technical report H

greenhouse gas.

Environment Effects Statement | May 2021

western outer ring main

a project of apa

APA VTS (Operations) Pty Ltd

APA WORM - Environment Effects Statement
Greenhouse Gas Report

May 2021

This Greenhouse Gas Impact Assessment Report (Report):

1. Has been prepared by GHD Pty Ltd ("GHD") for APA VTS (Operations) Pty Ltd (APA);
2. May only be used for the purpose of informing the Environment Effects Statement and Pipeline Licence Application for the Western Outer Ring Main Project (and must not be used for any other purpose); and
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Executive summary

This technical report is an attachment to the Western Outer Ring Main Project Environment Effects Statement (EES). It provides an assessment of the potential greenhouse gas emission impacts associated with the construction and operation of the Project, and defines the environmental management measures necessary to meet the EES evaluation objectives.

Overview

The Western Outer Ring Main Project (the Project) is a buried 600 millimetre nominal diameter high pressure gas transmission pipeline between APA's existing Plumpton Regulating Station (approx. 38 kilometres north west of Melbourne's CBD) and Wollert Compressor Station (approx. 26 kilometres north east of Melbourne's CBD), providing a high pressure connection between the eastern and western pipeline networks of the Victorian Transmission System (VTS).

The Project includes a new buried pipeline, three above-ground mainline valves along the pipeline alignment, and an additional compressor unit and regulating station at the existing APA Wollert Compressor Station.

APA is the proponent for the Project.

On 22 December 2019, the Minister for Planning determined that the Project would require an Environment Effects Statement (EES) under the *Environment Effects Act 1978* (EE Act).

GHD was commissioned to undertake a greenhouse gas assessment for the purpose of the EES.

Technical area context

The construction and operation of the Project would involve activities that generate carbon dioxide and other greenhouse gases. Quantifying the greenhouse gas emissions from the Project is an important process by which to understand the context at which it contributes to state and national emissions.

The greenhouse gas report includes Scope 1, Scope 2 and Scope 3 emissions from the construction and operation of the Project. The definitions of Scope 1 and Scope 2 emissions are provided in the National Greenhouse and Energy Reporting Regulations 2008:

- Scope 1 emissions: The release of greenhouse gas into the atmosphere as a direct result of the Project's activities during construction and operations (including ancillary activities). For example, fuel consumption in construction vehicles or on-site plant.
- Scope 2 emissions: The release of greenhouse gas into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the Project but that do not form part of the facility. For example, the use of grid electricity during construction or operation. Note, Scope 2 emissions are within the scope and were considered in this assessment. However, the quantity of Scope 2 emissions is assumed to be negligible, because the amount of electricity from the grid consumed during construction and operation is in itself negligible. Therefore Scope 2 emissions do not contribute to the emissions totals presented in this report.

The definition of scope 3 emissions is provided by the Clean Energy Regulator (CER, 2018):

- Scope 3 emissions: Other indirect release of greenhouse emissions during construction that are generated in the wider economy. They occur as a consequence of the activities of the Project, but from sources not owned or controlled by the Project's business. For example, emissions associated with the production of raw materials consumed during construction such as steel.

For the purposes of this assessment, only material Scope 3 emissions have been estimated. Materiality has been determined in accordance with accepted practice under the NGER legislation, and is based on knowledge of the Project and past similar greenhouse gas assessments.

For the purposes of this assessment, material Scope 3 emissions are limited to:

- Construction and operation fuel consumption
- Embodied emissions associated with pipeline construction materials (steel and concrete)

The greenhouse gas assessment methodology was performed in accordance with the principles set out in the following documents:

- NGER (Measurement) Determination 2008 (as amended) and NGER Act 2007, Commonwealth Department of Environment and Energy
- The Greenhouse Gas Protocol (GHG Protocol), the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)
- ISO 14064-1:2006 Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals
- ISO 14040:2006 Environmental management – Lifecycle assessment – Principles and framework and ISO 14044:2006 Environmental management – Lifecycle assessment – Requirements and guidelines. These standards are applicable to the calculation of materials lifecycle impacts using the Infrastructure Sustainability (IS) Materials Calculator.

Existing conditions

The existing conditions of the Project, related to greenhouse gas emissions, were considered on a state and national level. Estimated emissions directly attributed to the construction and operation of the Project were compared against state and national emissions totals for the year 2018, being 102.2 million-tonnes of carbon dioxide equivalent (Mt CO_2-e) and 537.4 Mt CO_2-e respectively (DISER, 2020).

Construction assessment

A greenhouse gas emissions assessment has been undertaken to determine the impacts of the Project on greenhouse gas emissions and to identify management and mitigation measures to reduce potential risks of the Project.

A summary of the total greenhouse gas emissions associated with construction of the Project is presented in Table 1. A comparison of construction Scope 1 emissions with state and national emissions totals is also presented.

Significant aspects of greenhouse gas emissions contribution include:

- Embodied emissions from construction materials (Scope 3)
- Land clearance emissions (Scope 1)

Table 1 Summary of estimated greenhouse gas emissions associated with the Project

Activity	Emissions tonnes carbon dioxide equivalent (t CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
Construction (Pipeline and Compressor Station works)	19,570	0	31,240	**50,810**
Percentage of Victorian annual emissions	0.019%		-	
Percentage of Australian Annual Emissions	0.004%		-	

Operational assessment

A summary of the total annual greenhouse gas emissions associated with operation of the Project are presented in Table 2. A comparison of operational Scope 1 emissions with state and national emissions totals is also presented within Table 2.

Significant areas of GHG emissions contribution include:

- Consumption of natural gas at the compressor station (Scope 1)

Table 2 Summary of estimated greenhouse gas emissions associated with the Project

Activity	Emissions tonnes carbon dioxide equivalent (t CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
Operation	14,340		1,040	**15,380**
Percentage of Victorian annual emissions	0.014%		-	
Percentage of Australian Annual Emissions	0.003%		-	

Potential network efficiency gains

In its annual Victorian Gas Planning Reports (VGPR), the Australian Energy Market Operator (AEMO) provided comments on the business case for construction of the WORM Project. In its 2017 report, AEMO notes that the current method of transporting gas from Longford to Port Campbell is very inefficient (AEMO, 2017).

In the 2018 Victorian Gas Planning Report (AEMO, 2018), AEMO goes on to quantify the potential efficiency gains that the Project would bring:

“The 2017 VGPR noted the inefficiency of the current method of transporting gas from Longford to Port Campbell, given pipeline pressure must be reduced at Dandenong [City Gate], then recompressed at Brooklyn to flow along the [Brooklyn to Lara Pipeline] (BLP) and [South West Pipeline[(SWP) towards Port Campbell. Brooklyn [Compressor Station] (CS) used some 414 TJ of fuel gas in 2016-17, at an estimated cost of $3.5 million.

With the WORM connecting into the BLP, which would enable gas to flow to Port Campbell via the SWP, half the fuel gas would be required to transport the same quantity, compared to the current fuel gas usage via Brooklyn CS”.

AEMO estimates that half of the 414 TJ of fuel gas used in 2016/17 would be required to transport the same quantity of gas with the operation of the Project. This equates to a saving of 207 TJ of fuel gas, or approximately 10,700 t CO_2-e less emissions per annum if the predicted efficiency gains are achieved.

Environmental management measures

In undertaking this greenhouse gas assessment, environmental management measures have been identified to reduce the impact of construction and operation emissions associated with the Project. Key environmental management measures include:

- Low embodied energy materials will be considered and used where they are of comparable quality, utility, availability and cost (EMM GG1(a))
- Fuel efficient plant and equipment will be considered and used where practicable during construction (EMM GG1(b))
- Locally sourced materials, including those provided by suppliers, will be considered and implemented where they are of comparable quality, utility, availability and cost. (EMM GG1(c))
- The amount of vegetation removal along the pipeline alignment will be reduced as far as reasonably practicable (EMM GG1(d))
- Implementation of the Protocol for Environmental Management (PEM): Greenhouses Gas Emissions and Energy Efficiency in Industry 2001 for the operation of the compressor station including consideration of energy efficiency best practice (EMM GG2(a))

Conclusion

The Project is estimated to contribute 50,810 t CO_2-e to state and national emissions during the construction phase and 15,380 t CO_2-e per annum during operations. However operation of the Project is predicted to lead to efficiency gains in the overall Victorian gas supply network, leading to a net reduction in total greenhouse gas emissions across the VTS. These estimated efficiency gains are predicted, based on data from AEMO, to lead to a net annual operational saving of 10,110 t CO_2-e across the VTS. Given the net reduction emissions of 10,110 t CO_2-e per annum across the VTS, operation of the Project contributes positively to state and national emissions reduction targets. Therefore, the Project provides an emissions benefit compared to the no-project scenario.

