Appendix U1

Economic assessment (cost benefit analysis)

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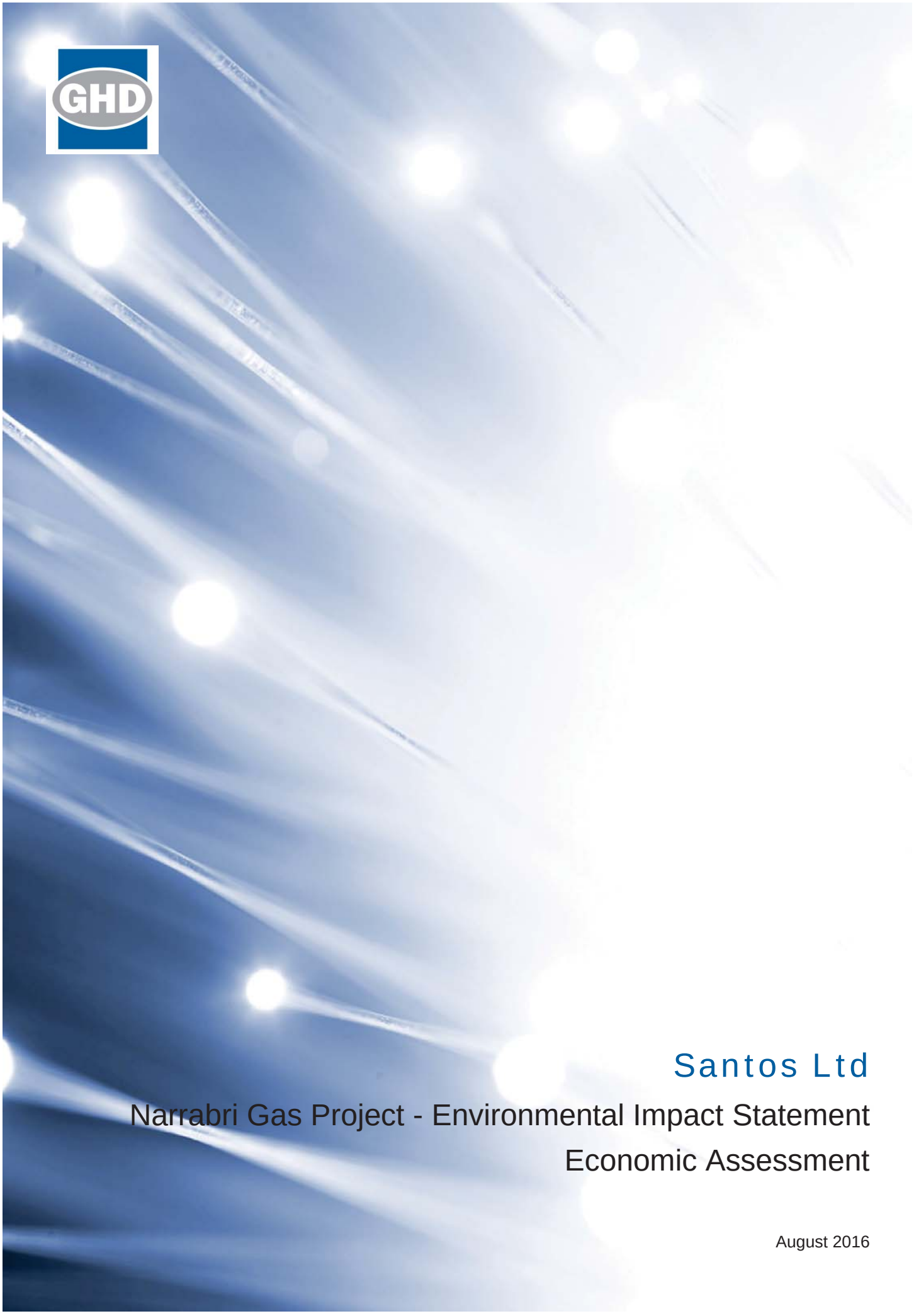

Santos Ltd

Narrabri Gas Project - Environmental Impact Statement

Economic Assessment

August 2016

Executive summary

Introduction and project description

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri. The natural gas produced would be treated at a central gas processing facility on a rural property located approximately 25 kilometres southwest of Narrabri (the Leewood property). The gas would then be piped via a high-pressure gas transmission pipeline to market. The gas transmission pipeline would be part of a separate approvals process and is therefore not part of this project.

Objective of the Cost Benefit Analysis Report

The objective of this cost-benefit analysis report is to estimate the net benefit (or cost) to the Australian community if the project proceeds. All costs and benefits have been assessed from the point of view of society as a whole. For the purposes of this analysis, society is assumed to be Australia.

Cost Benefit Analysis methodology

The base or 'no project case' is a do nothing case. The base case assumes that the status quo is maintained. Land use in the project area does not change, the value of unlocking the gas resource is not realised and there are no incremental public infrastructure costs associated with the additional project workforce.

The 'project case' assumes that project proceeds. Project operating costs, project-related environmental externalities, foregone forestry production and changes to agricultural production are accounted for, and where possible, monetised. The project proceeding unlocks the value of the gas resource which accrues as a benefit to Santos' domestic shareholders. Consistent with the geographical scope of the analysis, the benefits that accrue to Santos' international shareholders are excluded from the analysis. It has been assumed that 87 per cent of Santos shareholders are Australian residents and two per cent are international residents.

The Cost Benefit Analysis has been undertaken consistent with state and national Cost Benefit Analysis guidelines. A seven per cent real discount rate has been used to denominate costs and benefits that occur in the future in 2016 / 17 dollars.

Cost Benefit Analysis results

The Cost Benefit Analysis estimates that proceeding with the project under a self-generated electricity supply (Option 1) will deliver a net benefit to Australia which is estimated to be $1.54 billion in net present value (NPV) terms. The Benefit-Cost Ratio is estimated at 1.39 which means the project is expected to deliver a net benefit to society. A summary of the key inputs to the Cost Benefit Analysis is presented in the table below. While corporate taxes and royalties are considered to be transfers of producer benefits to government for redistribution, government transfers have been disaggregated to identify net transfers attributable to the NSW Government.[1]

[1] Transfers to the NSW Government are comprised of 100 per cent of royalties and 32 per cent of corporate taxes, which is based on the ratio of NSW population to Australian population. Source: NSW Department of Planning and Environment (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals*, p. 20.

Summary of the Cost Benefit Analysis Results (7% discount rate)

Category of cost/benefit ($2016 / 17M) (discounted at 7% discount rate)	Electricity Option 1 (Self-generated)	Electricity Option 2 (Grid supplied)
Costs		
Capital costs	2,004.3	2,004.3
Operating costs	1,578.0	1,578.0
Foregone agricultural production	3.1	3.1
Noise and vibration costs	1.7	1.7
Vegetation offsets	43.5	43.5
Social cost of carbon	267.5	164.0
Residual Value (land and infrastructure)	0.0	0.0
Total costs	**3,898.1**	**3,794.6**
Benefits		
Project revenue	5,403.4	5,403.4
Additional agricultural output (amended water)	0.8	0.8
Compensation received by existing landholders	29.7	29.7
Total benefits	**5,433.9**	**5,433.9**
Net present value	**1,535.8**	**1,639.3**
Benefit-cost ratio	**1.39**	**1.43**

Note: Figures may not add up due to rounding.

The positive net present value is driven primarily by the value of unlocking the gas resource.

Other economic benefits not quantified in the Cost Benefit Analysis

Consistent with the microeconomic (welfare) foundations of cost-benefit analysis, the analysis does not include macroeconomic benefits such as increased employment, economic output (gross state product) and industry value added. These benefits are assessed in Appendix U2, Economic Impact Report (ACIL Allen Consulting 2016). The benefits estimated through the Cost Benefit Analysis are therefore additional to the benefits estimated in Appendix U2. These include:

- An increase in Gross State Product of $11.9 billion relative to the base case (with a net present value of $5.1 billion, using a 7 per cent real discount rate).
- An increase in real incomes in New South Wales of $6.0 billion over the life of the project (with a net present value of $2.8 billion, using a 7 per cent real discount rate).
- An average increase of 512 full time equivalent (FTE) jobs in New South Wales over the course of the project with peak employments occur during 2017 to 2021. Specifically, an average increase of 127 FTE jobs is expected to be generated within the Narrabri region, 161 FTE within the Narrabri surrounds region and 224 FTE in the rest of NSW.

