



Chapter 1

Introduction

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Chapter 1 Introduction

Santos NSW (Eastern) Pty Ltd (the proponent) on behalf of its joint venture participants, propose to develop natural gas in the Gunnedah Basin about 20 kilometres south-west of the town of Narrabri, NSW (the Narrabri Gas Project or the project).

The project area is contained within the existing petroleum exploration lease (PEL) 238 and incorporates petroleum assessment lease (PAL) 2 and petroleum production lease (PPL) 3. Santos NSW Pty Ltd and its joint venture participants, who hold these tenures, lodged four petroleum production lease applications (PPLAs) in May 2014 covering the project area, being PPLAs 13, 14, 15 and 16. The total project area is around 95,000 hectares; however, the disturbance footprint from project infrastructure would take up no more than 1,000 hectares, or around one per cent of the project area.

The project area is largely located on land that the NSW government has specifically designated for commercial extraction activities. The project area contains a portion of the region known as ‘the Pilliga’, with the majority of the project located on Crown land. The Pilliga is an agglomeration of forested areas covering more than 500,000 hectares around Coonabarabran, Baradine and Narrabri. In 2005, the NSW Government completed a comprehensive review of land use in the Pilliga, including a regional assessment of the Brigalow and Nandewar Bioregions. The regional assessment was a landscape scale land-use planning project and entailed multidisciplinary studies. The assessment sought to balance conservation, recreation, cultural values, extractive land uses and commercial activities.

A key outcome of this regional assessment resulted in around 240,000 hectares, or almost half of the Pilliga, being protected as reserves under the *National Parks and Wildlife Act 1974* in 2005. The location and area of the new national park reserves were established outside of the project area in recognition of its potential to support a natural gas project.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purposes of ‘forestry, recreation and mineral extraction’ under the *Brigalow and Nandewar Community Conservation Area Act 2005*. One of the strategic aims for the areas zoned State forest was to “provide for exploration, mining, petroleum production and extractive industry”. The parts of the project area on state land are located within this section of the Pilliga.

The project requires the installation of gas wells, gas and water gathering systems, gas processing and compression facilities, and other supporting infrastructure. The natural gas would be treated at a central gas processing facility on a property called Leewood that is owned by Eastern Star Operations Pty Ltd (now Santos NSW (Operations) Pty Ltd) and its joint venture participants.

The gas would be made available to the NSW market via a high-pressure gas transmission pipeline which would connect to the existing Moomba to Sydney gas pipeline. The pipeline will be constructed and operated by specialist pipeline company APA Group, and is not part of this project Environmental Impact Statement (EIS).

A general introduction to the production of natural gas is provided in Section 1.1, while the project that is the subject of this environmental impact statement is discussed further in Section 1.2. The detailed description of the project is contained in Chapter 6 and the project’s water management strategy is discussed in Chapter 7.

1.1 General introduction to natural gas

1.1.1 Natural gas resources

Natural gas is a valuable resource as it is a reliable source of energy that is utilised across a number of sectors, including gas powered electricity generation facilities, for heating and cooking in residential homes and businesses and in large industrial uses such as manufacturing. The resource complements renewable energy and results in lower greenhouse gas emissions per unit of energy when compared to coal. It has been part of Australia's energy mix since 1997 (CSIRO 2015).

It is important to note that natural gas from coal seams is the same as natural gas (methane) from other types of rock, for example sandstone or shale. The exploration and development processes, engineering principles and scientific underpinnings of well integrity are fundamentally the same.

If undisturbed by either geological processes or human intervention, natural gas in underground coal seams remains bonded to the surface of coal particles. The coal seams are typically saturated with water, and it is the pressure of water on the coal that keeps the gas in place (refer to Figure 1-1). Natural gas in coal seams is held by water pressure typically at depths of between about 500 and 1,200 metres.