Abbreviations

Abbreviation	Definition
CBD	Central Business District
CEMP	Construction Environment Management Plan
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
EES	Environment Effects Statement
GED	General environmental duty
GJ	Gigajoules
Ha	Hectares
ICCP	impressed current cathodic protection
IS	Infrastructure Sustainability
ISCA	Infrastructure Sustainability Council of Australia
LDP	Longford Dandenong pipeline
m^3	Cubic metres
MPa	Megapascal
MLV	Mainline valve
MSA	Melbourne Strategic Assessment
N2O	Nitrous oxide
NGER	National Greenhouse and Energy Reporting
PEM	Protocol for Environmental Management: Greenhouses Gas Emissions and Energy Efficiency in Industry 2001
SCM	Supplementary cementitious materials
SWP	South West pipeline
t CO_2-e	Tonnes of carbon dioxide equivalent
TJ	Terajoules
UGS	Underground storage
UNFCCC	United Nations Framework Convention on Climate Change
VGPR	Victorian Gas Planning Report
VNI	Victorian Northern Interconnect
VTS	Victorian Transmission System

Abbreviation	Definition
WBCSD	World Business Council for Sustainable Development
WORM	Western Outer Ring Main
WRI	World Resources Institute

Glossary

Term	Definition
APA	APA VTS (Operations) Pty Ltd, trading as APA Group, the proponent for the Project
Climate Change Act	Climate Change Act 2017 (Vic)
Environmental management measure	Approaches, requirements or actions to avoid, mitigate or manage potential adverse impacts
EP Act	Environment Protection Act 1970 (Vic) and Environment Protection Act 2017
NGA Factors	National Greenhouse Accounts Factors
NGER Act	National Greenhouse and Energy Reporting Act 2007
NGER Measurement Determination	National Greenhouse and Energy Reporting (Measurement) Determination 2008
Project	The Western Outer Ring Main Project
Safeguard Mechanism	National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015
SEPP AQM	State Environment Protection Policy (SEPP) Air Quality Management (AQM) 2001
Scoping requirements	The EES Scoping requirements for the Project issued by the Minister for Planning in August 2020

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1. Introduction

1.1 Purpose of this report

The Western Outer Ring Main (WORM) gas pipeline project (the Project) is a proposed 600 millimetre nominal diameter high pressure gas transmission pipeline that will provide an additional high pressure connection between the eastern and western pipeline networks of the Victorian Transmission System (VTS) with related facilities.

APA is the proponent for the Project. APA is Australia's largest natural gas infrastructure business. In Victoria, the VTS is owned and maintained by APA and consists of some 2,267 kilometres of gas pipelines. The VTS serves a total consumption base of approximately two million residential consumers and approximately 60,000 industrial and commercial users throughout Victoria.

The Project has been designed to provide critical infrastructure for Victoria's gas supply, distribution, and consequent security, efficiency and affordability. The key objectives of the project are to:

- Improve system resilience and security of gas supply
- Increase the amount of natural gas that can be stored for times of peak demand
- Improve network performance and reliability
- Address potential gas shortages as forecasted by AEMO in the March 2020 Victorian Gas Planning Report update

The Minister for Planning determined on 22 December 2019 that APA and the Western Outer Ring Main (WORM) gas pipeline project (the Project) would require an Environment Effects Statement (EES) under the *Environment Effects Act* 1978 (EE Act). The EES will inform assessment of approvals required for the Project including under the *Pipelines Act* 2005, *Aboriginal Heritage Act* 2006 and *Environment Protection and Biodiversity Conservation Act* 1999.

The purpose of this report is to assess the potential greenhouse gas impacts associated with the Project, identify options for reducing direct and indirect greenhouse gas emissions resulting from the construction and operation of the Project, and to define the environmental management measures necessary to meet the EES evaluation objectives.

1.2 Why understanding greenhouse gas emissions is important

Over the past centuries, the Earth's climate has been altered as a direct result of anthropogenic climate change. As a direct result, global atmospheric and sea-surface temperatures are increasing, sea levels are rising and glaciers and ice sheets have decreased in size. In Australia, climate change exacerbates existing climate risks and creates new risks, such as affected temperatures, rainfall, and fire weather. The largest contributing factor driving anthropogenic climate change is the increase in atmospheric carbon dioxide concentrations since 1750 (CSIRO, 2016).

The construction and operation of the Project would involve activities that generate greenhouse gases. Quantifying the greenhouse gas emissions from the Project is an important process by which to understand the scale at which it contributes to state and national emissions. Management of activities to reduce greenhouse gas emissions is important in the efforts to reduce our state and national emissions, and reduce the effects of climate change in the future.

It is relevant to note that a benefit of the Project is to allow for more efficient transmission of gas in Victoria. This is an important potential contribution to reducing emissions and helping to meet state and federal greenhouse gas emission targets.

1.3 Limitations

This report has been prepared by GHD for APA VTS (Operations) Pty Ltd and may only be used and relied on by APA VTS (Operations) Pty Ltd for the purpose agreed between GHD and the APA VTS (Operations) Pty Ltd as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than APA VTS (Operations) Pty Ltd 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 (refer to section 5.7 of 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 APA VTS (Operations) Pty Ltd and others who provided information to GHD (including Government authorities), 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.

2. EES scoping requirements

2.1 EES evaluation objectives

The scoping requirements for the EES, released by the Minister for Planning, set out the specific environmental matters to be investigated and documented in the Project's EES, and informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objective is relevant to the greenhouse gas assessment:

Waste Management – *Minimise generation of wastes from the project during construction and operation, and to prevent adverse environmental or health effects from storing, handling, transporting and disposing of waste products.*

2.2 EES scoping requirements

The scoping requirements relevant to the greenhouse gas evaluation objectives are shown in Table 3, as well as the location where these items have been addressed in this report.

Table 3 Scoping requirements relevant to greenhouse gas

Aspect	Scoping requirement	Reference
Key issues	Potential for adverse environmental or health effects from waste materials/streams generated from Project works. Potential for emissions of greenhouse gases to result from the Project, including embedded emissions due to construction materials and processes as well as direct and indirect emissions from construction and operation.	Section 8 – Greenhouse Gas Assessment
Existing environment	Identify potential greenhouse gas emissions that will result from the Project.	Section 5.8 – Existing Conditions
Mitigation measures	Identify options for reducing direct and indirect greenhouse gas emissions resulting from the construction and operation of the Project, including the potential for fugitive emissions	Section 9 – Environmental Management Measures
Likely effects	Quantify anticipated greenhouse gas emissions from the Project during construction and operation, and assess the implications of these emissions in the context of the targets outlined in the *Climate Change Act 2017.* Assess risks associated with unplanned spills/leakages of gas or other pollutants	Section 8 – Greenhouse Gas Assessment

Aspect	Scoping requirement	Reference
Performance criteria	Describe proposed measures to reduce, monitor and audit greenhouse gas emissions from the Project.	Section 9 – Environmental Management Measures

2.3 Linkages to other reports

This report relies on the technical assessment as indicated in Table 4.

Table 4 Linkages to other technical reports

Specialist report	Relevance to this technical study
Technical Report A – Biodiversity	Defines the potential area of vegetation removal due to construction of the Project
Technical Report E – Contamination	Addresses the risks of gas emissions from existing or closed landfills near the Project alignment

3. Project description

3.1 Project overview

The Project provides a new link between APA's existing Plumpton Regulating Station (approx. 38 kilometres north west of Melbourne's CBD) and Wollert Compressor Station (approx. 26 kilometres north east of Melbourne's CBD). The Project includes the following key components:

- **A new pipeline**: The pipeline would be approximately 51 kilometres in length. The pipeline would be within a 15 metre wide permanent easement and be buried for its entire length to a minimum depth of cover of 750 millimetres.
- **Mainline valves**: Three mainline valves (MLV) would be located along the pipeline alignment. The area required for mainline valves would be subdivided and acquired by APA to provide ongoing access for any maintenance or inspection activities from the existing roads. The mainline valves would be spaced at intervals of approximately 15 kilometres, and located at approximately KP 6, KP 22 and KP 35.
- The **Wollert Compressor Station upgrade**: The installation of a new Solar Centaur 50 compressor, an end of line scraper station and a pressure regulating station within the existing APA facility at Wollert.

A schematic illustration of the Project context is shown in Figure 3-1.