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Glossary of terms

Term	Description
AUD	Australian Dollar
Benefit Cost Ratio	The ratio of the present value of the benefits of the project case to the present value of the costs of the project case. Projects with a Benefit Cost Ratio greater than one are estimated to have net benefits to society over the appraisal period.
Cost Benefit Analysis	An economic evaluation technique that seeks to evaluate costs and benefits of a project or policy change. Cost Benefit Analysis is generally used as a decision making tool to determine whether a project will deliver net benefits. Where benefits outweigh costs, the project has a net benefit to society. In this case, society is defined to be Australia.
Discount rate	The rate by which the value of costs and benefits that accrue in the future are discounted to find an equivalent dollar value expressed in present value terms (today's dollars). Discounting future costs and benefits recognises that a dollar today is worth more than a dollar at some time in the future. This concept is known as the time value of money.
Evaluation year	The evaluation or 'base' year is the year to which costs and benefits have been discounted to arrive at a Present Value (PV). The base year is usually the same as the price year and should preferably be the year in which the decision on whether to proceed with the project is made so that a decision is made based on the present value of costs and benefits. In this analysis, the evaluation year is 2017.
Gross State Product	Is generally made up of compensation of employees, gross operating surplus, gross mixed income plus taxes and less subsidies on production and imports (ABS, 2013).
Net Present Value	The present value of the benefits of the project case minus the present value of the costs of the project case. Projects with a positive Net Present Value have net benefits to society over the appraisal period.
Residual value	The value of an asset at the end of the economic evaluation period. Residual values at the end of the project are discounted to a present value and netted off project costs.

1. Introduction

1.1 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (refer Figure 1-1).

The Narrabri Gas Project (the project) seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approvals process and is therefore not part of this development proposal.

The primary objective of the project is to commercialise natural gas to be made available to the NSW gas market and to support the energy security needs of NSW. Production of natural gas under the project would deliver economic, environmental and social benefits to the Narrabri region and the broader NSW community. The key benefits of the project can be summarised as follows:

- Development of a new source of gas supply into NSW would lead to an improvement in energy security and independence to the State. This would give NSW gas markets greater choice when entering into gas purchase arrangements. Potential would also exist for improved competition on price. Improved competition on price would have flow on benefits for NSW's economic efficiency, productivity and prosperity.
- The provision of a reduced greenhouse gas emission fuel source for power generation in NSW as compared to traditional coal-fired power generation.
- Increased local production and regional economic development through employment and provision of services and infrastructure to the project.
- The establishment of a regional community benefit fund equivalent to five per cent of the royalty payment made to the NSW Government within the future production licence area. If matched by the NSW Government, the fund could reach $120 million over the next two decades.

1.2 Description of the project

The project would involve the construction and operation of a range of exploration and production activities and infrastructure including the continued use of some existing infrastructure. The key components of the project are presented in Table 1-1, and are shown on Figure 1-1.

Table 1-1 Key project components

Component	Infrastructure or activity
Major facilities	
Leewood	• a central gas processing facility for the compression, dehydration and treatment of gas • a central water management facility including storage and treatment of amended water and brine • optional power generation for the project • a safety flare • treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities • other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage • continued use of existing facilities such as the brine and amended water ponds • operation of the facility
Bibblewindi	• in-field compression facility • a safety flare • supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower • upgrades and expansion to the staff amenities and car parking • amended water, brine and construction water storage, including recommissioning of two existing ponds • continued use of existing facilities such as the 5ML water balance tank • operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	• widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines
Leewood to Wilga Park underground power line	• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	
Gas exploration, appraisal and production infrastructure	• seismic geophysical survey • installation of up to 850 new wells on a maximum of 425 well pads – new well types would include exploration, appraisal and production wells – includes well pad surface infrastructure • installation of water and gas gathering lines and supporting infrastructure • construction of new access tracks where required • water balance tanks • communications towers • conversion of existing exploration and appraisal wells to production

Component	Infrastructure or activity
Ancillary	• upgrades to intersections on the Newell Highway • expansion of worker accommodation at Westport • a treated water pipeline and diffuser from Leewood to Bohena Creek • treated water irrigation infrastructure including: – pipeline(s) from Leewood to the irrigation area(s) – treated water storage dam(s) offsite from Leewood • operation of the irrigation scheme

The project is expected to generate approximately 1,300 jobs during the construction phase and sustain around 200 jobs during the operational phase; the latter excluding an ongoing drilling workforce comprising approximately 100 jobs.

Subject to obtaining the required regulatory approvals, and a financial investment decision, construction of the project is expected to commence in early 2018, with first gas scheduled for 2019/2020. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2018 and early/mid-2021. The gas wells would be progressively drilled during the first 20 or so years of the project. For the purpose of impact assessment, a 25-year construction and operational period has been adopted.

1.3 Project location

The project would be located in north-western NSW, approximately 20 kilometres south-west of Narrabri, within the Narrabri local government area (LGA) (see Figure 1-1).

The project area covers about 950 square kilometres (95,000 hectares), and the project footprint would directly impact about one per cent of that area.

The project area contains a portion of the region known as 'the Pilliga', which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW *National Parks and Wildlife Act 1974*. The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of 'forestry, recreation and mineral extraction, with a strategic aim to "provide for exploration, mining, petroleum production and extractive industry" under the *Brigalow and Nandewar Community Conservation Area Act 2005*. The parts of the project area on state land are located within this section of the Pilliga.

The semi-arid climate of the region and general unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing. Commercial timber harvesting activities in the Pilliga were preceded by unsuccessful attempts in the mid-1800s to establish a wool production industry. Resource exploration has been occurring in the area since the 1960s; initially for oil, but more recently for coal and gas.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of drought and wildfire.

The project area avoids the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve and Brigalow Park Nature Reserve. Brigalow State Conservation Area is within the project area but would be protected by a 50 metre surface exclusion zone.

Agriculture is a major land use within the Narrabri LGA; about half of the LGA is used for agriculture, split between cropping and grazing. Although the majority of the project area would be within State forests, much of the remaining area is situated on agricultural land that supports dry-land cropping and livestock. No agricultural land in the project area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and detailed soil analysis has established the absence of BSAL. This has been confirmed by the issuance of a BSAL Certificate for the project area by the NSW Government.

1.4 Planning framework and structure of this report

1.4.1 Planning Framework

The project is permissible with development consent under the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*, and is identified as 'State significant development' under section 89C(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *State Environmental Planning Policy (State and Regional Development) 2011*.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the EP&A Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

The project is also a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The project was declared to be a controlled action on 5 December 2014, to be assessed under the bilateral agreement between the Commonwealth and NSW Governments, and triggering the following controlling provisions:

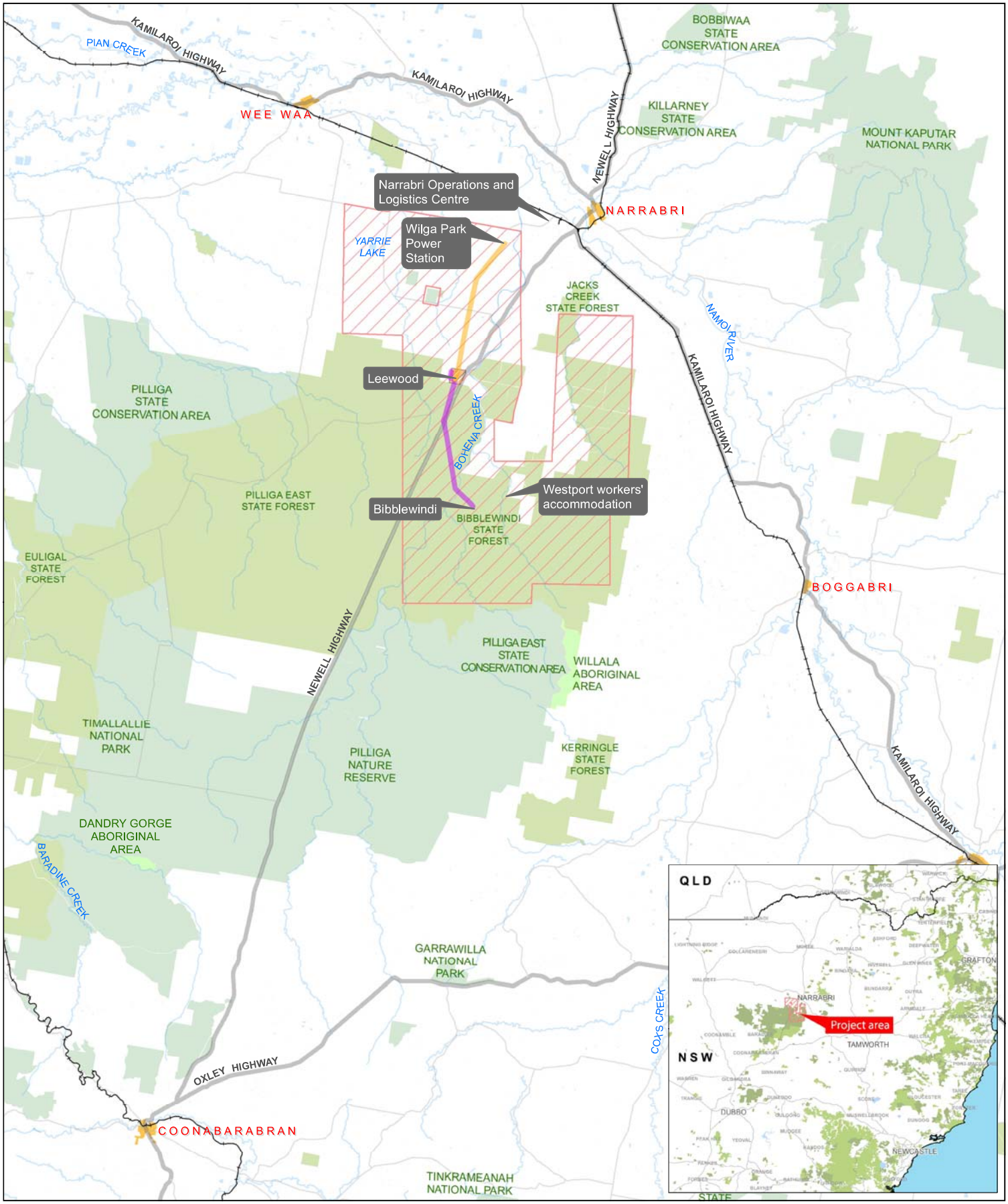
- listed threatened species and ecological communities
- a water resource, in relation to coal seam gas development and large coal mining development
- Commonwealth land.