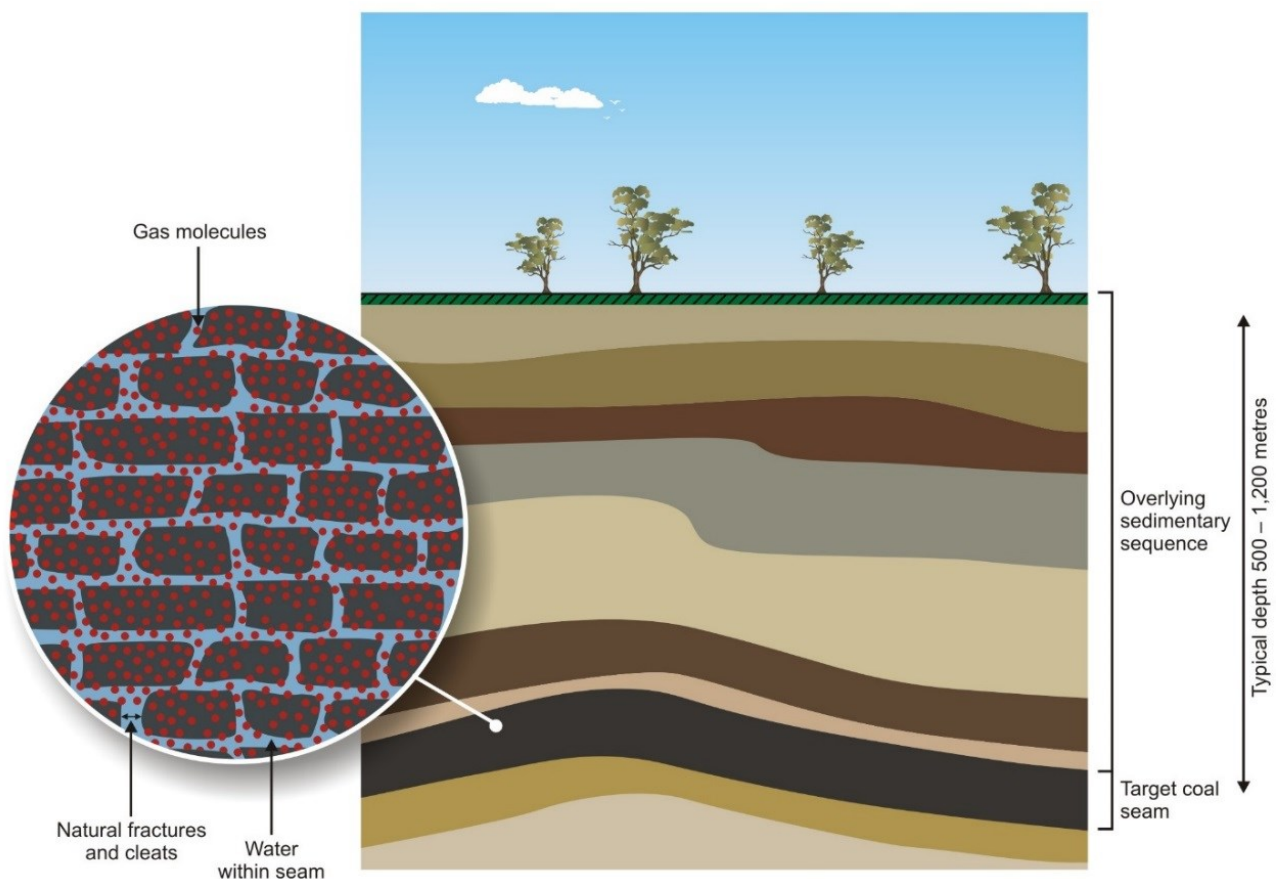


Figure 1-1 Diagram showing adsorption of gas molecules within a coal seam

Natural gas from coal seams is reached by drilling a gas well through overlying rock strata until it reaches the target coal seam. To release the gas from the coal, the water pressure must first be reduced. This is achieved by extracting the water through the gas well which then allows the gas to flow to the surface through the well. At the surface, the water and gas are separated and piped to water and gas processing facilities respectively. The typical process for producing natural gas from coal seams is shown in Figure 1-2.

There are a number of key differences between the process of extracting natural gas from coal seams and open cut resource mining. In gas extraction, the area required to host infrastructure is proportionally small and widely dispersed. This is in contrast to open cut mining, whereby a very large contiguous area is either mined or required to host supporting infrastructure.

Natural gas extraction does not require the removal of overburden material—with rock, coal and minerals remaining in place in the ground. Consequently, there is minimal change to the surface landscape as a result of natural gas extraction, and no permanent voids, pits or waste rock emplacements are left at the end of the lifecycle of development.

