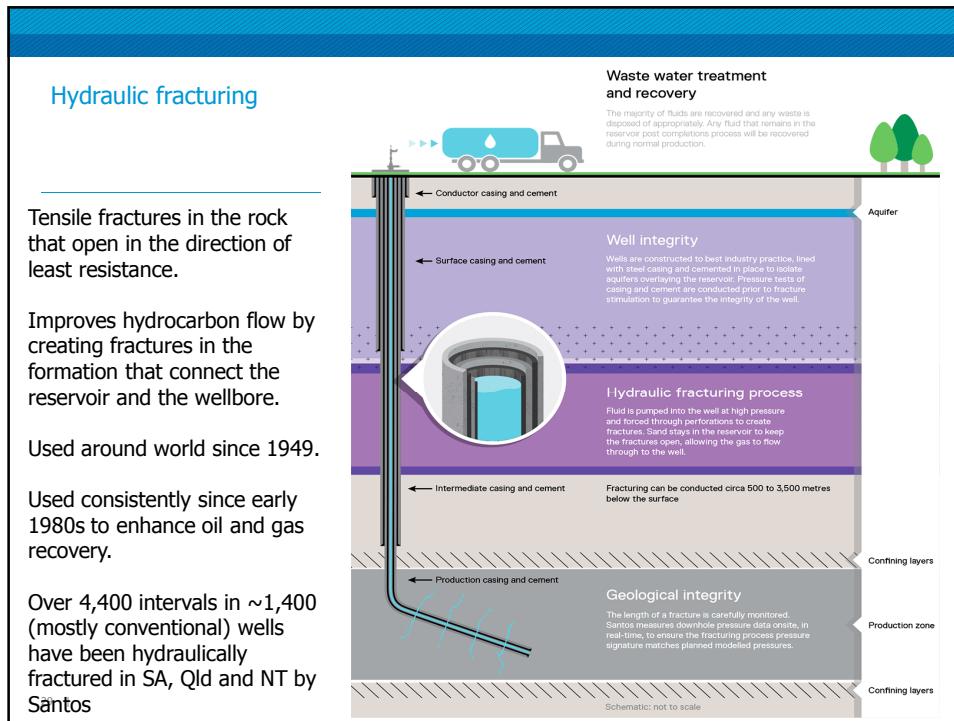
27 |

Santos
We have the energy.

**Interest Group Issue:
Hydraulic Fracturing**

Santos
We have the energy.

Santos
We have the energy.



Hydraulic fracturing (HF) Utilised extensively over a long period of oil and gas production

HF are designed and monitored by engineers: In situ stresses control the pressure and direction of fracture initiation and growth, consistent with the laws of physics.

Fluid is pumped into the formation containing oil or gas at high pressure. The pressure of the fluid fractures the layer to produce tiny cracks.

Underground target formations are geologically separated from other underground layers and all wells are surrounded by steel and concrete. This ensures no movement of fluid into aquifers.

Even in the highly unlikely event that there was some connection between fracturing fluid and an aquifer, the CSIRO concludes that the risk of contamination would be minimised because during production water would flow away from the aquifer and towards the well.

CSIRO found potential for groundwater contamination from HF fluids is considered low risk.

Santos
We have the energy.

Hydraulic fracturing (HF)

The fluid is around 99% water and sand. The sand remains underground to hold open the cracks, whilst the rest of the fluid is pumped back to surface and recovered.

A small amount of chemicals are also used to reduce friction, remove bacteria, dissolve some minerals and improve the transportation of sand. These chemicals are found in many household products such as toothpaste, baked goods, ice cream, food additives, detergents and soap.

Fracture height growth has been extensively measured using micorseismic monitoring in the US and Cooper Basin (SA)

- Average growth of 100m with maximum typically around 300-350m
- NO evidence of fracture growth into shallow aquifers has been recorded

Numerous reputable independent reports and inquiries have found the HF process to be safe and sustainable when accompanied by operational capability, good management processes and a robust regulatory framework.

Santos
We have the energy.

Interest Group Issue: Stakeholder Engagement

Santos
We have the energy.



Queensland operations: Economic and Community Opportunity	<p>Natural gas activity in Queensland has led to significant investment throughout the state</p>
<p>Investment by the Santos-led GLNG project since January 2011:</p> <ul style="list-style-type: none"> • \$15.4 billion in materials and services Australia wide • \$8 billion in Queensland alone (\$1 billion in regional areas) • 10,000+ people have worked on GLNG, and many more suppliers and businesses have benefitted • Roma unemployment of 1.9% compared to Queensland's 6.1% • \$63 million in landowner compensation • \$65 million in regional community projects: aeromedical services, airports, hospitals, schools, housing, training, infrastructure, pest and weed management, community events and organisations • \$140 million in road upgrades and maintenance 	
	

33 |

Queensland operations: Landowners and Communities	<p>Respect, openness and regular communication underpin strong relationships</p>
<p><u>Landholder relationships</u></p> <ul style="list-style-type: none"> • Respect and openness at all times • Engage early and regularly • Results to date: ~1450 agreements with ~410 landholders for long-term gas production infrastructure • Opportunity for landowners to improve their own business <p><u>Community considerations</u></p> <ul style="list-style-type: none"> • All parties must commit to open and regular communication • Invest time to educate, answer questions, listen to each other and respond to concerns • Recognise and prepare for the distinct phases of high-activity construction and long term operation 	
	