This Cost Benefit Analysis assessment identifies economic costs and benefits issues associated with construction and operation of the Narrabri Gas Project and addresses the Secretary's environmental assessment requirements for the project (see *Section 3*). The assessment will be used to support the EIS for the project. The Director-General requirements addressed in this report include:

An assessment of the likely economic impacts of the development, paying particular attention to:

i) Economic benefits of the project for the State and region; and

ii) The demand for the provision of local infrastructure and services, having regard to Narrabri Council's requirement.



LEGEND

- Project area
- Leewood
- Urban
- State forest
- Parks and reserves
- Aboriginal areas
- Lakes and dams
- Watercourses
- Highways
- Major Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 5 10 20
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix

Regional context and location of key infrastructure

Job Number 21-22463
Revision A
Date 12 Mar 2015

Figure 1-1

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

1.4.2 Structure of report

The report is structured as follows:

- **Chapter 1 – Introduction.** This chapter introduces the proposed development and the proponent and describes the project area.
- **Chapter 2 – Methodology.** This chapter defines the study area assessed in this report and describes the steps undertaken in the assessment.
- **Chapter 3 – Legislative context.** This chapter outlines the relevant Commonwealth and State legislation relating to the assessment. Guidelines and assessment criteria (where applicable) relevant to the gasfield construction, operation and decommissioning are also identified.
- **Chapter 4 – Impact assessment.** This chapter examines the potential environmental impacts associated with the construction and operation of the gasfield.
- **Chapter 5 – Conclusion.** This chapter presents a conclusion to the report and presents the next steps in the advancement of the project.

1.5 Limitations

This report has been prepared by GHD for Santos and may only be used and relied on by Santos for the purpose agreed between GHD and Santos as set out in this report.

GHD otherwise disclaims responsibility to any person other than Santos arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Santos which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information. This information includes:

- Construction and operations expenditure estimates.
- The split of Santos' domestic and international shareholders.
- Long-term gas price estimates.
- Gas production estimates.
- Corporate tax and royalty payments.

It was outside the scope of this analysis to independently appraise project parameters such as forecast gas prices, capital and operating costs and gas production estimates.

2. Methodology

2.1 Approach to Cost Benefit Analysis

A step-by-step approach to the Cost Benefit Analysis (CBA) methodology used in this assessment is illustrated in Figure 2-1.

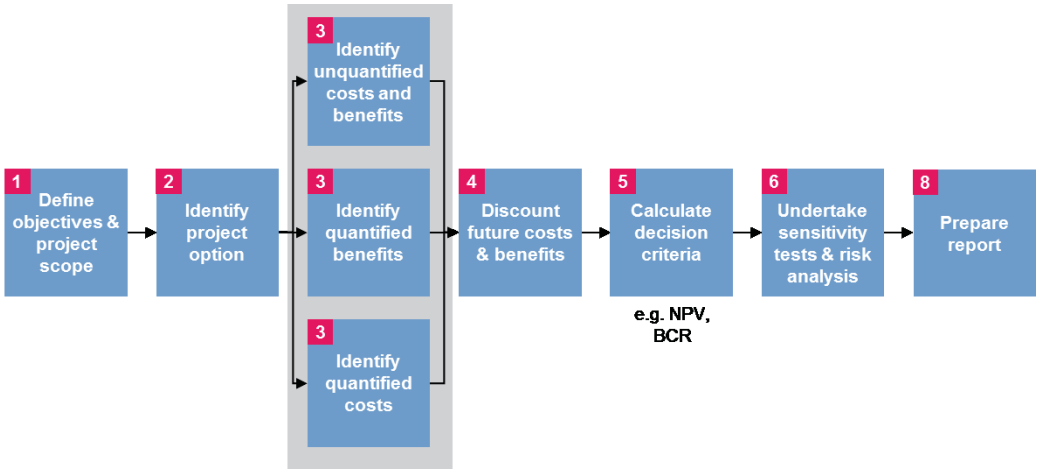

Figure 2-1 Cost-benefit methodology

The CBA has two key features:

1. Comparison of the base case (no project case) with the project case; and
2. Monetisation of costs and benefits wherever possible.

For the purpose of impact assessment, a 25-year assessment period has been adopted. Where costs and benefits can be monetised, they have also been evaluated over the same 25-year assessment period as the remainder of the environmental impact assessment (i.e. 2017-2042).

Specifically, the methodology involves:

- Defining the project objectives and scope;
- Defining the project case and base case for comparison;
- Identifying the costs and benefits that may be expected due to the move from the base case to the project case;
- Determining key parameters for the analysis;
- Quantifying (where possible) costs and benefits over the appraisal period and discounting future values to present value equivalents;
- Generating measures of net economic worth, such as Net Present Value (NPV) and the Benefit Cost Ratio (BCR); and
- Interpreting measures of net economic worth, including accounting for non-quantified costs and benefits.

The measures of net economic worth utilised are:

- NPV – the present value of the incremental benefits of the project case minus the present value of the incremental costs of the project case. Projects with a positive NPV have net benefits to society over the appraisal period.

- BCR – the ratio of the present value of the incremental benefits of the project case to the present value of the incremental costs of the project case. Projects with a BCR greater than one have net benefits to society over the appraisal period.

The CBA was prepared using a Microsoft Excel spread sheet developed by GHD. The CBA evaluation was undertaken consistent with current state and national guidelines – specifically:

- New South Wales Treasury's 2012 publication, '*Guideline for the use of Cost Benefit Analysis in Mining and Coal Seam Gas Proposals*'.
- New South Wales Department of Planning and Environment's 2015 *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals.*
- Australian Department of Finance and Deregulation *Handbook of Cost-Benefit Analysis*, 2006.

2.1.1 Defining the objectives of the Cost Benefit Analysis

The objective of the CBA is to estimate the net benefit (or cost) to the Australian community if the project proceeds. CBA is one of a number of tools designed to guide the decision making process; in this case, the approvals process. A key advantage of CBA is that it considers project costs and benefits over the entire project and quantifies key costs and benefits in 2016/17 dollars.

The CBA complements the Economic Impact Assessment Report (refer to Economic Impact Technical Appendix (Appendix U2)) which estimates employment, income and gross regional and state product benefits likely to accrue as a result of proceeding with the project.

2.1.2 Defining the scope of the CBA

The CBA seeks to determine whether the benefits are expected to outweigh the costs. All costs and benefits have been assessed from the point of view of society as a whole. For the purposes of this analysis, and consistent with Volume 5 of the Australian Transport Council's National Guidelines for CBA, society is assumed to be Australia. It can be argued that the inter-connected nature of the economy and spill-overs between states mean that assessing costs and benefits from the point of view of Australia is a sound approach (see for example, Bennett, 2011). It is also considered to be impractical to isolate revenue benefits to New South Wales only given mobility in the shareholder register and the confidentiality issues that isolating New South Wales shareholders could bring. However, an approximate amount of the net benefits attributable to New South Wales has been calculated based on the percentage recommended by the New South Wales Department of Planning and Environment's *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*.

2.1.3 Definition of the base case and the project case

The definition of the base case and project case is as follows:

- The base or 'no project case' is a do nothing case. The base case assumes that the status quo is maintained. Land use in the project area does not change, the value of unlocking the gas resource is not realised.
- The 'project case' assumes that project proceeds. Project operating costs, project-related environmental externalities and changes to agricultural production are accounted for and where possible, monetised. The project proceeding unlocks the value of the resource which accrues as a benefit to domestic shareholders.

Under the terms of GHD's commission, there was no requirement to assess alternative projects or variations of the proposed project. The CBA therefore assesses the project case as described in section — against the 'do-nothing' base case only.