The rehabilitation of areas disturbed during natural gas extraction is generally easier than for open cut mining. This is largely due to the smaller area of surface disturbance at each location, along with plant root zones remaining intact, and therefore, ecologically functional. This minimises the impacts of fragmentation and allows vegetation and ecosystems to rehabilitate effectively due to the proximity of surrounding undisturbed landscape.

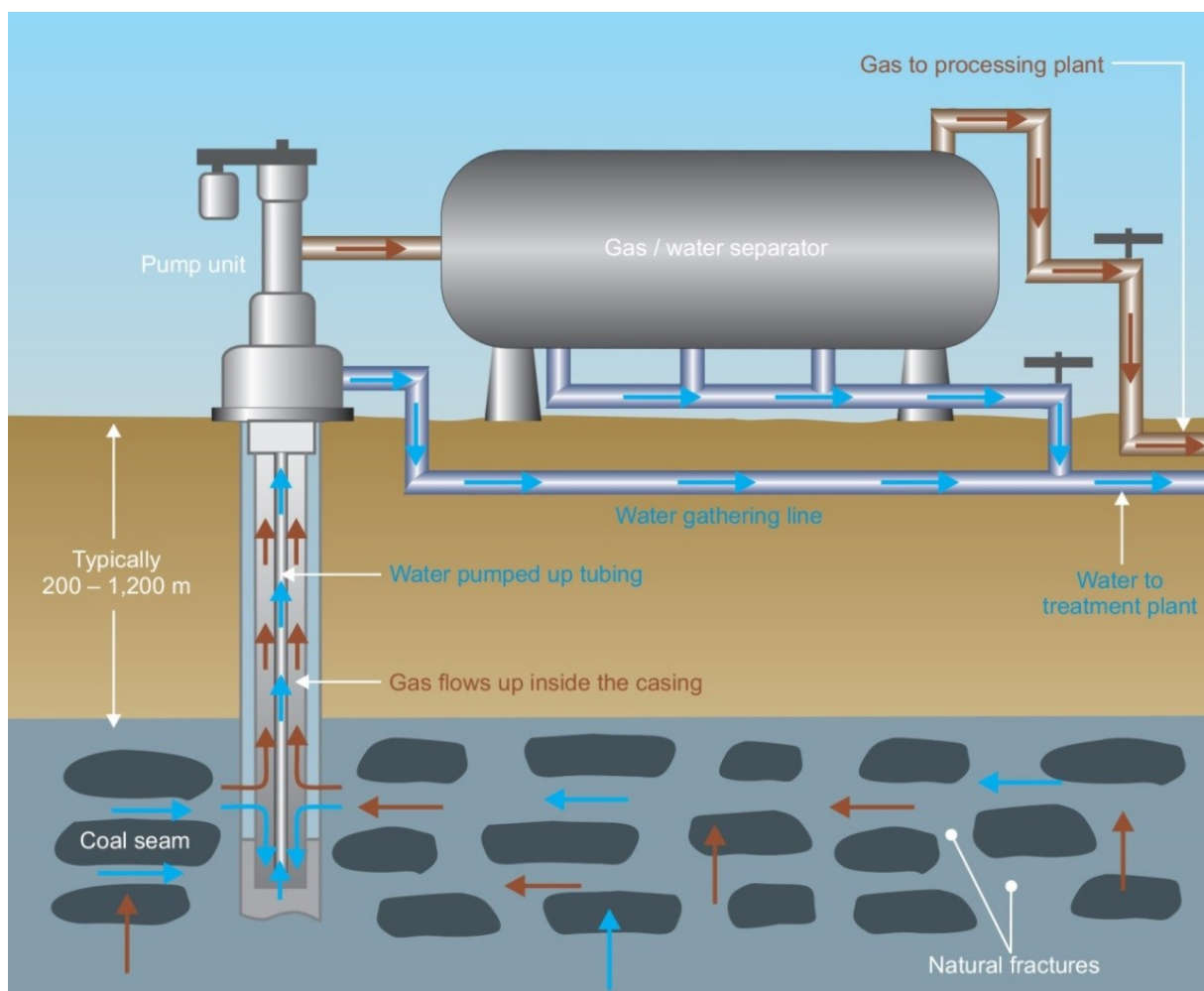


Figure 1-2 Typical gas and water lifting design for producing natural gas from coal seams

1.1.2 Lifecycle of development

Field development of natural gas resources generally occurs over the following four key phases:

- exploration and appraisal – which is how the gas resources are identified and then assessed
- construction – which includes drilling and completion of gas wells and associated supporting infrastructure
- operation - the production of gas
- decommissioning and rehabilitation – where gas wells are decommissioned in line with Government guidelines, including sealing of the well with cement, removing surface infrastructure and rehabilitating the well pad.