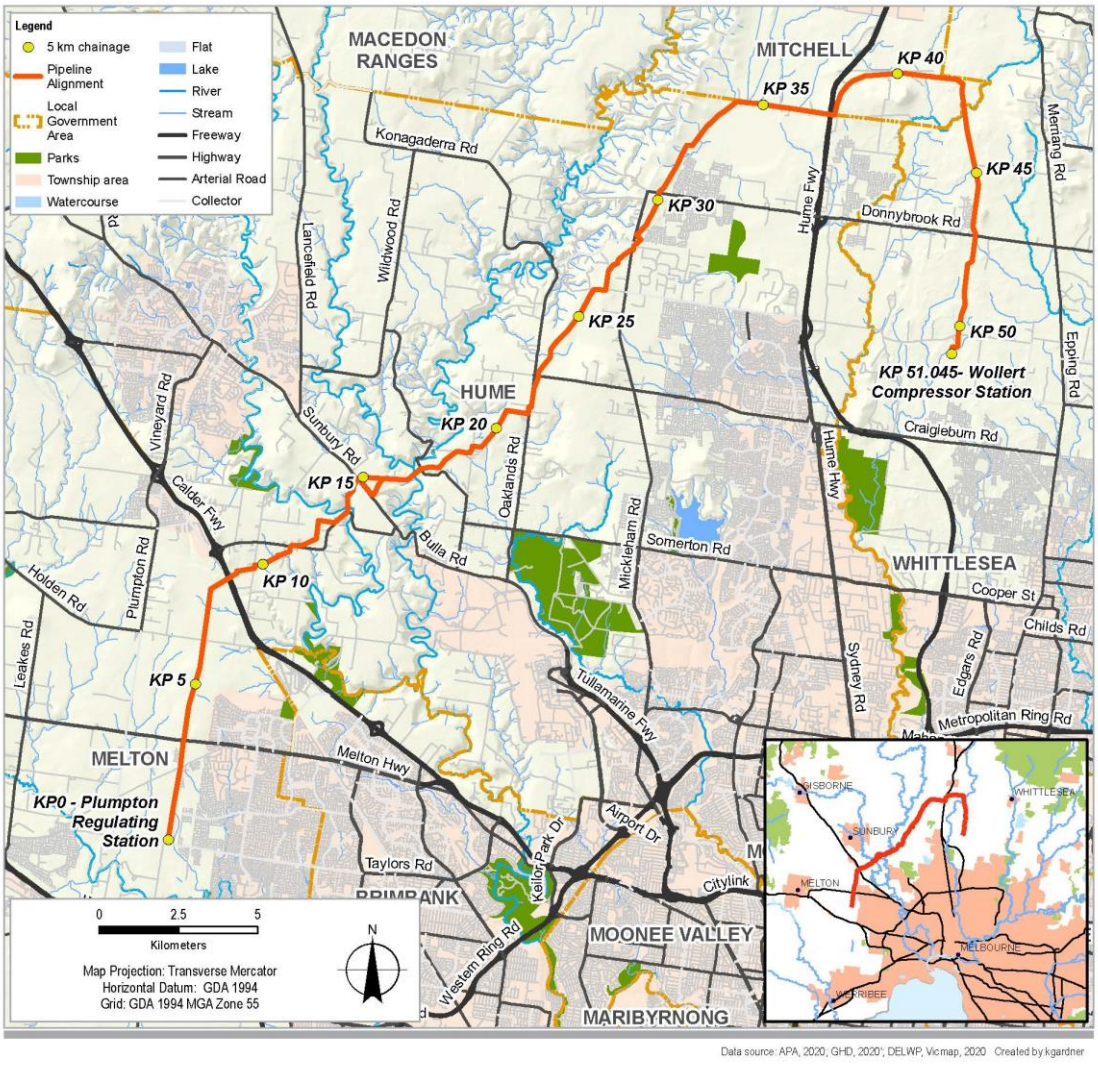

Figure 3-1 Overview study area

3.2 Construction

Subject to the staging of the works, construction for the entire Project is expected to take approximately nine months. Key construction activities for the Project include:

- Establishing offsite construction sites and construction/laydown areas
- Constructing the pipeline
- Constructing three mainline valves
- Construction of upgrades associated with the Wollert Compressor Station
- Rehabilitation

3.2.1 Construction sites

Two temporary construction sites would be established for construction.

One offsite compound for pipeline works nominally 200 metres x 200 metres, include laydown and storage areas. This would be located on a site where the activity is permitted under the relevant Planning Scheme, most likely within an existing industrial area.

The second temporary laydown area and construction offices would be established for the Wollert Compressor Station construction works. The construction offices and site laydown area for the compressor station equipment would be located within the existing compressor site area at Wollert.

3.2.2 Pipeline construction area

The Project would require a construction area for the pipeline, which would typically comprise a 30 metre wide corridor along the pipeline alignment. Most construction activity would be located within this construction area. The activities and facilities within the construction corridor would include access tracks and additional work areas such as vehicle turn around points and additional work spaces for crossings, stockpiling of materials and storage of pipe. Additional work areas up to 50 m x 50 m or 50 m x 100 m (such as for vehicle turn-around points, areas to accommodate HDD) would be required in some locations.

3.2.3 Pipeline construction methodology

The techniques used to construct the underground pipeline would include various methods including, open trenching and alternative techniques at certain locations such as horizontal directional drilling (HDD) or horizontal boring.

Where crossing watercourses, major roads, rail line reserves or other constraints, the pipeline may be constructed using trenchless construction techniques such as HDD or shallow horizontal boring, to avoid construction disturbance within the sensitive area.

The pipeline construction sequence starts with survey works and continues with site establishment (including laydown area), clearing and grading, pipe stringing, pipe bending, welding and coating, trenching, lowering pipe into trench and backfilling, hydrostatic testing, commissioning, and finally rehabilitation.

There would be dedicated access points into the construction corridor with vehicular movements along the Project alignment kept within the construction corridor.

3.2.4 Construction of other facilities

The construction sequence for the Wollert Compressor Station works starts with survey works and continues with site establishment (including laydown area), bulk earthworks, civil works (concrete slab and footings), mechanical works, electrical and instrumentation works, hydrostatic testing, commissioning, and site completion.

Various components of the compressor are assembled offsite. When delivered to site the various components are assembled together in-situ. Cranes are used to lift the compressor into place with all connecting pipework fitted.

3.3 Operation

Following the reinstatement of land as part of the pipeline construction, the land would be generally returned to its previous use. When commissioned, the pipeline would be owned and maintained by APA. The pipeline would be contained within a 15 metre wide permanent easement corridor (within the area that formed the 30 metre construction corridor). Routine corridor inspections would be undertaken in accordance with APA procedures and AS2885 to monitor the pipeline easement for any operational or maintenance issues.

Excavating or erecting permanent structures, buildings, large trees or shrubs over the underground pipeline would be prohibited in accordance with the *Pipelines Act 2005* and pursuant to easement agreements with landowners.

Maintenance and inspections of the MLVs and the Wollert Compressor Station would also be conducted periodically in accordance with APA procedures. The activities usually include vegetation management, valve and compressor operation and corrective maintenance.

The key operation and maintenance phase activities include:

- Easement maintenance (vegetation control, weed management, erosion and subsidence monitoring)
- Pipeline, MLVs and compressor station maintenance
- Specialist pigging operations
- Cathodic protection surveys for mechanical and electrical preventative and corrective maintenance
- Monitoring and routine inspections and surveillance

3.4 Design, construction and operation considerations relevant to greenhouse gas emissions

3.4.1 Design and construction considerations

The embodied carbon in construction materials may be a significant contributor to the greenhouse gas emissions associated with construction of the Project. The two most significant construction materials, from a greenhouse gas perspective, for the Project are steel and cement.

The majority of steel is utilised in the construction of the underground pipeline. The material to be used is American Petroleum Institute (API) Specification 5L X52 high strength steel pipe, internally lined with epoxy and externally coated with dual layer fusion bonded epoxy with field applied joint coating. Steel is also used in various components of the compressor and will be used for associated equipment in the compressor station upgrade. The new Solar - Centaur 50 gas turbine driven compressor unit, along with associated valves, pipework and equipment, would be installed within the existing Wollert Compressor Station. The gas turbine compressor unit has an engine efficiency of 30% (Solar Turbines Incorporated, 2020).

Concrete is used throughout the pipeline length as support and slab protection. Concrete is also used in construction of the compressor station upgrade.

3.4.2 Operation considerations

The Project is designed to provide critical infrastructure for Victoria's gas supply and distribution. The Australian Electricity Market Operator (AEMO) monitors, manages and undertakes forecast planning for energy systems across Australia, and have forecast natural gas shortages in Victoria. The predicted shortfall is forecast due to supply constraints, rather than changes in demand, which is not expected to increase in the next four years.

Therefore, operation of the Project is not predicted to increase fuel gas consumption beyond current use, but to improve operational efficiency in the Victorian Transmission network.

4. Legislation, policy and guidelines

4.1 Legislation, policy and guidelines

The EES is prepared under the EE Act and will inform assessment of approvals required for the Project. The legislation relevant to the principal approvals required for the Project is:

- Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). For the component of the Project that is located outside of the Melbourne Strategic Assessment (MSA) area, the Project requires assessment and approval under the EPBC Act, under the assessment bilateral agreement with Victoria made under section 45 of the EPBC Act.

  The MSA program is the Victorian Government's approach to managing the impact of urban development in Melbourne's growth areas on significant vegetation communities, plants and animals. Areas within the approved Melbourne Strategic Assessment (MSA) area occur between approximately KP 0 to KP 3.2, KP 28.16 to KP 28.57, and KP 32 to KP 51. Areas outside of the MSA occur approximately between KP 3.2 to KP 28.1, and KP 28.57 to KP 32.

- Pipeline Licence under the *Pipelines Act 2005* (Vic) (Pipelines Act). Licence approval is required under the Pipelines Act 2005 (Vic) (Pipelines Act) for the Western Outer Ring Main Project. The Pipeline Licence application is exhibited with the EES.

  Section 49 of the Pipelines Act requires that the following matters be considered before granting a licence:

  > *(a) the potential environmental, social, economic and safety impacts of the proposed pipeline;*
  >
  > *(f) the assessment of the Environment Effects Minister in relation to the proposed pipeline, if an assessment has been made;*
  >
  > *(g) any written comments received from the Planning Minister or the relevant responsible authority on the effect of the proposed pipeline on the planning of the area through which it is to pass;*
  >
  > *(h) any written comments received from the Water Minister and from the relevant Crown Land Minister on the impact of the proposed pipeline.*

  Section 3 of the Pipelines Act state the objectives of the Act, including:

  > *(a) to facilitate the development of pipelines for the benefit of Victoria;*
  >
  > *(e) to protect the public from environmental, health and safety risks resulting from the construction and operation of pipelines;*
  >
  > *(f) to ensure that pipelines are constructed and operated in a way that minimises adverse environmental impacts and has regard for the need for sustainable development.*

  Section 4 of the Pipelines Act sets out the principles of sustainable development to be given regard in implementing the Act including that decision-making should be guided by a careful evaluation to avoid serious or irreversible damage to the environment wherever practicable and an assessment of the risk-weighted consequences of various options.