2.1.4 Cost-benefit analysis appraisal parameters

The key parameters used in the CBA are listed in Table 2-1.

Table 2-1 Appraisal parameters – central case

Parameter	Values applied
Discount rate	7 per cent real. Sensitivity tests: 4 and 10 per cent real.
Price year	All benefits and costs are estimated in 2016/17 constant prices.
Evaluation year	2017 i.e. the year in which an approvals decision is expected to be made
Appraisal period	2017 – 2042 The period for which project approval is being sought, and was therefore assessed against. It includes exploration and appraisal, construction, operation and maintenance, and decommissioning.
Economic appraisal	Costs and benefits are appraised from the community or society perspective. This includes quantifiable costs and benefits that are both internal and external to direct industry participants, such as environmental impacts.

2.1.5 Identifying costs and benefits

A critical step in the CBA is to identify a comprehensive list of potential costs and benefits. Where costs and benefits are material and where sufficient data was available, costs and benefits of moving from the base case to the project case have been monetised and expressed in 2016 / 17 dollar terms.

While every attempt has been made to quantify environmental externalities, the materiality of the impact and availability of data were used to determine which environmental externalities were quantified (see section 4.1.6 for further detail).

Consistent with the microeconomic (welfare) foundations of CBA, the analysis does not include macroeconomic benefits such as increased employment, economic output (e.g. gross state product) and industry value added.[2] Alternative methods, such as input-output analysis and desirably computable general equilibrium analysis are required to measure these effects[3].

2.1.6 Quantifying environmental externalities

There are a number of difficulties associated with quantifying environmental externalities. These difficulties arise due to:

1. Uncertainty surrounding the probability of an environmental impact occurring.
2. Uncertainty surrounding the outcomes should a particular environmental impact occur.
3. Uncertainty surrounding who would bear the costs of a particular environmental impact occurring.

The analysis uses a risk assessment approach to determine which externalities are likely to be material. A number of risk assessment workshops were held to identify risks, determine a reasonable ex ante estimate of the probability of the risk occurring and assigning a risk outcome to each potential risk (for more detail on the risk assessment approach and results, refer to Chapter 10 of the main EIS document). Where risks can be mitigated or appropriately managed, they have not been considered further. Table 2-1 and Table 2-2 show the cost and benefit items that were identified and indicates which cost and benefit streams have been monetised in the CBA.

[2] Industry value added is final output less purchases of goods and services (intermediate inputs) (ABS 2010).
[3] These measures are presented in Economic Impact Technical Appendix (Appendix U2).

Table 2-2 Cost items identified

Cost items	Monetised in Cost Benefit Analysis	Comment
Exploration costs attributable to this project	Yes	Exploration costs exclude historical exploration costs within the project area with data provided by Santos
Project construction costs	Yes	Data provided by Santos
Project operations costs	Yes	Data provided by Santos
Project rehabilitation costs	Yes	Data provided by Santos
Foregone agricultural production	Yes	The impacts are calculated by multiplying the area of agricultural land impacted by an average adopted gross income of $533 per hectare, as assessed in the agricultural impact assessment (Refer to Agricultural Impact Statement, Appendix K of the EIS).
Foregone forestry production	Yes	Forestry land access costs are included in project expenditure estimates.
Water quality (groundwater) impacts	No	The groundwater impact assessment undertaken for the environmental impact statement found the magnitude of impacts to groundwater resources would be small in terms of impacts to quantity and quality of water. A corresponding risk assessment found that all residual risks were low. The most material initial risk was the potential impacts to water quality during the drilling process. This risk is to be mitigated through compliance with the NSW Government *Code of Practice for Coal Seam Gas Well Integrity.* Refer to Table 2-3 for further information.
Water quality (surface water) impacts	No	Risk of impacts assessed to be remote.
Noise impacts	Yes	The majority of the noise impacts will occur during construction including drilling. Estimates of the number of sensitive receivers and the duration of the noise impact have been calculated. Santos will negotiate individually with each landholder where noise levels are predicted to exceed the guidelines at an occupied residence. An indicative cost estimate of Santos' costs to offset noise impacts is included in the CBA.
Net greenhouse gas emission impacts (project construction and operations emissions less reduced energy consumption emissions where gas substitutes for alternate energy sources)	Yes	The greenhouse gas emissions attributable to the project have been estimated in the Greenhouse Gas Assessment. While under the existing regulatory framework in Australia, there is no carbon trading market or carbon tax to benchmark the shadow price of greenhouse gas emissions to be included in the cost-benefit analysis, the 2015 Guidelines require the estimation of social cost of carbon. Calculation in the CBA is based on the US EPA carbon price (indexed to 2015 September values), as included in the Greenhouse Gas Valuation Workbook. Refer to section 4.1.6(4) for further information.

Cost items	Monetised in Cost Benefit Analysis	Comment
Air quality impacts (e.g. well pad engine emissions, dust from land clearing, earthworks, diesel engine operations)	No	The risk assessment found residual risks to air quality to be “very low”. Construction activities will generate dust but dust suppression will reduce the risk of settlement on crops and pastures with subsequent impact on production unlikely to be significant (Refer to Agricultural Impact Statement, Appendix K of the EIS).
Ecosystem/Biodiversity loss	Yes	An estimate of the cost to Santos of offsetting the vegetation/biodiversity loss has been used.
Non-Aboriginal heritage	No	Risk assessment found residual risks to non-aboriginal heritage to be “very low”
Aboriginal heritage	No	Risk assessment found that it is possible that a disturbance of an unidentified item of aboriginal significance—the consequence of which would be major. However, given that all currently known sites and most sensitive site types are to be avoided, and that access to the area will be largely unaffected, impacts to the Aboriginal cultural heritage will be minor. Aboriginal cultural heritage is not directly included in the CBA as the physical and social assessment in the Aboriginal cultural heritage assessment adequately deals with this issue. In addition, the settlement of a native title agreement under Section 31 of the Commonwealth *Native Title Act 1993*, and development of other programs delivering a broad package of benefits, would extend over the life of the project and beyond.
Amenity impacts (e.g. visual)	No	Costs deemed to be immaterial
Tourism / recreation	No	Recreational activities in the Pilliga include: - Sandstone caves - Salt caves - Baradine Discovery Centre - Yarrie Lake - Wildflowers (September) - Bird watching - Hunting These activities are concentrated towards the western side of Newell Highway and do not fall in the project area. The small and dispersed nature of the gasfield infrastructure is expected to impact approximately one per cent of the project area (including one per cent of the forest). Furthermore, Siding Springs is around 80 kilometres from the project area; it is therefore unlikely that tourist and recreational activities will be impacted by the project activities.
Traffic impacts	Yes (but not separately identified)	Based on the results of the technical assessment, the existing capacity of the road network is sufficient to accommodate the transport tasks required by the project with the exception of some of the safety risks identified which requires intersection upgrades near the exit of the Newell Highway. The costs of constructing and maintaining the upgraded intersections have been included in the capital and operational cost estimates. Refer to section 4.1.6(1) for additional explanation.

Table 2-3 Benefit items identified

Benefit items	Monetised in Cost Benefit Analysis	Comment
Revenue to Australian shareholders	Yes	This represents the value of unlocking the resource. Benefits that accrue only to Australian shareholders have been included[4]
Residual value of land at the end of the project	Yes	Leewood was the only property purchased for the project. While it is expected that this land would have an alternative use (opportunity cost) at the end of the project, additional regulatory approvals for post 2041 operation of the project would need to be considered. As such, an assumption of zero residual value is used in the CBA[5]
Residual value of infrastructure	Yes	As above, an assumption of zero residual value is used in the CBA.
Additional agricultural output associated with amended water	Yes	Water produced as a result of the extraction process will be treated and used in irrigation.
Royalties	Yes (but not separately identified)	However, royalties payable to the NSW Government are not deducted from the Cost Benefit Analysis as they are transfers of producer surplus from Santos to the NSW Government. Royalties are discussed in section 4.3.1 as they are a benefit to the NSW Government enabled by unlocking the value of the resource.
Taxes	Yes (but not separately identified)	Taxes payable to the Commonwealth Government such as income tax and company tax are paid out of revenue and a transfer of producer surplus from Santos to the Commonwealth Government. However, an amount has been calculated to be attributable to New South Wales as recommended by the New South Wales Department of Planning and Environment's *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*, Taxes are discussed further in section 4.3.1.
Jobs (direct and indirect)	No	It is expected that an average additional 540 full time equivalent jobs in New South Wales will be generated over the course of the project. This analysis is assessed through a separate study (Economic Impact Technical Appendix of Appendix U2)
Additional economic output (Gross Regional Product)	No	Assessed through a separate study. Refer to section 4.3.2 for a summary and Economic Impact Technical Appendix (Appendix U2)
Additional Income generated from project	No	Assessed through a separate study. Refer to section 4.3.2 for a summary and Economic Impact Technical Appendix (Appendix U2)
Benefits to NSW business as a result of increased gas supply certainty (and reduced prices)	No	These benefits are discussed in Part A, Chapter 4 of the EIS, Strategic Context and Need).