There is a significant amount of overlap between the key phases of field development. Exploration and appraisal activities are generally ongoing as different locations are investigated over the lifecycle of development. Similarly, some well sites may be undergoing decommissioning and rehabilitation activities, while new gas wells are being constructed elsewhere in the field.

The placement of field infrastructure is dependent on the ongoing assessment of gas reserves that occurs during the exploration and appraisal phase. Therefore, the exact placement of field infrastructure cannot be precisely determined in early planning stages, and is instead, typically marked for development within a broader area for planning purposes. The precise placement of infrastructure is also dependent on environmental and social factors identified and assessed through planning processes such as environmental impact assessment and resultant management plans and protocols.

Exploration and appraisal

Exploration activities are undertaken to determine the geological context and availability of gas at a particular location. Exploration often involves initial studies to identify prospective resources through geological assessments and geophysical surveys, including seismic surveys. Where these assessments identify the location of a suitable geology that may contain gas, core and chip holes may be drilled to determine the geological conditions within the seam. No gas is produced during core and chip hole drilling.

If geophysical surveys and core hole drilling identify promising geological conditions, pilot wells (also known as appraisal wells) can be drilled to confirm the composition, quality and volume of gas within the seam, and ultimately, to determine the viability of further developing the field. Access to pilot well sites is provided by an access track. A number of pilot wells, known as a well set, are usually developed in a small group to assess the gas resource in the area.

Depending on the findings of exploration and appraisal, pilot wells may be converted into production wells or be decommissioned. Conversion of pilot wells into production wells involves construction activities as described below. Decommissioning currently involves sealing the well with a pressure-tested cement plug, removing surface infrastructure and fully rehabilitating the site in line with Government guidelines. Decommissioning activities are typically undertaken in accordance with industry standard practices and subject to statutory requirements in place at the time of decommissioning.

Construction

Once an exploration and appraisal program has confirmed the availability and quality of gas, production wells and associated infrastructure may be constructed. The required infrastructure includes production wells and associated well head equipment, underground gas and water gathering lines, water management facilities and gas processing facilities. Sometimes, in-field gas compression is also required.

The configuration of production wells varies between developments. The wells are usually developed in phases across the field. They are connected by a system of buried gas and water gathering lines, which converge at gas and water processing and management facilities.

Construction can occur throughout the lifecycle of field development. During this time, results from the ongoing assessment and appraisal of pilot and production wells, plus the overall productivity of the coal seam, inform the location of future production wells.

Within NSW, all wells drawing natural gas from coal seams (including exploration and appraisal wells) must be managed in accordance with the:

- *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012)
- *NSW Petroleum (Onshore) Act 1991*
- *Exploration Code of Practice: Environmental Management* (NSW Department of Industry, Skills and Regional Development 2015)
- *Exploration and Production Guideline: Petroleum Drilling and Well Servicing - Competencies* (NSW Department of Industry, Skills and Regional Development 2015a)
- *Exploration Code of Practice: Rehabilitation* (NSW Department of Industry, Skills and Regional Development 2015b).

The drilling of wells involves a number of safeguard mechanisms to prevent the mixing of waters between aquifers, and to protect water quality within shallow aquifers used for irrigation, agricultural production and drinking water supply.

Operation (production of gas)

As noted above, the gas production process typically first involves the extraction of water from a coal seam in order to liberate the natural gas. Field development requires integrated management of both the gas and water produced during its operation, which influences the timing and number of gas wells that are drilled, and when those wells are commissioned for production. The indicative relationship between water and gas yields from a typical production well is shown in Figure 1-3, which shows an initial peak in water extracted from the coal seams. During the consistent production phase, methane production peaks, with water volumes reducing over time.