34 |

**Queensland operations:
Landowners and
Communities**

Landholder engagement process

```

graph TD
    A[Meeting with you] --> B[Keeping in contact]
    B --> C[Site access]
    C --> D[Possible re-access]
    D --> E[Keeping in contact]
    E --> F[Compensation payment]
    F --> G[Pre-start meeting]
    G --> H[Site monitoring & compliance]
    H --> I[Keeping in contact]
    I --> J[Continued access]
    J --> K[Keeping in contact]
    K --> L[Meetings to discuss preparation of the CCA]
    L --> M[Property mapping]
    M --> N[Preliminary discussions]
    N --> O[Meetings to discuss preparation of the CCA]
    O --> P[Deliver the CCA & letter of offer]
    P --> Q[Agree on the CCA]
    Q --> R[Average first access]
    R --> S[Tool box meeting]
    S --> T[Potential variations to the CCA]
    T --> U[Ongoing compensation]
  
```

**Master Conduct and Compensation Agreement
Property Wide Rules of Conduct** **Santos**
GLNG Project

The primary document governing the behaviour by those entering private property for Petroleum Activities is the *Land Access Code (November 2010)*. In addition, all activities associated with the Santos GLNG project are subject to these Rules of Conduct.

1. Vehicles	<ul style="list-style-type: none"> a) Vehicles will use approved, agreed-upon paths of entry, access roads, tracks, designated work areas or set-down areas. b) Driving to be conducted to suit the prevailing conditions and to minimise noise and dust. c) Vehicles will give way to livestock. d) Injury or killing of livestock will be reported as soon as reasonably practicable. e) In wet conditions vehicle movements must be minimised to essential traffic and minimise damage to access points, roads and tracks. f) Vehicles driven by or carrying Landholders and their families, personal visitors, employees and contractors, have right of way over Santos project-related traffic.
2. Dust	<ul style="list-style-type: none"> a) Activities will have procedures in place to control dust impacts.
3. Fire	<ul style="list-style-type: none"> a) Appropriate fire management procedures will be in place when undertaking activities. b) No smoking except in designated areas.
4. Livestock	<ul style="list-style-type: none"> a) Where practicable, activities will be conducted with minimal disturbance to livestock.
5. Environment	<ul style="list-style-type: none"> a) Weed and pest management procedures will be used when undertaking activities. b) All vehicles must hold current weed hygiene declarations. c) All rubbish must be disposed of in designated receptacles and removed from property.
6. Infrastructure	<ul style="list-style-type: none"> a) Gates must be left in the position found, unless Landholder advises otherwise. b) No modifications are to be made to gates, fences, grids, roads or tracks without the Landholder's consent. c) Damage to the Landholder's infrastructure must be reported as soon as reasonably practicable. d) Landholder infrastructure is off-limits, unless access has been granted by the Landholder.

35 |

**Queensland operations:
Landowners and
Communities**

Example of our commitment to open and thorough communication: Ready Reckoner guide for landholders

The guide illustrates and explains every possible activity that may take place through exploration, development, production and rehabilitation.

Ready Reckoner
Construction and operations activity guide for landholders

Site monitoring and compliance

As construction is the phase with the highest potential impact on your property, it is critical to its successful completion and monitoring during this phase. Your Santos GLNG landholder liaison will monitor and enforce the rules of conduct outlined in the CCA.

Access and movement of the speed compensation including other compensation

- monitor and enforce the rules of conduct outlined in the CCA
- monitor and enforce the speed compensation including other compensation (e.g. ATVs)
- monitor and enforce weed and erosion control procedures in line with Santos GLNG guidelines
- monitor and enforce compliance and enforcement of the rules of conduct outlined in the CCA

Santos GLNG has control measures in place to regulate traffic around the Maranoa region. This includes using an in-vehicle monitoring system.

Doorsteps: ongoing

Your Santos GLNG landholder liaison is always happy to answer any questions or concerns you have.

Doorsteps: at request

Your Santos GLNG landholder liaison.

Potential variations to the CCA

Throughout the construction phase there may be times when changes or additions to the CCA are required. Some examples of anticipated Some examples are:

- change in location of fence
- change in location of access road
- the location of smaller associated infrastructure.

Doorsteps: as required

Once rehabilitation is complete, the land is returned to you in accordance with your chosen purpose. Refer to wet lease rehabilitation and decommissioning on page 10 for further information.

Doorsteps: as required, weekly to periodically throughout the year

Your Santos GLNG landholder liaison.

Santos
We have the energy.

36 |

<p>Narrabri Gas Project: Landholder benefits</p> <p>Santos was a primary signatory to the 'NSW Principles of Land Access'.</p> <p>Currently have sufficient agreements with landholders in the Narrabri area</p> <p>Land Access Agreements and Farm Management Plans are agreed with landholders covering infrastructure location, conduct and timing of activities, communication, compensation and any property specific requirements.</p> <p><u>Compensation Framework in NSW for production</u></p> <p>Year 1: \$30,000 annual service fee + 120% of land value of the area utilised</p> <p>Year 2 onwards: \$30,000 annual service fee + share of Landholder Incentive Fund.</p> <p>Landholder Incentive Fund = 5% of Santos' annual royalty payment. Each landholder receives a share proportionate to the amount of their land being utilised.</p>	<p>Santos has no shortage of landholders for access</p> <p>Santos We have the energy.</p>
--	--

37 |

<p>Coexistence with other land uses</p> <p>Harvest at Tintsfield property, near Narrabri, December 2016</p>	 <p>Santos We have the energy.</p>
--	---

38 |

Interest Group Issue: Rehabilitation activities Narrabri

Santos
We have the energy.



Santos
We have the energy.

Rehabilitation activities: Narrabri

Rehabilitation of sites impacted by previous operator's activities is progressing well

Bibblewindi facility:



May 2013



May 2017

Santos
We have the energy.

<p>Rehabilitation activities: Narrabri</p>	<p>Rehabilitation of sites impacted by previous operator's activities is progressing well</p>
	

In closing.....

Questions?

Santos
We have the energy.



Santos
We have the energy.