  Section 54(c) of the Pipelines Act states that conditions on a licence may include conditions concerning the protection of the environment.

- Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act 2006* (Vic) (AH Act). Two CHMPs are currently in progress for the Project (CHMP 16593 and CHMP 16594).

A number of legislative, policy, guidance and standard documents were found to be relevant to the greenhouse gas assessment and are discussed further in this report. The key legislation, policy and guidelines that apply to the greenhouse gas assessment for the Project are summarised in Table 5. Further detail on the international, Commonwealth, state, and local frameworks and guidelines is provided in Section 4.2 to 4.5.

Table 5 Key legislation, policy and guidelines

Legislation/policy/guideline	Relevance to Assessment
Paris Agreement	The Paris Agreement is an agreement within the United Nations Framework Convention on Climate Change (UNFCCC) with the goal of keeping global average temperature to well below 2°C above pre-industrial levels; and to pursue efforts to limit the increase to 1.5°C. The Paris Agreement is a driver for setting Commonwealth and state greenhouse gas legislation, policy and targets.
National Greenhouse and Energy Reporting Act 2007 (Commonwealth) ('NGER Act')	The NGER Act provides the framework for the NGER Scheme for reporting greenhouse gas emissions, greenhouse gas projects and energy consumption and production by corporations in Australia.
National Greenhouse and Energy Reporting (Measurement) Determination 2008 (NGER Measurement Determination)	The NGER Measurement Determination outlines the required methods for measuring greenhouse gas and energy use for reporting.
National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015	The Safeguard Mechanism provides a framework for Australia's largest emitters to measure, report and manage their emissions.
Climate Change Act 2017 (Vic) ('Climate Change Act')	The Climate Change Act provides the legislative framework for managing climate change risks and opportunities and drives Victoria's transition to net zero emissions by 2050
Environment Protection Act 1970 (Vic) and *Environment Protection Act 2017 (Vic)* ('EP Act')	The EP Act establishes the legislative framework for protecting the environment in Victoria. The EP Act defines greenhouse gases as a waste and gives authority to the EPA Victoria to issue approvals and licences.
Pipelines Act 2005 (Vic) ('Pipelines Act')	The Pipelines Act 2005 is the primary Act governing the construction and operation of pipelines carrying liquid and gaseous fuels at high pressure in Victoria.

Legislation/policy/guideline	Relevance to Assessment
State Environment Protection Policy (SEPP) Air Quality Management (AQM) 2001	The SEPP AQM identifies the beneficial uses of the air environment which are to be protected, and defines the air quality indicators which must be managed to ensure that the beneficial uses, inclusive of human health and well-being, are protected.
Protocol for Environmental Management (PEM): Greenhouses Gas Emissions and Energy Efficiency in Industry 2001	This PEM provides guidance for businesses on the SEPP AQM and its requirements for the management of greenhouse gas emissions and energy consumption.
Victoria's Climate Change Framework (2016)	The Framework sets out Victoria's long-term plan to achieve net zero emissions by 2050, including the steps the Government is taking and the transitions required across the economy.
Melton City Council's Environment Plan 2017-2027	The environment plan demonstrates how the Council will work to improve environmental outcomes until 2027. The plan includes a focus on issues relating to greenhouse gas emissions.
Hume City Council's Greenhouse Action Plan 2018-2022	The action plan is Hume City Council's commitment to tackling climate change and reducing greenhouse gas emissions within its own operations.
Mitchell Shire Council's Sustainable Resource Management Strategy 2011	This strategy summarises Council's strategic documents around climate change and water management into one key strategy, and includes high priority actions to make positive change.
City of Whittlesea's Climate Change Adaptation Plan	The adaptation plan outlines how the Council will respond and adapt to a changing climate, including its commitment to reducing greenhouse gas emissions.

4.2 International framework

The Paris Agreement

Established in 2015, the Paris agreement's central aim is to strengthen the global response to the threat of climate change. The agreement sets the framework for nations to make nationally determined contributions to the common goal of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels". Australia ratified the Paris Agreement in November 2016, and is committed to reducing GHG emissions by 26-28 percent below 2005 levels by the year 2030.

4.3 Commonwealth framework

National Greenhouse and Energy Reporting Act 2007 (NGER Act)

The NGER Act establishes the legislative framework for the NGER Scheme, which is a national framework for reporting greenhouse gas emissions, greenhouse gas projects and energy consumption and production by corporations in Australia. Under the NGER Act, a corporation is considered to be the entity that has operational control. Controlling corporations that exceed the following thresholds are required to report under the NGER Act:

- For facilities, consumption of more than 100 terajoules (TJ) of energy annually or emits over 25,000 tonnes CO2-e annually
- For corporations, consumption of more than 200 TJ of energy annually or emits 50,000 tonnes CO2-e annually

APA will be required to report operational emissions associated with the Project in its annual NGER report. It is not expected that APA would report operational emissions from the Project as a separate facility. Given that the Project involves the development of a link between existing stations, it is expected that emissions will be reported under a currently defined facility.

Further, contractors engaged during construction of the Project may be required to report their Scope 1 and Scope 2 greenhouse gas emissions and energy use if they exceed these thresholds.

National Greenhouse and Energy Reporting (Measurement) Determination 2008

The Measurement Determination sets out the details that establish compliance rules and procedures for administering the NGER Act. The Measurement Determination provides methods, criteria and measurement standards for calculating greenhouse gas emissions and energy data under the NGER Act. The measurement determination is updated annually.

National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015

The Safeguard Mechanism provides a framework for Australia's largest emitters to measure, report and manage their emissions. The Safeguard Mechanism applies to facilities with operational scope 1 covered annual emissions of greater than 100,000 tonnes of carbon dioxide equivalent (t CO_2-e). Application of the Safeguard Mechanism may be applicable to APA if the WORM Project is to be part of a larger facility which has been defined by APA under the NGER Act.

4.4 State framework

Climate Change Act 2017

The *Climate Change Act 2017* provides a legislative foundation for the management of risks and opportunities related to climate change. The Act sets out a policy framework that is consistent with the international Paris Agreement and drives Victoria's transition to net zero emissions by 2050 by providing interim and long-term state targets as well as guiding principles and adaptation action plans.

The *Climate Change Act 2017* requires decision-makers to take climate change into account when making specified decisions under Victoria's *Catchment and Land Protection Act 1994, Coastal Management Act 1995, Environment Protection Act 1970, Flora and Fauna Guarantee Act 1998, Public Health and Wellbeing Act 2008* and the *Water Act 1989*.

The Environment Protection Authority (EPA) Victoria must regulate the potential impacts of greenhouse gas emissions relating to Victoria's long-term and interim emissions reduction targets as part of the works or other development approvals process.

Environment Protection Act 1970 and Environment Protection Act 2017

The *Environment Protection Act 1970* and *Environment Protection Act 2017* (the EP Act) establish the legislative framework for protecting the environment in Victoria. The *Environment Protection Act 2017* (as amended by the *Environment Protection Amendment Act 2018*) introduces the concept of general environmental duty (GED), which requires Victorians to understand and minimise their risks of harm to human health and the environment, from pollution and waste. Commencement of the *Environment Protection Amendment Act 2018* has been postponed until 1 July 2021.

Under the EP Act, greenhouse gases are defined as a waste. The Act authorises EPA Victoria to issue works or other development approvals and licenses to regulate the State Environment Protection Policies (SEPP).

State Environment Protection Policy (Air Quality Management) (SEPP AQM)

State environment protection policies (SEPPs) are subordinate legislation made under the provisions of the *Environment Protection Act* 1970. SEPPs aim to safeguard the environmental values and human activities (beneficial uses) that need protection from the effects of pollution and waste. The SEPP AQM sets the requirements for management of sources of pollution such that the air quality objectives of SEPP AAQ are met, air quality improves and the cleanest air possible is achieved. The SEPP AQM identifies the beneficial uses of the air environment which are to be protected, and defines the air quality indicators which must be managed to ensure that the beneficial uses, inclusive of human health and well-being, are protected.

Protocol for Environmental Management (PEM) Greenhouse gas emissions and energy efficiency in industry

This PEM provides guidance for businesses on the SEPP AQM and its requirements for the management of greenhouse gas emissions and energy consumption. The PEM outlines the steps required by businesses for compliance with the policy principles and provisions of the SEPP related to greenhouse gas emissions. The PEM stipulates a range of thresholds based on the annual predicted or actual number of gigajoules of energy used, or tonnes of energy-related CO2-e.

Victoria's Climate Change Framework

Victoria's Climate Change Framework outlines the state's long term vision for 2050 and sets out the approach to achieving it. The framework outlines four pillars which will drive emissions reductions and transition the state to net zero emissions:

- Increase energy efficiency and productivity
- Move to a clean electricity supply
- Electrify our economy and switch to clean fuels
- Reduce non-energy emissions and increase carbon storage

4.5 Local framework

Melton City Council's Environment Plan 2017-2027

The plan provides a framework to assist Council in managing the environmental impacts from its service delivery and operations. The purpose of the plan is to guide planning, decision making and activities that impact the environment.