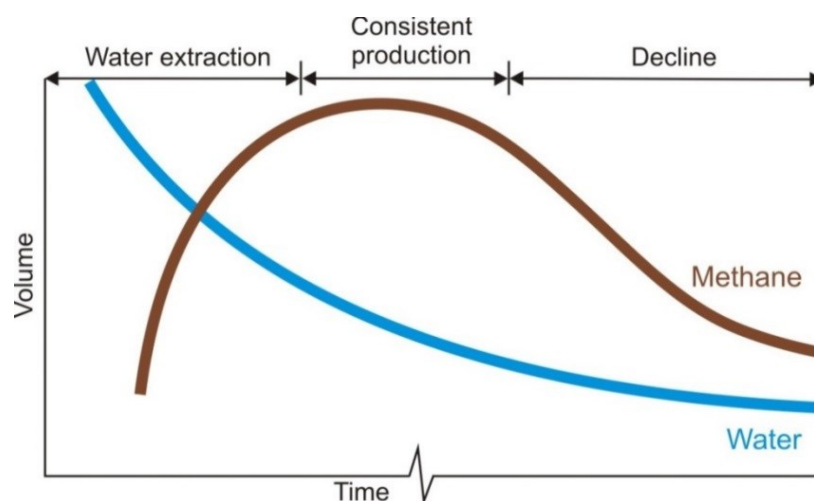


Figure 1-3 General relationship between gas and water yields from a natural gas from coal seam well

During the production process, water and gas travel up the production well to a separator located at the well head (refer to Figure 1-2).

Once the water is extracted from a production well it is transferred, typically via buried water gathering lines, to facilities for treatment and management. Water treatment usually includes a salt removal process that would yield both treated water and salt (refer to Figure 1-4).

Once the treated water is of suitable quality it can be beneficially reused in accordance with relevant water quality standards. The treated water is commonly beneficially reused for irrigation, stock watering, construction and dust suppression activities. The salt is managed in accordance with relevant regulations which may include disposal to a suitably licensed landfill.

The gas is also transferred, typically via buried gas gathering lines, to processing facilities for the removal of impurities and subsequent compression. In-field compression of the gas is often required to help boost gas pressure to enable it to be transferred to the processing facilities. The treated and compressed gas can then be sent to market. A generalised flow chart of this process is provided in Figure 1-4.

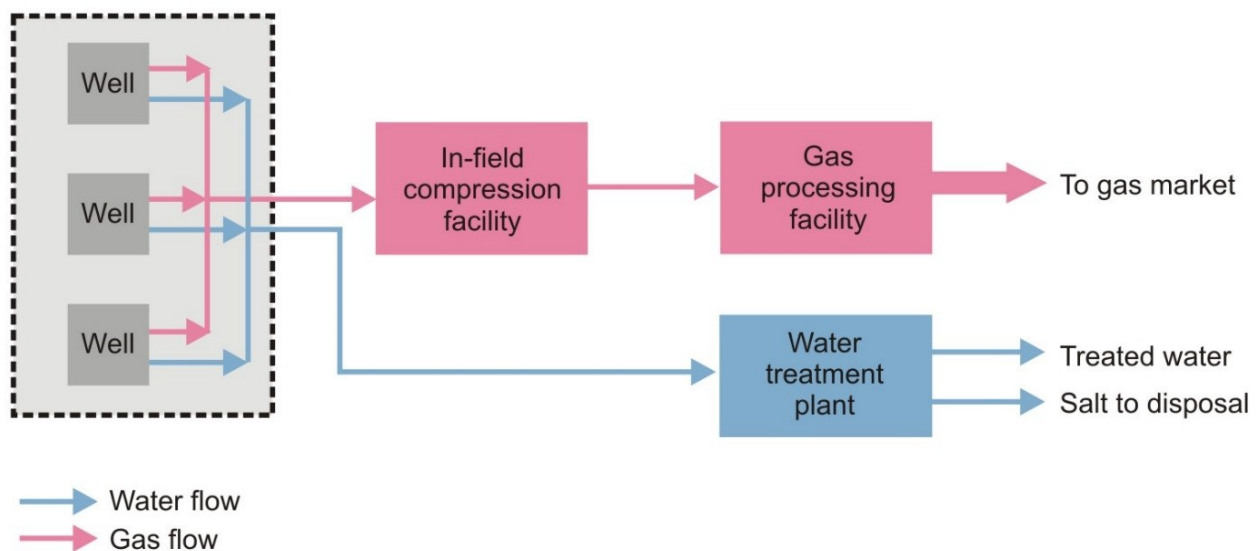


Figure 1-4 Typical water and gas flow during operations

Gas and water flow rates at production wells vary over time and from well to well. Production well lifespans can also vary, though are typically longer than 20 years.