[4] Based on data provided by Santos, 87 per cent of shareholders are assumed to be domestic shareholders.

[5] See for example, Australian Transport Council, 2006, National Guidelines for Transport System Management in Australia.

2.2 Data sources

The CBA was undertaken based on information gathered from Santos, data collected through desktop analysis and GHD's risk assessment process which was used to identify environmental risks and to focus the CBA on material costs and benefits only. The methodology did not extend to primary data collection such as assessing environmental externalities through non-market valuation techniques such as Contingent Valuation methods. Key data sources included:

- Capital cost estimates supplied by Santos.
- Operating cost estimates supplied by Santos.
- Gas production forecasts supplied by Santos.
- Gas price forecasts supplied by Santos.
- Corporate tax and royalty payments.
- Residual value assumptions provided by Santos.
- Agricultural gross margin data sourced from NSW Department of Primary Industries.

2.2.1 Cost Benefit Analysis – key model input assumptions

The key assumptions that underpin the CBA are outlined in Table 2-4.

Table 2-4 Key CBA data assumptions

Data input parameter	Unit	Rationale
Gas price	Dollar per GJ	Santos estimated a constant gas price of $8.70 per GJ for the duration of the appraisal period. This gas price estimate includes the implicit costs of transporting gas to the Sydney to Moomba pipeline.
Gas production volumes	GJ per annum	Starts at 12.8 million GJ per annum in 2020 and increases to 74.1 million GJ per annum in 2025 where production plateaus
CPI (to bring values to 2016 terms)	Per cent per annum	2.5 per cent per annum – i.e. the middle of the Reserve Bank of Australia's target rate for inflation[6]
Residual values	2016/17 dollar term	Residual values for assets are assumed to be zero

[6] The Reserve Bank of Australia (RBA) notes in its 2014 Statement on the Conduct of Monetary Policy that "in pursuing the goal of medium-term price stability, both the Reserve Bank and the Government agree on the objective of keeping consumer price inflation between 2 and 3 per cent, on average, over the cycle. This formulation allows for the natural short-run variation in inflation over the cycle while preserving a clearly identifiable performance benchmark over time" (RBAa, 2014).

3. Legislative context

The project is permissible with development consent under the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*, and is identified as 'State significant development' under *State Environmental Planning Policy (State and Regional Development) 2011*.

The Director-General requirements specify that the economic impact assessment should consider:

1. An assessment of the likely economic impacts of the development, paying particular attention to:

   i) The significance of the resource, including its potential to help meet the projected (sic) demand for gas in NSW (refer to Part A, section 3 of the EIS – strategic context and need);

   ii) Economic benefits of the project for the State and region; and

   iii) The demand for the provision of local infrastructure and services, having regard to Narrabri Council's requirements which, in relation to economic impacts include:

      (1) Further detail and certainty on the provision of the Gas Community Benefit Fund and certainty on the provision and any management expectations by Santos. This should also include the contributions referenced from State Government (refer to section 4.3.3)[7].

While the Director-General requirements do not explicitly stipulate that a CBA should be completed, the analysis has been prepared to assist the decision making process.

[7] There are a number of other requirements outlined by Narrabri Shire Council which are addressed in the Social Impact Assessment report at Appendix S.

4. Impact assessment

4.1 Quantifying project costs

4.1.1 Project capital costs

Project capital cost estimates were provided to GHD by Santos. The construction of the project is expected to involve a nominal capital investment of $3.57 billion, accounting for inflation. This equates to a real (without inflation) investment of $2.98 billion with a net present value of $2.00 billion, applying a discount rate of 7 per cent per annum.

4.1.2 Project operating costs

Project operating cost estimates were provided to GHD by Santos. The project would require ongoing operating costs over the 25-year assessment period, totalling a nominal investment of $5.47 billion, or a real investment of $3.79 billion, equivalent to a net present value of $1.58 billion when 7 per cent discount rate is applied. Operating costs include costs incurred in the appraisal, operating and remediation phases of the project but excludes costs associated with exploration that has already been undertaken.

4.1.3 Foregone agricultural production value

The Agricultural Impact Statement Technical Appendix (Appendix K) has quantified the area currently being used for agricultural production that may be sterilised—either temporarily (as wells are drilled during construction) or longer-term (over the course of the project). The area of agricultural land temporarily removed from production during the construction phase is estimated to be 532 hectares (refer to Appendix K). The area of agricultural land removed temporarily (i.e. for approximately five to 20 years) from production during the operation phase is estimated as being 351 hectares (refer to Appendix K).

Indirect impacts may also occur as a result of both construction and operational activities which alter the ability of landholders to fully utilise the productive capacity of their land. Indirect impacts include impeded access or severance of agricultural land, interruptions to agricultural activities, reduced agricultural output as a result of increases in dust and/or noise[8]. However, impacts will be minimised by landholder agreements and a farm management plan, which includes negotiation and agreement on the location of gas wells.

The economic impact of direct and indirect agricultural impacts during construction is shown in Table 4-1. The impacts are calculated by multiplying the area of agricultural land impacted by an average adopted gross income of $533 per hectare. The impacts vary between $326,588 and $368,056 per year. These values represent between 2.3% and 2.6% of the annual value of agriculture in the project area and between 0.08% and 0.09% of the annual value of agriculture in the Narrabri LGA. The extent of damage to farm infrastructure and consequent impact on production cannot be accurately quantified due to the evolving nature of the gas field development. However, the damages can be limited by adopting appropriate mitigation measures which are discussed in Section 6 of the Agricultural Impact Statement Technical Appendix (Appendix K). Consultation with landholders will limit damage caused as collaborative planning with regard to location and timing of disruption could be jointly decided to fit in with planned farming activities. Such consultation is also important in minimising potential indirect impacts discussed in section 5.2 of the Agricultural Impact Statement Technical Appendix.

[8] Refer to the Agricultural Impact Statement (Appendix K) for a more comprehensive discussion of these impacts.

Table 4-1 Value of impacts on agriculture (construction)

Impact	Agricultural land (ha)		Annual value of agricultural production	
	Low	High	Low	High
Direct	532	532	$283,120	$283,120
Indirect				
Impeded access	5%	10%	$14,156	$28,312
Interrupted management	5%	10%	$14,156	$28,312
Labour costs	5%	10%	$14,156	$28,312
Other			$ -	$ -
Total			**$325,588**	**$368,056**
Per cent of project area total		**2.3%**		**2.6%**
Per cent of Narrabri LGA total		**0.08%**		**0.09%**

Note: Figures may not add up due to rounding.

Source: GHD, Agricultural Impact Statement (Appendix K)

The economic impact of direct and indirect agricultural impacts is shown in Table 4-2 for the operations phase of the project. The impacts vary between $215,452 and $243,554 per year. These values represent between 1.5 per cent and 1.7 per cent of the annual value of agriculture in the project area and approximately 0.05 to 0.06 per cent of the annual value of agriculture in the Narrabri LGA.

Table 4-2 Value of impacts on agriculture (operation)

Impact	Agricultural land (ha)		Annual value of agricultural production	
	Low	High	Low	High
Direct	351	351	$187,349	$187,349
Indirect				
Impeded access[9]	5%	10%	$9,367	$18,735
Interrupted management	5%	10%	$9,367	$18,735
Labour costs	5%	10%	$9,367	$18,735
Other	n/a	n/a	$ -	$ -
Total			**$215,452**	**$243,554**
Per cent of project area total		**1.5%**		**1.7%**
Per cent of Narrabri LGA total		**0.05%**		**0.06%**

Note: Figures may not add up due to rounding.

Source: GHD, Agricultural Impact Statement

The CBA includes the high point of the ranges for both construction and operations for the purposes of estimating the economic impacts of agriculture. This is to deliver a conservative approach to cost estimation.

[9] Refer to Table 5 4 Indirect impacts of construction and operation activities of the Agricultural Impact Statement for the issues and potential impacts on agriculture arising from operations.

4.1.4 Foregone forestry production value

Approval is being sought for a maximum of 988.8 ha of new disturbance of native vegetation. Of that; it is estimated that around 700 ha of state forest will be temporarily cleared to accommodate the project. This assumption is based on the approximate 30:70 percent spatial ratio of agricultural land:forest within the project area. Santos will compensate the Forestry Corporation of New South Wales through annual rent for the area that is temporarily sterilised. The costs of this compensation are included in the construction and operations cost estimates and are therefore not costed separately.