The plan includes targets aimed at mitigating climate change through reduction of greenhouse gas emissions. Targets include a 20% reduction in emissions from 2015/16 levels by 2020/2021 and net-zero emissions by 2040. This will be achieved through several initiatives such as reducing emissions by upgrading lighting and Council's fleet as well as increasing building energy efficiency and use of renewable energy."

Hume City Council Greenhouse Action Plan 2018-2022

The Greenhouse Action Plan is Hume City Council's response to climate change and focusses on the reduction of greenhouse gas emissions, primarily in Council operations, but also within the community. The action plan contains targets and goals under key themes; buildings and renewables, waste, public lighting, fleet, supporting community emission reductions and contributing to positive change.

Mitchell Shire Council's Sustainable Resource Management Strategy 2011

This strategy summarises Council's strategic documents around climate change. The document contains energy reduction commitments, to ensure accountability, demonstrate leadership and save money. Council has committed to reducing corporate greenhouse gas emissions by 20% on 2009/2010 levels by 2020/2021.

City of Whittlesea's Climate Change Adaptation Plan

The climate change adaptation plan outlines the actions City of Whittlesea is undertaking to adapt to the ongoing changes in the climate. The document outlines the Council's response to climate change and commitment to reducing greenhouse gas emissions.

4.6 Greenhouse gas quantification methods and tools

Standards and guidelines used in preparing this greenhouse gas report for both construction and operation of the Project include:

National Greenhouse Accounts Factors (NGA Factors) published by the Department of Environment and Energy[1], August 2019

The NGA Factors, alongside the NGER Measurement Determination have been used as a guide for calculating emissions. The methods in the NGA factors draw from the Measurement determination and can be applied to the estimation of a broad range of greenhouse emissions inventories. Both the NGA factors and the measurement determination are updated annually.

The Greenhouse Gas Protocol (GHG Protocol), the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)

The GHG Protocol provides a global standardised framework to measure and manage greenhouse gas emissions. The Protocol provides standards, guidance, tool and training for business and government to measure and manage climate-warming emissions.

Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability (IS) Materials Calculator

ISCA is the peak industry body for advancing sustainability in Australia's infrastructure. ISCA is a member-based, not-for-profit industry (public and private) council. ISCA's mission is 'Improving the productivity and liveability of industry and communities through sustainability in infrastructure'. ISCA has developed the IS Materials Calculator, which evaluates environmental impacts in relation to use of materials on infrastructure projects and assets. The calculator is based on the best available data from the Australian life cycle inventory databases.

[1] As of 2020, known as Department of Industry, Science, Energy and Resources

5. Methodology

5.1 Overview of method

This section describes the method that was used to assess the potential impacts of the Project. A risk-based approach was applied to prioritise the key issues for assessment and inform the measures to avoid, minimise and offset potential effects. Figure 5-1 shows an overview of the assessment method.

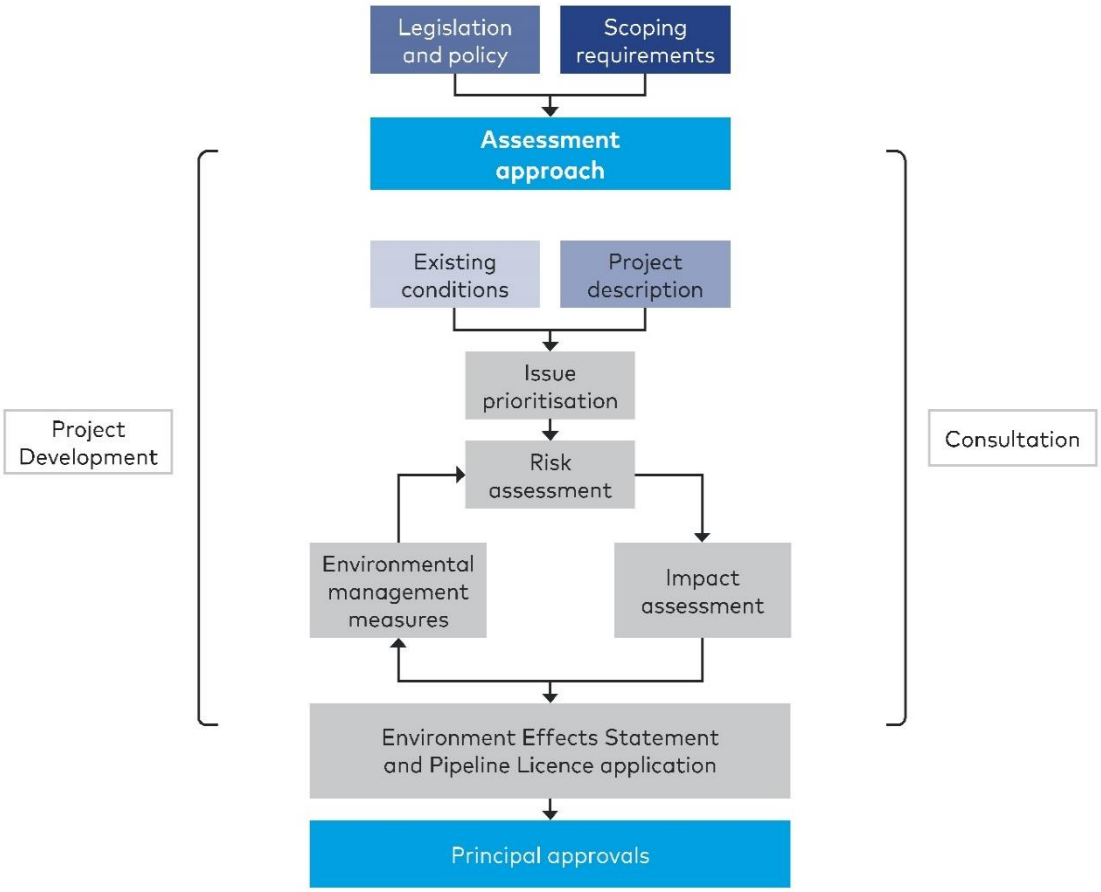

Figure 5-1 Overview of assessment method

Major stages of impact assessment procedures are based on:

- Identification of key issues or risks (refer section 7)
- Characterisation of the existing environment (refer section 5.8)
- Identification the potential greenhouse gas impact from operational and construction activities (pre-mitigation) (refer section 8)
- Suggestion of design and mitigation measures to reduce impacts (refer section 9)

5.2 Study area

For the purposes of this report, the study area is defined as the area required for the construction and operation of the Project, i.e. a 30 metre wide construction corridor is proposed along the pipeline alignment. The study area commences at the current termination of the Truganina to Plumpton pipeline located near the Plumpton Regulating Station and following the entire proposed pipeline alignment, until the Wollert Compressor Station. Activities for the Project's construction and operation are summarised in Section 3. The expected life of the project is 60 years and operational emissions were estimated over this period.Whilst construction and operation activities occur within the study area, greenhouse gas emissions have a global impact. For this reason, we have considered broader impacts of the Project, and emissions have been assessed at a state and national level. These impacts include the consideration of embodied emissions associated with material use during construction, and electricity use during construction and operation. The assessment therefore includes consideration of greenhouse gases which, while emitted remotely from the Project, are directly due to the Project.

Similarly, the broader benefits of the Project must also be considered. Consideration was given to the potential gas savings which would occur elsewhere in the Victorian gas supply network.

5.3 Existing conditions

Existing conditions for this assessment provide a base case against which the emissions from the Project can be compared. Existing conditions should be discussed in a regional context. The Project is intended to play a key role in avoiding gas supply shortages in Victoria, and should thus be reviewed in a state level emissions context and also a national level.

For this reason, emissions from the Project are compared against both Victorian state and Australian national totals. Emissions data was sourced from Australian National Greenhouse Accounts: State and Territory Greenhouse Gas Inventories 2018 (DISER, 2020).

5.4 Risk assessment

A risk assessment for the Project was carried out using an approach that is consistent with Australian/New Zealand Standard AS/NZS ISO 31000:2018 Risk Management Process.

This risk assessment was used to identify the issues for assessment and apply a structured approach to the level of assessment and analysis undertaken of potential environmental effects within each technical study. Applying the risk framework facilitated an approach for the EES to identify and then investigate issues with a focus proportionate to the risk, and to consider management measures focused on reducing identified risks.

The risk assessment methodology included:

- Defining the context for the risk assessment based on the existing assets, values and uses (baseline) assessments of each technical area and the proposed Project activities which interact with those existing conditions
- Identifying the risk pathways based on a specific cause and effect
- Identifying standard management/mitigation measures (including those in guidelines and standards) and initial mitigation measures that are part of the Project description
- Analysing the consequence and likelihood of the identified risk based on a consequence guide developed for each technical area and a likelihood guide
- Defining the risk level based on the risk matrix

The greenhouse gas assessment then focused on those risks with a higher rating and/or where additional management/mitigation measures may be required.

The identification, analysis and evaluation of risks was conducted within each technical area and across technical areas where there was input or connection across disciplines.

The consequences of a greenhouse gas risk occurring were assigned using consequence categories from insignificant to severe developed based on the existing conditions and values in the study area. The consequence levels and descriptors are provided in Appendix A.

A likelihood rating for each identified risk was assigned ranging from 'almost certain' where the event is expected to occur to 'rare', where the event may occur only in exceptional circumstances. The likelihood levels and descriptors are provided in Appendix A.

The risk matrix used to define each risk level is also provided in Appendix A.