Decommissioning and rehabilitation

Decommissioning and rehabilitation is undertaken in line with industry standard practices, statutory requirements and conditions of approval, usually collated and implemented through project-specific decommissioning and rehabilitation plans. Decommissioning and rehabilitation plans typically include a range of measures, including requirements to return disturbed areas to a stable condition similar to the surrounding area.

The decommissioning and rehabilitation of wells is an ongoing process that occurs throughout the lifecycle of development. Once a gas well is constructed, the part of the well pad not required for gas production may be rehabilitated. This is known as partial rehabilitation and allows vegetation and ecosystems to regenerate adjacent to the operating well infrastructure (refer to Figure 1-5). Areas cleared to establish gas and water gathering lines, and access tracks, may also be partially rehabilitated following construction, resulting in a narrow corridor remaining to allow for servicing during their operation.

Once wells reach the end of their operational life they are required to be decommissioned, with the site rehabilitated in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012). At the end of the operational life of a development, the infrastructure is decommissioned, and the sites fully rehabilitated.



Figure 1-5 A partially rehabilitated well pad showing vegetation regrowth between years two and three

1.2 The Narrabri Gas Project

1.2.1 Context

In September 2014, the NSW Chief Scientist and Engineer, Professor Mary O'Kane, released her review into coal seam gas activities in NSW (NSW Chief Scientist and Engineer 2014). The in depth review studied the risks associated with the industry and concluded that 'provided drilling is allowed only in areas where the geology and hydrogeology can be characterised adequately, and provided that appropriate engineering and scientific solutions are in place to manage the storage, transport, reuse or disposal of produced water and salts – the risks associated with exploration and production can be managed'. The review also found that gas extraction 'is not significantly more likely to be damaging or dangerous than other extractive industries' (NSW Chief Scientist and Engineer 2014).

The NSW Chief Scientist and Engineer concluded that ‘the technical challenges and risks posed by the industry can in general be managed through:

- careful designation of areas appropriate in geological and land-use terms for gas extraction
- high standards of engineering and professionalism in gas companies
- creation of a State wide ‘Whole-of-Environment Data Repository’ so that data from gas industry operations can be interrogated as needed and in the context of the wider environment
- comprehensive monitoring of gas operations with ongoing automatic scrutiny of the resulting data
- a well-trained and certified workforce
- application of new technological developments as they become available’.

The NSW Chief Scientist and Engineer made recommendations to establish a world-class regime for extraction of gas, including (amongst other things) a clear public statement that covers the rationale or need for gas extraction. The NSW Government subsequently released the NSW Gas Plan (NSW Government 2014) to address the recommendations made by the NSW Chief Scientist and Engineer.

The NSW Gas Plan accepted all recommendations made by the NSW Chief Scientist and Engineer. Under the NSW Gas Plan, the NSW Government pledged to:

- make better science and information available to decision-makers and the community
- take a more strategic approach to issuing petroleum exploration titles
- introduce strong and certain regulation with a lead regulator responsible for compliance and enforcement of conditions of approval for gas activities in NSW
- share the benefits of gas development with landholders and local communities
- secure gas supplies by exploring all supply options.

In the NSW Gas Plan, the NSW Government highlights the Narrabri Gas Project as a key existing Strategic Energy Project.

1.2.2 Key features of the project

The development of the project would involve the following activities:

- gas exploration and appraisal – acquiring seismic data, drilling chip and core holes, and pilot wells
- development and operation of a field – converting pilot wells to production wells, drilling new production wells and monitoring bores, developing gas and water gathering and treatment systems and in-field gas compression facilities
- decommissioning and rehabilitation – sealing production wells, removing surface infrastructure and rehabilitating sites.

The key project activities related to this EIS are shown in Figure 1-6.