4.1.5 Costs to local infrastructure

Potential costs to local infrastructure include increased renewals and maintenance costs associated with increased demand on local infrastructure services. Local infrastructure at most risk of being affected includes the local road network, water and sewerage services and the power grid should the grid option to power the project be adopted. The initial transport upgrade costs have been included in the project capital cost component of this Cost Benefit Analysis. Traffic generated by the project has the potential to affect road condition, which can accelerate the rate of ongoing maintenance and renewals incurred by the relevant road authorities. Santos would monitor and report on evident deterioration of road conditions over the peak construction period and would consult with the relevant road authorities regarding potential maintenance liability where the deterioration is attributable to project activities. Costs associated with maintenance and renewals would likely form a small proportion of the ongoing capital and operating costs of the project. The proportional increase in traffic generated by the project on major roads like the Newell Highway is not expected to significantly impact on the safety or condition of these roads, which are designed to carry heavy vehicles.

4.1.6 Quantifiable External environmental costs

(1) Traffic impacts

Traffic impacts that have been identified in the risk assessment include impacts on the Newell Highway and those that are likely to occur on local roads in and around Narrabri. Traffic impacts on the Newell Highway are predominantly safety impacts associated with construction vehicles entering the high speed environment of the Newell Highway from the access point to Leewood. Similarly, there are potential traffic impacts associated with vehicles slowing to exit the Newell Highway on to access roads. As outlined in the Traffic Technical Appendix (Appendix P), these impacts are proposed to be ameliorated through the provision of intersection upgrades. The costs of constructing and maintaining the upgraded intersections have been included in the cost estimates provide to GHD by Santos. These costs are therefore included in the CBA.

(2) Biodiversity/vegetation

Development of the project will require biodiversity and vegetation land acquired for the purpose of offsetting the project's biodiversity impacts. It should be noted however, that the land proposed to be acquired has been designated for forestry, mining and petroleum activity under the NSW *Brigalow and Nandewar Community Conservation Area Act 2005*.

The Cost Benefit Analysis seeks to estimate the cost to the society of ensuring there is no net biodiversity loss. For this exercise, an assessment of the cost to Santos of acquiring biodiversity offsets through the NSW Government's Biodiversity Banking and Offsets Scheme has been undertaken in accordance with the NSW Government, 2007:

The NSW Biodiversity Banking and Offsets Scheme helps to address the loss of biodiversity in NSW. It achieves this by enabling landowners in NSW to establish biobank sites to secure conservation outcomes and offset impacts on biodiversity values.[10]

It is acknowledged that this approach assumes that the offset, as determined by the regulator, does achieve no net loss.

Based on information provided by Santos, the total biodiversity offset package is estimated to cost between $35 million and $58 million, which includes in perpetuity management costs. For the purpose of this analysis, the mid-point of this range (i.e. $46.5 million) was used. It was assumed that this expenditure will occur in 2017. In Net Present Value terms, it is estimated that the cost to Santos for offsetting the vegetation/biodiversity required by the project is $43.5 million.

(3) Noise and vibration

The majority of the noise impacts will occur during drilling. Estimates of the number of sensitive receivers and the duration of the noise impact have been calculated (Refer to Technical Appendix M). Due to uncertainty in the location of wells, the estimates for noise costs assume an even spread of wells throughout the project area. The main noise generators during operation in Leewood and Bibblewindi have been assessed and these are within acceptable noise limits.

Santos will negotiate individually with each landholder where noise levels are predicted to exceed the guidelines at an occupied residence. An indicative cost estimate of Santos' costs to offset noise impacts is included in the Cost Benefit Analysis.

In Net Present Value terms, it is estimated that the cost to Santos of offsetting noise and vibration impacts over the life of the project is $1.7 million.

(4) Greenhouse gas emissions

The greenhouse gas emissions attributable to the project have been estimated in the Greenhouse Gas Assessment (refer Technical Appendix R). For the purpose of the Cost Benefit Analysis, the emissions under the project case need to be compared to the do nothing base case. Under the base case, gas currently being imported to NSW is assumed to be exported as LNG to meet contractual agreements in Asia with a potential shortage in the supply of domestic gas market from 2017 onwards. The energy currently being supplied from gas sources to industry and households in NSW may need to come from an alternate source. This could possibly comprise a mix of energy options including coal, solar, biomass and hydro-electricity sources, or it may stimulate more efficient use of the limited gas supply. Under the project case, annual direct greenhouse gas emissions for the project in a typical operating year would be about 0.96 Mt CO2-e with the on-site power generation facility (Option 1), or 0.53 Mt CO2-e with electricity sourced from the national grid (Option 2). This is the equivalent of less than 0.2 per cent of current annual emissions in Australia and less than 0.002 per cent of current global emissions.

For the purpose of estimating an indicative social cost of carbon as recommended under the 2015 *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*, the following assumptions were applied to both electricity supply options:

1. Construction phase emission – equal emission annually for a total of 2.2 Mt CO2-e over the three year period (i.e. 733,333 tonnes of CO2-e per annum).

[10] Department of Environment and Climate Change (2007) *Biodiversity Banking and Offsets Scheme: Scheme overview*.

2. Operation phase emission – a total of 24.1 Mt CO2-e for Option 1 (on-site power generation) or a total of 13.3 Mt CO2-e for Option 2 (grid sourced electricity), and weighted based on production level each year.
3. Decommission phase emission – zero.
4. Carbon price based on the value estimated by the United States Environmental Protection Agency as included in the Greenhouse Gas Valuation Workbook accompanying the 2015 Guidelines, escalated to 2015 September dollar value (as an approximate for 2016/17 dollar value) using the same ABS Consumer Price Index series.[11]

4.2 Quantifying project benefits

4.2.1 Revenue benefits to Australian shareholders

The major quantifiable benefit of the project is the revenue that accrues as a result of unlocking the value of the resource. To calculate this benefit stream, it has been assumed that:

1. 87 per cent of Santos shareholders are assumed to be Australian residents[12].
2. The remaining 13 per cent of shareholders are assumed to be international residents, however for the purpose of calculating benefit cost ratio, the total revenue benefits are included in the calculation of benefits.
3. Production commences in 2019/20 and increases as outlined in Table 4-3.
4. A conservative estimate of $8.70 per Gigajoule (GJ) for the gas price.

Table 4-3 Production and gas price data

	2019	2020	2021	2022	2023	2024	2025	2026..	2041
Million GJ/annum	13	34	55	69	74	74	74	74	55
Gas price $/GJ (real)	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7

Notes: GJ = Gigajoule

4.2.2 Additional agricultural output (amended water)

Under the project case, it is proposed that water produced during gas extraction will be treated at the Leewood water treatment facility and then be made available for irrigated agriculture. Water volume is expected to peak during the early years (around years two to four) at approximately 10 megalitres (ML) per day with a gradual decline over the life of the project to a long term average yield of approximately 4 ML per day. (Note that the EIS assesses the beneficial reuse of up to 12 ML per day up to year four to provide operational flexibility in treated water management options). The average annual water production rate over the 25-year assessment period is estimated to be 1.5 gigalitres (GL) per annum. It is considered that the gypsum-amended water will be in demand by irrigators especially for the production of irrigated lucerne hay (refer to Appendix G2 and Appendix K).

Of the long term average yield of around 4 ML per day, it is estimated that around 2.9 ML per day would be beneficially reused through irrigation, the remainder would be beneficially reused through drilling, construction and / or dust suppression. This is equivalent to approximately

[11] ABS 2015, *Consumer Price Index*, Category No. 6401.0, All Groups CPI Australia, Index Series ID A2325846C.
[12] Based on advice provided to GHD by Santos.

1,060 ML per year for irrigation of suitable crops and pastures. Irrigation water requirements vary depending on the choice of crops or pastures. Assuming 7.5 ML/ha/year water use requirement for the production of lucerne hay, this volume of amended water would be sufficient to irrigate approximately 143 hectares. The NSW Department of Primary Industries' website provides information on irrigation water usage, with examples being for surface irrigated lucerne that requires 8.8 ML/ha and for cotton that requires 7 ML/ha (see http://www.dpi.nsw.gov.au/agriculture/farm-business/budgets/summer-crops). The gross margin for irrigated lucerne hay is estimated as $1,000 per hectare based on NSW DPI gross margins[13]. Assuming that net benefits are 50 per cent of the gross margin (escalated to $2016/17, i.e. $512.50/ha) to allow for irrigation infrastructure development costs, the total net benefits from 143 hectares of lucerne hay would be $73,288 per annum ($2016/17, undiscounted) which would partly offset the costs of impacts to agricultural production during the operations phase of the project which are presented in Table 4-1 and Table 4-2.

4.2.3 Compensation received by landholders

Under the project case, Santos is expected to compensate landholders, third parties and forestry management owners for the foregone agricultural production value (refer to section 4.1.3) and foregone forestry production value (refer to section 4.1.4). Given that this payment has been included in Santos' operating cost estimate, this transfer of value requires a corresponding offset to avoid double counting in the costs associated with the project.

4.3 Other benefits not considered in Cost Benefit Analysis

4.3.1 Government taxes and royalties

Government taxes and royalties have not been included as discrete benefit line items in the CBA as they are paid out of revenue (producer surplus) which is included in the Cost Benefit Analysis. Including these items would be double accounting. However, for the purposes of assessing the contribution of the project to the NSW and Australian Governments, the discounted royalties and taxes have been calculated and are presented in Table 4-4.