The risk ratings were revisited during the greenhouse gas assessment where additional environmental management measures were applied to identify the residual impacts and risks.

5.5 Greenhouse gas assessment

The greenhouse gas assessment methodology was performed in accordance with the principles set out in the following documents:

- NGER (Measurement) Determination 2008 (as amended) and NGER Act 2007, Commonwealth Department of Environment and Energy
- The Greenhouse Gas Protocol (GHG Protocol), the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)
- ISO 14064-1:2006 Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals
- ISO 14040:2006 Environmental management – Lifecycle assessment – Principles and framework and ISO 14044:2006 Environmental management – Lifecycle assessment – Requirements and guidelines. These standards are applicable to the calculation of materials lifecycle impacts using the Infrastructure Sustainability (IS) Materials Calculator.

Greenhouse gas emission factors and calculation methodologies for the estimation of greenhouse gas emissions have been sourced from the following references:

- National Greenhouse and Energy Reporting (Measurement) Determination 2008, July 2020
- National Greenhouse Accounts Factors, August 2019
- IS Materials Calculator v. 2.0 2010-05-31
- Carbon Gauge GHG Calculator v 01.130612

A full list of the emission factors used in estimating construction emissions is presented in Appendix B and emission factors used in estimating operational emissions is presented in Appendix A.

5.5.1 Scope and boundaries for greenhouse gas assessment

The greenhouse gas assessment includes Scope 1, Scope 2 and Scope 3 emissions from the construction and operation of the Project. The definitions of Scope 1 and Scope 2 emissions are provided in the National Greenhouse and Energy Reporting Regulations 2008:

- Scope 1 emissions: The release of greenhouse gas into the atmosphere as a direct result of the Project's activities during construction and operations (including ancillary activities). For example, fuel consumption in construction vehicles or on-site plant.
- Scope 2 emissions: The release of greenhouse gas into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the Project but that do not form part of the facility. For example, the use of grid electricity during construction or operation. Note, Scope 2 emissions are within the scope and were considered in this assessment. However, the quantity of Scope 2 emissions is assumed to be negligible, because the amount of electricity from the grid consumed during construction and operation is in itself negligible. Therefore Scope 2 emissions do not contribute to the emissions totals presented in this report.

The definition of scope 3 emissions is provided by the Clean Energy Regulator (CER, 2018):

- Scope 3 emissions: Other indirect release of greenhouse gas emissions during construction that are generated in the wider economy. They occur as a consequence of the activities of the Project, but from sources not owned or controlled by the Project's business. For example, emissions associated with the production of raw materials consumed during construction such as steel.

For the purposes of this assessment, only material Scope 3 emissions have been estimated. Materiality has been determined in accordance with accepted practice under the NGER legislation, and is based on knowledge of the Project and past similar greenhouse gas assessments.

For the purposes of this assessment, material Scope 3 emissions are limited to:

- Construction and operation fuel consumption
- Embodied emissions associated with pipeline construction materials (steel and concrete)

A key assumption underpinning the greenhouse gas assessment is related to the intent of the Project. The purpose of the Project is not to increase consumption beyond current fuel gas usages, but to maintain the movement of the same amount of gas as is currently consumed with more efficient movement through the Victorian fuel gas network. For this reason, emissions associated with consumption of the fuel gas transported by the Project have not been calculated.

Refer to section 5.7 for a full list of assumptions related to materiality.

Table 6 lists the relevant emission sources for the greenhouse gas assessment.

Table 6 Greenhouse gas emission scopes for relevant construction and operational activities

Category	Emissions Source	Emission Scope		
		Scope 1	Scope 2	Scope 3
Construction				
Fuel use	Construction plant and equipment	✓		✓
	Site vehicles	✓		✓
Materials	Construction Materials			✓
Land use changes	Land clearing / vegetation removal within the construction corridor	✓		
Operation				
Fuel Use	Compressor fuel consumption	✓		✓
	Fugitive emissions	✓		

Emission sources have been deemed immaterial based on the likely size and significance of the estimated emissions. The following construction greenhouse gas emission sources were deemed to be immaterial and not included in the assessment:

Scope 1

- Explosive consumption: The type and quantity of explosives used during construction of the Project have not yet been determined. A blast management plan will be developed by a specialised blasting contractor prior to the works. It is assumed that ammonium nitrate/fuel oil (ANFO) based explosives would be used during construction of the Project, in quantities that would lead to GHG emissions which are immaterial to this assessment.
- Maintenance vehicles: Maintenance activities include vegetation control, weed management, erosion and subsidence monitoring, pigging operations and cathodic protection surveys. Any fuel consumption used in these activities is deemed immaterial.

Scope 2

- Purchased electricity: The estimated energy use of purchased electricity from the Victorian grid during construction of the Project is extremely low. Most of the electricity required by plant or equipment would be generated using diesel generators, which are accounted for under stationary energy use. Any electricity used in site offices or equipment during construction is deemed immaterial.

Scope 3

- Employee travel to and from site
- International delivery of plant, equipment and materials

5.6 Rationale

The methodology selected for the greenhouse gas assessment is consistent with the principles outlined in the documents presented in section 5.5. The level of assessment was designed to be suitable for an EES, taking into account the limitations noted in section 5.7.

5.7 Limitations, uncertainties and assumptions

5.7.1 Assessment based on design information available

This greenhouse gas assessment and the associated calculations have been undertaken based on the currently available information for the Project. It was assumed for calculation purposes the following would not occur:

- Inefficient use of materials, fossil fuels and electricity during the Project's construction and operation.
- Construction delays causing additional consumption of materials and fossil fuels during construction.
- Accidental release of natural gas during operation of the transmission gas pipeline. The nature, frequency and quantity of any accidental releases of natural gas cannot be predicted and has therefore not been included in the assessment. The risk of accidental releases has been accounted for under risk ID GG6 and GG7.
- Unacceptable quality of materials from the manufacture of precast (or other materials) leading to additional resource consumption.
- Increases in the construction corridor leading to further fuel use or increase in vegetation clearing.
- Greenhouse gas impacts from the alignment traversing existing or closed landfills. The risk of impacts from gaseous emissions are negligible from a greenhouse gas perspective and have been considered in Technical Report E – Contamination.

If any of these assumptions prove incorrect, it may be that emissions increase beyond those estimated in this assessment.

5.7.2 Construction assessment assumptions

Stationary energy emissions

- All fuel consumed is assumed to be diesel oil
- Consumption of fuel in vehicles not registered for road use contribute to stationary fuel consumption Transport energy emissions
- All fuel consumed is assumed to be diesel oil
- Only vehicles registered for road use included in transport emissions
- Staff travel to and from site has not been considered

Land clearing emissions

- Total areas of each vegetation class have been sourced from a combination of GHD surveyed data (GHD EES Technical report A Biodiversity and habitats) and data presented in the Western Outer Ring Main (WORM) Biodiversity assessment (Biosis, 2020).
- A total of 109.25 ha of vegetation is estimated to be present within the Project area of 185 ha. The remaining area (75.75 ha) is assumed to contain no vegetation and made up of existing roads, tracks etc.

- A total of 109.25 ha of vegetation is assumed to be cleared within the construction corridor, of which 18.57 ha is native vegetation and 90.88 ha is non-native vegetation. The vegetation to be cleared is predominantly grassland and shrubland. A breakdown of the vegetation to be removed based on vegetation class is provided in Appendix B.
- All (100%) vegetation within the construction corridor is assumed to be mature vegetation at the time of clearing for construction, including areas that may have been recently cleared or grazed. This is not consistent with vegetation surveyed within the corridor, but a general approach has been used for the purpose of estimating a worst-case scenario for assessing the emissions associated with land clearing.
- All (100%) vegetation within the construction corridor is assumed to be cleared. Whilst this is unlikely to be the case in reality, this assessment provides a worst-case scenario for the emissions associated with land clearing.
- The potential maximum biomass class for the pipeline route is Class 4. An assumption has been made to use highest biomass value up to class 4 for all Vegetation Classes A-I is assumed, to provide a conservative approach to estimating emissions.

Embodied emissions

- Embodied emissions associated with pipeline construction materials are dominated by steel and concrete. Other materials are deemed immaterial and have been excluded from this assessment.
- The density of steel piping is assumed to be 7,850 kg/m^3 (197.14 kg/m).
- All construction concrete is assumed to have a strength grade of 20 megapascal (MPa) and contain 0% supplementary cementitious materials (SCM).

5.7.3 Operation assessment assumptions

Stationary energy emissions

- All fuel consumed by the compressor unit assumed to be natural gas.
- For the purposes of this assessment, it is assumed that the compressor unit will operate at 100% capacity (i.e. 24 hours per day) for 200 days per year.

A key assumption underpinning the greenhouse gas assessment is related to the intent of the Project. The purpose of the Project is not to increase consumption beyond current fuel gas usages, but to maintain the movement of the same amount of gas as is currently consumed with more efficient movement through the Victorian fuel gas network. For this reason, emissions associated with consumption of the fuel gas transported by the Project have not been calculated.

Fugitive emissions

- Fugitive emissions refer to the emissions of gases from pressurised equipment due to leaks or other unintended or irregular releases. Fugitive emissions from operation of the pipeline have been estimated using Method 1, as per Section 3.72 of the NGER Measurement Determination. This method is based off a pipeline's length but encompasses fugitive emissions associated with pipeline infrastructure (ie compressor stations).