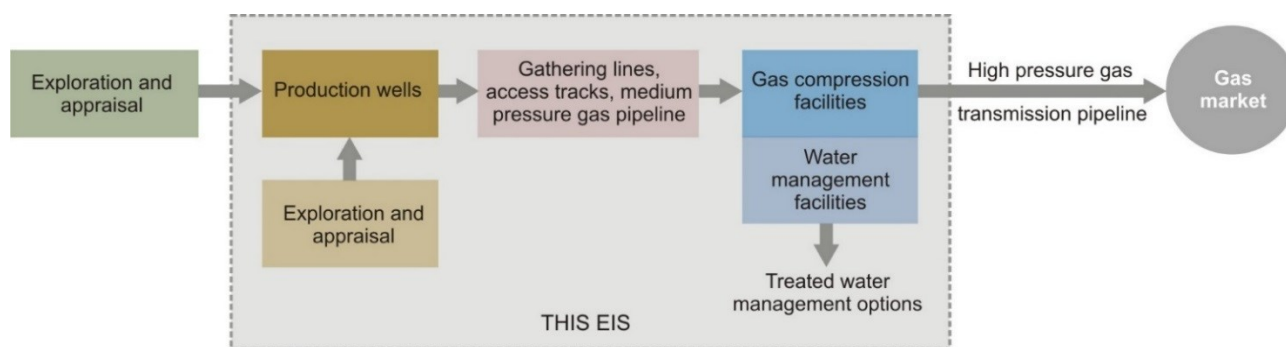


Figure 1-6 Project components relevant to this EIS

A Field Development Protocol will be implemented during field development of wells and some associated infrastructure to minimise environmental impacts. The Field Development Protocol is described in Chapter 10 and included as Appendix C of this EIS.

The project would also involve the construction and operation of supporting infrastructure including:

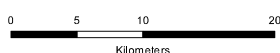
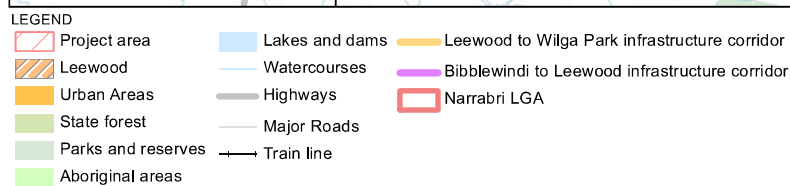
- a centralised gas processing facility for dehydration, compression and treatment of the gas
- centralised water management and treatment facilities, and infrastructure for the beneficial reuse of treated water
- telecommunication equipment, construction workforce accommodation, road intersection upgrades at the appropriate time, operational management facilities, power generation (if required) and distribution equipment, and other supporting infrastructure.

Some approved and existing facilities in the project area will be utilised as part of the project, such as underground gas and water gathering lines, and brine and produced water ponds. These facilities and their relationship to the project are described in Chapter 2. The regional context and location of key project infrastructure is shown in Figure 1-7.

1.2.3 The proponent

Santos NSW (Eastern) Pty Ltd (the proponent) will operate the project on behalf of its joint venture participants and the holders of Petroleum Exploration Licence 238, Petroleum Assessment Lease 2, Petroleum Production Lease 3 and Petroleum Production Lease applications 13, 14, 15 and 16 (and other tenures that may derive from these tenures). Santos NSW Pty Ltd and its joint venture participants are the holders of these tenures. Santos NSW (Eastern) Pty Ltd and Santos NSW Pty Ltd are both wholly owned subsidiaries of the Santos Limited group of companies (Santos).

Santos is an Australian energy company established in 1954 and has been supplying natural gas to NSW since 1976.



Narrabri Gas Project
Environmental Impact Statement

Regional context and location of
key project infrastructure

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Figure 1-7

1.2.4 Benefits of the project

The project would have the following major benefits:

- The project has the capacity to deliver up to 200 terajoules of gas per day, or about 50 per cent of current gas demand in NSW.
- The Narrabri Gas Project would help ensure that NSW can take advantage of the many opportunities arising from utilisation of its natural resources. The project's capacity to supply up to half of NSW's natural gas needs would promote balance across east Australian, NSW and export markets. A well-balanced market that allows both consumers and producers to respond to price signals efficiently is critical in ensuring maximum benefit to all stakeholders.
- The estimated \$3.6 billion capital investment (in nominal terms) will contribute to the economies of Narrabri, the wider region and NSW as a whole.
- The project will create job opportunities, including direct creation of approximately 1,300 jobs during peak construction, sustaining approximately 200 jobs through operation and the further creation of indirect job opportunities. Average direct and indirect employment over the 25-year assessment period of 512 full time equivalent jobs, were shown to be:
 - 127 full-time equivalent jobs in the Narrabri Local Government Area (LGA)
 - 161 full-time equivalent jobs in the wider region, being the Council areas of Gunnedah, Tamworth, Uralla, Armidale Dumaresq, Glen Innes Severn, Gwydir, Moree Plains, Walgett, Coonamble, Gilgandra, Dubbo, Warrumbungle and Liverpool Plains
 - 224 full-time equivalent jobs in the rest of NSW, in addition to the combined 288 full-time equivalent jobs described above.
- Establishment of a Gas Community Benefit Fund which would receive an estimated \$120 million through the life of the project. The NSW Government has committed that for every two dollars paid by a gas producer that holds a petroleum title into an authorised Gas Community Benefit Fund, the company will receive a one-dollar rebate on its gas royalties, up to a maximum of 10 per cent of the royalty due in each year.
- Economic modelling undertaken during this environmental impact assessment shows that real income will increase by around \$526 million in the Narrabri Local Government Area, with the project economic benefits shown to outweigh costs at a benefit-cost ratio of about 1.4.

1.3 Environmental assessment

1.3.1 Summary of the planning approval process

The project is development for the purposes of petroleum production and is State significant development under Part 4 Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As such, this EIS is required to support the project application in accordance with the requirements of the EP&A Act. This EIS was also prepared in accordance with the *Environmental Planning and Assessment Regulation 2000* and the Environmental Assessment Requirements of the Secretary of the NSW Department of Planning and Environment (the Secretary).

The project has been declared a 'controlled action' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, and approval is required from the Commonwealth Minister for the Environment. The controlled action decision determined that the project must be assessed under the bilateral agreement between the Commonwealth and NSW Government. Chapter 5 provides further

information on the controlled action and matters protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

1.3.2 Summary of EIS methodology

This EIS is required to be prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the project. A summary of the SEARs and where they are addressed in this EIS is provided in Appendix A.

The overarching approach to the environmental assessment involved:

- identifying existing conditions and environmental values
- completing an environmental risk assessment for the project
- undertaking an impact assessment to address the key risks determined in the risk assessment
- refining the project and / or identifying additional considerations for the Field Development Protocol
- identifying additional mitigation and management measures to manage residual risks.

The approach to impact assessment used in this EIS, along with an introduction to the Field Development Protocol, is discussed in more detail in Chapter 10.

This EIS supports the State significant development application by for project approval. The EIS provides:

- information on the project, including the project need and alternatives considered
- a description of the existing environment
- an assessment of the environmental impacts of the project
- the proponent's commitments in terms of measures to avoid, manage, mitigate or offset potential environmental impacts.

The structure of the EIS is presented below.

Volume 1 – Environmental assessment

Volume 1 (this volume) includes:

- An Executive Summary
- Part A: Introduction
 - an introduction to the environmental assessment (Chapter 1)
 - a description of the regional setting and location of the project, along with existing and approved infrastructure within the project area (Chapter 2)
 - an overview of strategic drivers, and the project need, objectives and benefits (Chapter 3)
 - an overview of the NSW statutory framework for the project (Chapter 4)
 - a summary of the Commonwealth requirements under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and other relevant Commonwealth statutes (Chapter 5).

- Part B: The project and consultation
 - a description of the project, including proposed components, technology and design features, operation, maintenance, and decommissioning and rehabilitation, plus other related information (Chapter 6)
 - a description of how produced water would be managed across the project (Chapter 7)
 - an overview of the alternatives considered during development of the project (Chapter 8)
 - a summary of the consultation that occurred during the project development and environmental assessment process (Chapter 9).

Volume 2 - Environmental assessment (con'd)

- Part C: Environmental assessment
 - approach to the impact assessment outlining the environmental risk assessment and Field Development Protocol (Chapter 10)
 - results of the assessment of key environmental risks as identified by the SEARs and the environmental risk assessment (Chapters 11 to 29).
- Part D: Commitments and conclusion
 - the proposed environmental management and monitoring framework (Chapter 30)
 - a statement of commitments in relation to avoiding, managing, mitigating or offsetting potential environmental impacts (Chapter 31)
 - a conclusion and justification for the project (Chapter 32)
 - references (Chapter 33)
 - terms and abbreviations (Chapter 34).

Volumes 3 to 15 – Appendices

Volumes 3 to 15 inclusive contain the specialist technical reports and supporting material prepared as part of the environmental assessment process.