[13] Gross margin data accessed from DPI website http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/175923/Irrigated-spray-lucerne-12-13.pdf on 28 August 2014).

Table 4-4 Government tax revenue increases

	Total (2017 to 2042) (2016/17 AUD $m)	Net Present Value ($2016/17) (7% real discount rate)
Project company taxes	1,386	456
Project royalties	821	293
NSW payroll taxes	129	60
Other taxes on income	294	120
Other taxes	503	237
TOTAL	**3,133**	**1,165**

Source: ACIL Allen (2016) and Santos NSW (Eastern) Pty Ltd

4.3.2 Additional economic output (Gross Regional Product, employment and income benefits)

Computable General Economic modelling was undertaken by ACIL-Allen Consulting to determine the macroeconomic benefits of the project. Results from the report indicate (ACIL-Allen 2016):

- An increase in Gross State Product of $11.9 billion relative to the base case (with a net present value of $5.1 billion, using a 7 per cent real discount rate).
- An increase in real incomes in New South Wales of $6.0 billion over the life of the project (with a net present value of $2.8 billion, using a 7 per cent real discount rate).
- An average increase of 512 full time equivalent (FTE) jobs in New South Wales over the course of the project with peak employments occur during 2017 to 2021. Specifically, an average increase of 127 FTE jobs is expected to be generated within the Narrabri region, 161 FTE within the Narrabri surrounds region and 224 FTE in the rest of NSW.

4.3.3 Assessing Local benefits

One criticism of CBA and other economic analytical tools such as Input-Output modelling and Computable General Economic modelling is that they do not provide a good indication of the distribution of economic costs and benefits. A common theme amongst the literature is that economic benefits accrue to shareholders, management and other employees; the majority of which are not local residents. It is often argued that it is local residents that incur the majority of the costs in the form of rising house prices (for aspiring owners), rising rates and higher costs to upgrade and maintain locally-funded infrastructure such as local roads and water and sewerage assets.

To ensure that the regional communities hosting Santos' activities directly benefit, a Gas Community Benefit Fund will be established, which is expected to deliver around $120 million to the region over the life of the project or an average of approximately $4.8 million per annum. These funds would be available to the Narrabri Shire Council to support major initiatives and infrastructure projects in the local community. These benefits are not included in the CBA as the money is funded from Santos' revenue stream.

4.3.4 Other local benefits - lessons from CSG development in Queensland

In western Queensland, natural gas from coal seam projects has brought about considerable change in regional areas. A 2014 report released by the Gas Industry Social and Environmental Research Alliance (GISERA) notes that natural gas from coal seam production is contributing to

reversing “decline in regional areas” (GISERA, 2014)[14]. Benefits identified in the research include:

- Increases in the youth population (people in their twenties) in regions producing natural gas from coal seams as opposed to decreases in similar comparable regions where natural gas activities are not occurring. These increases in the youth population relate to increased employment opportunities for both males and females. “For example in Chinchilla, total female employment increased 26 per cent from 1,204 in 2006 to 1,516 in 2011. Industries where more females were working between these periods included the mining, construction and hospitality industries.
- For every job created in the resources sector, “there have been around two new jobs created in the related sectors of construction and professional services. By contrast, for each new job in the resources sector there has been a reduction of 1.7 jobs in agriculture”.

Empirical research by Measham and Fleming (2014) also suggests that the CSG industry has had a positive impact on rural-urban decline[15], local employment and local income levels. In summary, the report finds that:

- Some skills which are in demand during the installation phase of a CSG project are familiar to local residents such as the need to fence off well sites to prevent stock intrusion.
- “During the operational phases, many of the labour demands are relatively low skilled, and can be sourced either from local towns or from nearby town centres. Whereas conventional mining for coal or metal ores tend to use a small number of large machines, unconventional gas tends to use a larger number of small machines, such as water pumps and gas separators, connected by an elaborate system of pipes. Each of these requires checking and maintaining on a regular basis, providing a need for skills that are relatively transferable between sectors. Similarly, skills such as truck driving and grading roads makeup a large part of the CSG labour force and can be sourced locally or from other towns and cities. These characteristics have resulted in a net increase in the total employment in CSG regions, as well as a transfer of labour from the agricultural sector to the resources sector”.
- The CSG industry in western Queensland has reduced the number of people and families who are living below the poverty line. For example, in Chinchilla, the number of families living below the poverty line in 2001 was 23 per cent. This number reduced to 8 per cent in 2011. Fly in Fly Out workers were excluded in the analysis which demonstrates the benefits to local residents.

While the research did find these positive impacts, it also noted that CSG projects tend to affect a wider geographical area compared to conventional mining projects which means that a greater area of agricultural land can be impacted. These impacts are considered in detail in section 4.1.3 and in (Agricultural Impact Statement Technical Appendix K).

[14] GISERA is a research alliance between the CSIRO, QGC and Australia Pacific LNG. These agencies jointly fund GISERA’s research.

[15] In this context, rural urban decline includes demographic changes such as net migration from rural to urban areas, declining human capital and lower incomes.

5. Cost Benefit Analysis results

5.1 Summary of results

Under the central case using a 7 per cent real discount rate, the CBA for Option 1 (on-site power generation) yields a net present value (NPV) of $ 1,535.8 million and a Benefit-Cost Ratio (BCR) of 1.39. For Option 2 (grid-supplied electricity) and a 7 per cent real discount rate, the analysis yields a NPV $1,639.3 million and a BCR of 1.43. This suggests that the project will deliver a net economic benefit for Australia. Table 5-1 presents a summary of the CBA results.

Table 5-1 Summary of the Cost Benefit Analysis Results

Category of cost/benefit ($2016/17, million) (discounted at 7% discount rate)	Electricity Option 1 (Self-generated)	Electricity Option 2 (Grid supplied)
Costs		
Capital costs	2,004.3	2,004.3
Operating costs	1,578.0	1,578.0
Foregone agricultural production	3.1	3.1
Noise and vibration costs	1.7	1.7
Biodiversity offsets	43.5	43.5
Social cost of carbon	267.5	164.0
Residual value (land and infrastructure)	0.0	0.0
Total project costs	**3,898.1**	**3,794.6**
Benefits		
Project revenue	5,403.4	5,403.4
Additional agricultural output (amended water)	0.8	0.8
Compensation to landholders	29.7	29.7
Total project benefits	**5,433.9**	**5,433.9**
Net present value	**1,535.8**	**1,639.3**
Benefit-cost ratio	**1.39**	**1.43**

Note: Figures may not add up due to rounding.

The positive net present value is driven primarily by the value of unlocking the gas resource.

Furthermore, this project represents a positive BCR of 1.34 and 1.38 within option 1 and 2 respectively when assessing the project benefits on an Australian only basis (i.e. excluding the revenue and other benefits that would likely be realised internationally as a result of international ownership in the company).[16]

[16] Based upon an assumed 87% Australian ownership of the company

5.2 Sensitivity tests

The Cost Benefit Analysis under the default project case scenario indicates that the project has a positive economic return, with a benefit-cost ratio of greater than one. A number of sensitivity tests were undertaken to test the robustness of this result, since the uncertainty surrounding key variables means that the evaluation is not expected to exactly represent the future outcome.

5.2.1 Discount rate

In the central case a real discount rate of 7 per cent is applied. Consistent with New South Wales Treasury's 'Guideline for the use of Cost Benefit Analysis in Mining and Coal Seam Gas Proposals' sensitivity testing on the discount rate has been applied using a low (4 per cent real) and high (10 per cent real) discount rate.

At 4 per cent, the BCR rises to 1.56 and the NPV to $2,785.2 million for Option 1 (on-site power generation) or BCR of 1.61 and NPV of $2,937.5 million for Option 2 (grid-supplied electricity), reflecting that future benefits are valued more highly in present terms under the lower discount rate.

At a 10 per cent discount rate, the BCR falls to 1.24 and 1.27 for Option 1 and Option 2 respectively. The BCR is still positive under all discount rate scenarios.

Table 5-2 Summary of the Cost Benefit Analysis Results under various discount rate assumptions

Category of cost/benefit ($2016/17 million)	Electricity Option 1 (On-site generation)		Electricity Option 2 (Grid supplied)	
	at 4% discount rate	at 10% discount rate	at 4% discount rate	at 10% discount rate
Costs				
Capital costs	2,333.7	1,757.4	2,333.7	1,757.4
Operating costs	2,229.7	1,161.5	2,229.7	1,161.5
Foregone agricultural production	4.1	2.4	4.1	2.4
Noise and vibration costs	2.4	1.2	2.4	1.2
Vegetation offsets	44.7	42.3	44.7	42.3
Social cost of carbon	377.4	198.7	225.1	125.6
Residual Value (land and infrastructure)	0.0	0.0	0.0	0.0
Total project costs	**4,991.9**	**3,163.5**	**4,839.6**	**3,090.4**
Benefits				
Project revenue	7,733.9	3,914.0	7,733.9	3,914.0
Additional agricultural output (amended water)	1.1	0.6	1.1	0.6
Compensation to landholders	42.1	22.0	42.1	22.0
Total project benefits	**7,777.1**	**3,936.7**	**7,777.1**	**3,936.7**
Net present value	**2,785.2**	**773.1**	**2,937.5**	**846.2**
Benefit-cost ratio	**1.56**	**1.24**	**1.61**	**1.27**

Note: Figures may not add up due to rounding.