5.8 Stakeholder engagement

Whilst stakeholder and community engagement was undertaken during the preparation of the EES, no community engagement was specifically required to inform this assessment.

EES Attachment III *Community and Stakeholder Consultation Report* provides details of the consultation activities undertaken for the Project more broadly and outcomes from those activities.

6. Existing conditions

The existing conditions of the Project, related to greenhouse gas emissions, were considered on a state and national level.

6.1 Victorian greenhouse gas emissions

The *Climate Change Act 2017* is designed to ensure Victoria is prepared for the impacts of climate change and to act as a driver for the state achieving net-zero emissions by 2050. This will be achieved through a set of interim targets, ultimately reducing emissions to the lowest possible amount, with the remaining emissions offset (DELWP, 2020).

Victoria's total greenhouse gas emissions for 2018 are presented in the *State and Territory Greenhouse Gas Inventories 2018* (DISER, 2020). This report provides the most up-to-date official greenhouse gas emissions data. Victoria's total net emissions in 2018 were 102.2 Mt CO_2-e, which represents a reduction of 17.5% from 2005 levels.

Victoria's greenhouse gas emissions for 2018 are presented in Table 7.

Table 7 Victorian greenhouse gas emissions by sector for 2018 (DISER, 2020)

Sector	Greenhouse gas Emissions (Mt CO_2-e)	Contribution to state emissions (%)
Electricity generation	46.4	45%
Other energy industries	3.1	3%
Manufacturing and construction	4.8	5%
Other sectors	9.8	10%
Transport	23.5	23%
Fugitive fuels	3.9	4%
Industrial processes	3.9	4%
Agriculture	15.7	15%
Waste	2.6	3%
Land use, land use change and forestry	-11.5	-11%
Total	**102.2**	**100%**

6.2 Australian greenhouse gas emissions

Emissions from the Project should also be viewed in terms of its contribution to national totals. Total emissions for 2018 were 537.4 Mt CO_2-e, which represents a reduction of 12.8% from 2005 levels.

National greenhouse gas emissions for 2018 are presented in Table 8.

Table 8 Australian greenhouse gas emissions by sector for 2018 (DISER, 2020)

Sector	Greenhouse gas Emissions (Mt CO_2-e)	Contribution to national emissions (%)
Electricity generation	183.2	34%
Other energy industries	30.7	6%
Manufacturing and construction	40.7	8%
Other sectors	25.8	5%
Transport	100.8	19%
Fugitive fuels	54.4	10%
Industrial processes	34.2	6%
Agriculture	75.6	14%
Waste	12.7	2%
Land use, land use change and forestry	-20.6	-4%
Total	**537.4**	**100%**

7. Risk assessment

A risk assessment of Project activities was performed in accordance with the methodology described in section 5.4.

The initial risk ratings considered an initial set of mitigation measures (where relevant), which are based on compliance with legislation and standard requirements that are typically incorporated into the delivery of infrastructure projects of similar type, scale and complexity. Risk ratings were applied to each of the identified risk pathways assuming that these mitigation measures were in place.

Where the initial risk ratings were categorised as medium or higher, these risks were a focus of the assessment and additional management measures were considered (where possible) as part of the assessment.

The assessment of the potential impacts associated with the identified risks during the construction and operation of the Project is presented in the following section of this report.

The risk register showing the risk pathways and findings of the risk assessment for greenhouse gas emissions is attached in Appendix A.

Four construction risks were identified and assessed and three operation risks.

A summary of the risk assessment results is presented in Table 9.

Table 9 Risk results

Risk ID	Risk description	Construction/ operation	Pipeline/ MLV/ compressor	Initial risk rating	Final risk rating
GG1	Greenhouse gas emissions due to embedded emissions associated with the production of raw materials consumed during construction.	Construction	All	Medium	Medium
GG2	Greenhouse gas emissions due to fuel use for onsite equipment, transportation of materials and the consumption of electricity during construction.	Construction	All	Medium	Medium
GG3	Greenhouse gas emissions due to vegetation removal within construction corridor and associated loss of stored carbon during construction.	Construction	All	Medium	Medium

Risk ID	Risk description	Construction/ operation	Pipeline/ MLV/ compressor	Initial risk rating	Final risk rating
GG4	Greenhouse gas emissions due to explosive consumption.	Construction	All	Low	Low
GG5	Greenhouse gas emissions due to gas consumption at the Wollert Compressor Station, fossil fuel use in vehicles and the use of electricity during operation.	Operation	Compressor	Medium	Medium
GG6	Greenhouse gas emissions due to unplanned activity, incident or emergency leading to venting during operation	Operation	Pipeline and compressor	Negligible	Negligible
GG7	Fugitive emissions from venting and leaks associated with the pipeline infrastructure during operation.	Operation	Pipeline and MLVs	Low	Low

8. Greenhouse gas assessment

This section provides the results of the greenhouse gas assessment. This includes predicted greenhouse gas emissions which would result from the construction and operation of the Project.

8.1 Construction impacts

The greenhouse gas assessment considered the potential greenhouse gas emissions from the Project's construction activities. A list of construction activities is presented in section 3.2. The construction activities included within the construction greenhouse gas assessment, and their linkages to the identified risks, include:

- Site clearing and site establishment (risk ID GG3, GG4)
- Construction of the WORM pipeline including materials, material transportation and Project vehicles (risk ID GG2)
- Embedded emissions in construction materials (risk ID GG1)

A summary of the total greenhouse gas emissions associated with construction of the Project is presented in Table 10.

Table 10 Predicted greenhouse gas emissions from the WORM Project construction by emissions source and scope

Emission source Category	Emission source	Risk ID*	Greenhouse gas emissions (t CO_2-e)**			
			Scope 1	Scope 2	Scope 3	Total
Fuel use	Stationary equipment	GG2	3,800		190	**3,990**
	Site Vehicles	GG2	2,270		120	**2,390**
Materials	Construction Materials	GG1			30,930	**30,930**
Land use changes	Vegetation removal	GG3	13,500			**13,500**
Total			19,570		31,240	**50,810**

*Refer to section 7

** Construction emissions are not recurrent (i.e. once-off emissions generated during construction)

The majority of Scope 1 construction emissions is attributed to land use changes caused by removal of vegetation in the construction corridor. It was assessed that the total construction corridor (i.e. the total Project Area of 185 ha) contained approximately 22.09 hectares (ha) of native vegetation and 88.55 ha of non-native vegetation. For the purposes of this assessment, a conservative assumption was made in that 100% of vegetation (i.e. 110.63 ha) within the construction corridor would be cleared. In reality, this will not be the case and where clearing of vegetation is avoided this will reduce the greenhouse gas emissions from this emissions source. The majority of the cleared vegetation is expected to be shrub land/grassland. Environmental management measures will be implemented to reduce the impact of land use changes, including the reduction in the amount of vegetation removal along the pipeline alignment as far as reasonably practicable (EMM GG1(d)) and the reinstatement of the construction corridor with the consideration of native vegetation composition (EMM B7).

Fuel use emissions also contribute significantly to Scope 1 emissions. Whilst the use of stationary equipment and site vehicles is unavoidable, environmental management measures will be implemented to including the consideration of fuel efficient plant and equipment where appropriate (EMM GG1(b)).

Scope 3 emissions from the use of construction materials have significant impacts outlined in section 8.3.

Construction emissions will be monitored via audit/monitoring processes (EMM GG1(e)), which include:

- Provision of construction greenhouse gas data as per NGER requirements (Scope 1 emissions) to APA by contractors
- Quarterly audits during the construction period to assess compliance with the Project's CEMP. Quarterly audits will be undertaken by APA HSE Advisors
- An audit at the end of the construction period (undertaken by APA) to confirm NGER Reporting requirements.

Detail on the assumptions relevant to each emissions source is presented in in section 5.7.

8.2 Operation impacts

8.2.1 Project emissions

The greenhouse gas assessment considered the potential annual greenhouse gas emissions from the Project's operation. The components included within the operation greenhouse gas assessment, and their linkages to the identified risks, include:

- Pipeline operation (risk ID GG6, GG7)
- Compressor station operation (risk ID GG5, GG6)

A summary of the total greenhouse gas emissions associated with operation of the Project are presented in Table 11.

Table 11 Predicted greenhouse gas emissions from the WORM Project operation by emissions source and scope

Emission source Category	Emission source	Risk ID*	Emissions (t CO_2-e)			
			Scope 1	Scope 2	Scope 3	Total
Fuel Use	Compressor fuel consumption	GG5	13,750		1,040	**14,790**
	Fugitive emissions	GG7	590			**590**
Total			14,340		1,040	**15,380**

*Refer to section 7

The majority of operation emissions are attributed to fuel use at the compressor station. For the purposes of this assessment, it is assumed that the compressor unit will be operating at 100% capacity for 200 days per annum. It should be noted that the Project will introduce efficiency gains to the overall Victorian gas supply network (refer section 8.2.2). Energy efficiency best practices will be considered in the design and operation of the compressor station upgrade (EMM GG2(a)).

Fugitive emissions from operation of the pipeline and compressor station are unavoidable and do not contribute significantly to operation impacts. To mitigate the risk of operational leaks, design and operation of the Project will be to industry standards, including *ASME B31.3 – Process Piping Code* and *AS2885 Pipelines – Gas and Liquid Petroleum* and will include routine maintenance and inspection in line with the existing VTS Operational Environmental Management Plan (VTS OEMP) (EMM GG3 and GG4).