5.2.2 Production estimates

Changes in the production estimates will result in changes to the revenue estimates which will affect the BCR and NPV. Table 5-3 shows that the BCR and NPV would still be positive if production was 10 per cent below forecast levels in each year of the appraisal period.

Table 5-3 Summary of the Cost Benefit Analysis Results under a 10 per cent reduction in production estimates

Category of cost/benefit ($2016/17 million) discounted at 7 % discount rate, 10 % reduction in gas production estimates across all years	Electricity Option 1 (On-site generation)	Electricity Option 2 (Grid supplied)
Costs		
Capital costs	2,004.3	2,004.3
Operating costs	1,578.0	1,578.0
Foregone agricultural production	3.1	3.1
Noise and vibration costs	1.7	1.7
Vegetation offsets	43.5	43.5
Social cost of carbon	267.5	164.0
Residual Value (land and infrastructure)	0.0	0.0
Total project costs	**3,898.1**	**3,794.5**
Benefits		
Project revenue	4,863.1	4,863.1
Additional agricultural output (amended water)	0.8	0.8
Compensation to landholders	29.7	29.7
Total project benefits	**4,893.6**	**4,893.6**
Net present value	**995.5**	**1,099.0**
Benefit-cost ratio	**1.26**	**1.29**

Note: Figures may not add up due to rounding.

5.2.3 Gas price estimates

Gas price estimates have determined as per Santos estimates and are outlined in Table 4-3. Recently, energy markets have been volatile. Sensitivity testing on a 10, 20 and 30 per cent reduction in the forecast gas price is for electricity generation Option 1 is presented in Table 5-4, and for electricity generation Option 2 is presented in Table 5-5. The results show that the BCR and NPV remain positive for 10 per cent and 20 per cent reduction in forecast gas prices, however the forecast gas prices is reduced by 30 per cent, the project will generate a negative NPV of $85.2 million.

Table 5-4 Summary of the Cost Benefit Analysis Option 1 Results under a 10-30 per cent reduction in gas price estimates

Category of cost/benefit ($2016/17 million), discounted at 7 % discount rate	Electricity Option 1 (On-site generation)		
	10 % reduction in the real gas price across all years	20 % reduction in the real gas price across all years	30 % reduction in the real gas price across all years
Costs			
Capital costs	2,004.3	2,004.3	2,004.3
Operating costs	1,578.0	1,578.0	1,578.0
Foregone agricultural production	3.1	3.1	3.1
Noise and vibration costs	1.7	1.7	1.7
Vegetation offsets	43.5	43.5	43.5
Social cost of carbon	267.5	267.5	267.5
Residual Value (land and infrastructure)	0.0	0.0	0.0
Total project costs	**3,898.1**	**3,898.1**	**3,898.1**
Benefits			
Project revenue	4,863.1	4,322.7	3,782.4
Additional agricultural output (amended water)	0.8	0.8	0.8
Compensation to landholders	29.7	29.7	29.7
Total project benefits	**4,893.6**	**4,353.2**	**3,812.9**
Net present value	**995.5**	**455.2**	**-85.2**
Benefit-cost ratio	**1.26**	**1.12**	**0.98**

Note: Figures may not add up due to rounding.

Table 5-5 Summary of the Cost Benefit Analysis Option 2 Results under a 10-30 per cent reduction in gas price estimates

Category of cost/benefit ($2016/17 million), discounted at 7 % discount rate	Electricity Option 2 (Grid supplied)		
	10 % reduction in the real gas price across all years	20 % reduction in the real gas price across all years	30 % reduction in the real gas price across all years
Costs			
Capital costs	2,004.3	2,004.3	2,004.3
Operating costs	1,578.0	1,578.0	1,578.0
Foregone agricultural production	3.1	3.1	3.1
Noise and vibration costs	1.7	1.7	1.7
Vegetation offsets	43.5	43.5	43.5
Social cost of carbon	164.0	164.0	164.0
Residual Value (land and infrastructure)	0.0	0.0	0.0
Total project costs	**3,794.5**	**3,794.5**	**3,794.5**
Benefits			
Project revenue	4,863.1	4,322.7	3,782.4
Additional agricultural output (amended water)	0.8	0.8	0.8
Compensation to landholders	29.7	29.7	29.7
Total project benefits	**4,893.5**	**4,353.2**	**3,812.9**
Net present value	**1,099.0**	**558.7**	**18.4**
Benefit-cost ratio	**1.29**	**1.15**	**1.00**

Note: Figures may not add up due to rounding.

5.2.4 Gas production and price estimates

Table 5-6 presents the results of the BCR and NPV under a scenario where production forecasts and gas prices both reduce by 10 per cent. With a BCR of 1.13 and a NPV of $509.2 million for Option 1 (on-site generation) or a BCR of 1.16 and a NPV of $612.7 million for Option 2 (grid-supplied), the analysis estimates that project will still deliver a net benefit under this scenario.

Table 5-6 Summary of the Cost Benefit Analysis Results under a 10 per cent reduction in gas production and gas price estimates

Category of cost/benefit, ($2016/17 million), discounted at 7 % discount rate, 10% reduction in production and gas price estimates across all years	Electricity Option 1 (On-site generation)	Electricity Option 2 (Grid supplied)
Costs		
Capital costs	2,004.3	2,004.3
Operating costs	1,578.0	1,578.0
Foregone agricultural production	3.1	3.1
Noise and vibration costs	1.7	1.7
Vegetation offsets	43.5	43.5
Social cost of carbon	267.5	164.0
Residual Value (land and infrastructure)	0.0	0.0
Total project costs	**3,898.1**	**3,794.5**
Benefits		
Project revenue	4,376.8	4,376.8
Additional agricultural output (amended water)	0.8	0.8
Compensation to landholders	29.7	29.7
Total project benefits	**4,407.3**	**4,407.2**
Net present value	**509.2**	**612.7**
Benefit-cost ratio	**1.13**	**1.16**

Note: Figures may not add up due to rounding.

5.2.5 Capital and operating costs

Table 5-7 presents the BCR and NPV under a scenario where capital and operating costs increase by 10 per cent across all years of the appraisal period. Under this scenario, the BCR and NPV remain positive at 1.17 and $786.4 million for Option 1 (on-site generation) or BCR of 1.20 with NPV of $889.9 million for Option 2 (grid supplied).

Table 5-7 Summary of the Cost Benefit Analysis Results under a 10 per cent increase in capital and operating costs

Category of cost/benefit, ($2016/17 million), discounted at 7 % discount rate, 10 % increase in CAPEX and OPEX estimates across all years	Electricity Option 1 (On-site generation)	Electricity Option 2 (Grid supplied)
Costs		
Capital costs	2,425.3	2,425.3
Operating costs	1,909.4	1,909.4
Foregone agricultural production	3.1	3.1
Noise and vibration costs	1.7	1.7
Vegetation offsets	43.5	43.5
Social cost of carbon	267.5	164.0
Residual Value (land and infrastructure)	0.0	0.0
Total project costs	**4,650.5**	**4,547.0**
Benefits		
Project revenue	5,403.4	5,403.4
Additional agricultural output (amended water)	0.8	0.8
Compensation to landholders	32.7	32.7
Total project benefits	**5,436.9**	**5,436.9**
Net present value	**786.4**	**889.9**
Benefit-cost ratio	**1.17**	**1.20**

Note: Figures may not add up due to rounding.

6. Conclusion

The Cost Benefit Analysis estimates that Santos' proposed project will deliver a net benefit to Australia which is estimated to be $1.54 billion in NPV terms with Benefit-Cost Ratio of 1.39 for Option 1 (on-site generation) or $1.64 billion in NPV terms with Benefit-Cost Ratio of 1.43 for Option 2 (grid-supplied).

The positive NPV and BCR for both electricity supply options means the project is expected to deliver a net benefit to Australia.

A number of sensitivities have been conducted on key parameters that are most likely to change the ratio of benefits to costs.

The NPV and BCR remain positive under:

- All discount rate scenarios;
- A scenario where capital and operating costs increase by 10 per cent across the entire appraisal period;
- Scenarios where the long-term gas price estimates are 10 per cent and 20 per cent below those forecast by Santos in the central case; and
- A scenario where the production estimates and forecast gas prices drop by 10 per cent per annum.

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