Operation emissions do not exceed the single facility threshold for NGER reporting. It is expected that APA will report emissions for the Project as it reaches the corporate threshold.

Operation emissions will be monitored via audit/monitoring processes (EMM GG2(c)), which include:

- Annual reporting of operation emissions or as per the requirements of the VTS OEMP
- Annual assurance audit in accordance with the NGER Act. This audit will be undertaken by an independent auditor and includes all APA assets

8.2.2 Potential network efficiency gains

In its annual Victorian Gas Planning Reports (VGPR), the Australian Energy Market Operator (AEMO) provided comments on the business case for construction of the WORM Project. In its 2017 report, AEMO notes that the current method of transporting gas from Longford to Port Campbell is very inefficient (AEMO, 2017).

In the 2018 Victorian Gas Planning Report (AEMO, 2018), AEMO goes on to quantify the potential efficiency gains that the Project would bring:

"The 2017 VGPR noted the inefficiency of the current method of transporting gas from Longford to Port Campbell, given pipeline pressure must be reduced at Dandenong [City Gate], then recompressed at Brooklyn to flow along the [Brooklyn to Lara Pipeline] (BLP) and [South West Pipeline[(SWP) towards Port Campbell. Brooklyn [Compressor Station] (CS) used some 414 TJ of fuel gas in 2016-17, at an estimated cost of $3.5 million.

With the WORM connecting into the BLP, which would enable gas to flow to Port Campbell via the SWP, half the fuel gas would be required to transport the same quantity, compared to the current fuel gas usage via Brooklyn CS".

AEMO estimates that half of the 414 TJ of fuel gas used in 2016/17 would be required to transport the same quantity of gas with the operation of the Project. This equates to a saving of 207 TJ of fuel gas, or approximately 10,700 t CO_2-e less emissions per annum if the predicted efficiency gains are achieved.

8.3 Comparison to existing conditions

The cumulative impacts of the Project are considered when comparing conditions to emissions to existing conditions. A comparison of the Project's estimated annual construction and operational Scope 1 and Scope 2 emissions to Australia's and Victoria's annual greenhouse gas emissions is presented in Table 12. State and national Scope 3 emissions are not reported under the NGER scheme (as they potentially double count another entities Scope 1 emissions) and hence are not compared in this section.

Significant areas of greenhouse gas emissions contribution include:

- Embodied emissions from construction materials
- Land clearance emissions for construction
- Consumption of natural gas during operation of compressor station

Table 12 Comparison of emissions against Australian and Victorian annual emissions

Emission source	Annual emissions (t CO_2-e)	% of Australia's total	% of Victoria's total
Australia (2018)	537.4 x 10^6	100%	-
Victoria (2018)	102.2 x 10^6	19%	100%
WORM Project (Construction)*	19,570	0.004%	0.019%
WORM Project (Annual operation)	14,340	0.003%	0.014%
Net reduction in operation (via avoided emissions)**	-10,110	-0.002%	-0.010%

* Construction emissions are not recurrent (i.e. once-off emissions generated during construction)

** Operation of the Project is predicated to result in a reduction of total state gas consumption, refer to section 8.2.2

As per AEMO's estimation (AEMO, 2018), operation of the Project is estimated to result in a net reduction in emissions of 10,700 t CO2-e per annum due to operational improvements gained in the VTS. Given the contribution of 590 t CO2-e due to fugitive emissions from operation of the Project, the net reduction in state and national emissions would equate to 10,110 t CO2-e per annum. This net reduction is considered to improve the cumulative position of greenhouse gas impacts.

Therefore, due to the avoided emissions resulting from the Project, there may be emissions benefit in operation compared to the no-Project scenario. In the context of emissions reduction targets, the Project would contribute positively to achieving:

- Net-zero emissions in the state of Victoria by 2050 (The Climate Change Act)
- The targets outlined in the local council frameworks (refer section 4.5)

The Project is predicted to have a positive impact on state and national emissions reductions targets and initiatives if the efficiency gains estimated by AEMO are achieved.

9. Environmental management measures

This section outlines the recommended management measures for greenhouse gas emissions identified as a result of the greenhouse gas assessment. Table 13 lists the recommended environmental management measures relevant to the greenhouse gas assessment.

The mitigation hierarchy has been applied in the development of the mitigation measures. It is the nature of construction projects/the operation of pipelines that the complete avoidance of greenhouse gas emissions is not possible. For this reason, the next highest level of the hierarchy has been applied in that measures taken to reduce the duration, intensity and extent of greenhouse gas impacts have been proposed.

Table 13 Environmental management measures

EMM #	Environmental management measure	Stage
GG1	**Construction emissions** Reduce greenhouse gas emissions during construction: a. Using low embodied energy materials where they are of comparable quality, utility, availability and cost. b. Using fuel efficient plant and equipment and used where practicable during construction c. Using locally sourced materials, including those provided by suppliers, where they are of comparable quality, utility, availability and cost. d. Reducing the amount of vegetation removal along the pipeline alignment as far as reasonably practicable. e. Monitoring construction greenhouse gas emissions via audit/monitoring processes f. Mulching trees for recycling g. Minimising the amount of fossil fuel based explosives required during the construction phase. Performance monitoring of these requirements are described in Section 12.2. of the CEMP.	Construction
GG2	**Normal operation of Wollert Compressor Station:** Implement the Protocol for Environmental Management (PEM): Greenhouses Gas Emissions and Energy Efficiency in Industry 2001 during operation of the Wollert compressor including consideration of energy efficiency best practice in the selection of the compressor type (greenhouse gas emissions and energy efficiency in industry). Comply with the conditions associated with the Pipeline Licence.	Design/ Operation

EMM #	Environmental management measure	Stage
	Monitor operation greenhouse gas emissions via audit/monitoring processes. Performance monitoring of these requirements are described in Section 12.2. of the CEMP.	
GG3	**Operational emergencies:** Implement industry standards including AS2885 in design, inspect and maintain the pipeline and Wollert Compressor Station to minimise the risk of operational emergencies.	Design/ Operation
GG4	**Operational leaks:** Perform ongoing maintenance and inspection on the Project to avoid leaks. Design to be undertaken in accordance with AS2885.	Design / Operation

In addition to the management measures listed in Table 13, EMM B7 (Site rehabilitation) (refer to Technical report A – Biodiversity and habitats) requires that the construction corridor is reinstated with consideration of the native vegetation composition and ground surface adjoining indigenous to the area, including re-instatement of habitat features.

9.1 Best practice in greenhouse gas

To mitigate the risk of operational leaks, design and operation of the Project will be to industry standards, including AS2885 and will include routine maintenance and inspection in line with the existing VTS Operational Environmental Management Plan (VTS OEMP) (EMM GG3 and GG4).

Compressor selection is based on the required compression power requirements for the Project. Other considerations, when compared to steam-turbines and diesel propulsion systems, the gas turbines offer greater power for a given size and weight, high reliability, long life, and more convenient operation.

No two vendors will produce identical machines for direct comparison of power output vs thermal efficiency. The thermal efficiency of the selected Solar Centaur 50 Gas Turbine is within ‘industry and best practices’ and it is also within the typical Simple Open Brayton Cycle operating envelopes for gas turbines. It is representative of a best practice, effective and efficient compression equipment selection for a typical long distance gas pipeline. Solar Turbines is a reputable international company with a long history of supply, service and overhaul of gas compression and gas turbine equipment in Australia. The compressor has an engine efficiency of 30% which is comparable to other gas compressors. For the power output requirement Solar Turbines are considered the market leader.

Operation emissions will be monitored via audit processes, as per environmental management measure GG2(c): *Operation greenhouse gas emissions will be monitored via audit processes.*

10. Conclusion

The purpose of this report is to provide a greenhouse gas assessment to inform the preparation of the EES required for the Project.

A summary of the key assets, values or uses potentially affected by the Project, and identified within this assessment, are summarised below.

10.1 Existing conditions

The context of the existing conditions for the greenhouse gas assessment was the current Victorian and Australian emissions profiles. In the 2017-18 NGER reporting year, Victoria's and Australia's total emissions were 102.2 and 537.4 Mt CO2-e respectively.

10.2 Greenhouse gas assessment

The estimated greenhouse gas emissions for the construction and operation of the Project is summarised in Table 14. In instances where the effect of the mitigation measure is known, the estimated greenhouse gas emissions represent the residual impacts (for example, the consideration of energy efficiency best practice in the selection of the compressor type). In other cases, the residual impacts are not currently known (for example, emissions from low embodied energy materials is not possible without knowing the specific materials to be used). However, as this report has assessed standard practice and is therefore considered conservative, by implementing the mitigation measures, the residual impacts are expected to be reduced and emissions impacts are expected to be minor.

Table 14 Summary of greenhouse gas emissions associated with the Project

Emissions activity	Greenhouse gas emissions (t CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
Construction emissions	19,570		31,240	**50,810**
Annual Operational Emissions	14,340		1,040	**15,380**
Annual Net reduction in operation (via avoided emissions)*	-10,110			**-10,110**

*Operation of the Project is predicated to result in a reduction of total state gas consumption, refer to section 8.2.2

The Project's estimated Scope 1 and Scope 2 construction emissions are estimated to contribute the equivalent of 0.019% of Victoria's and 0.004% of Australia's annual greenhouse gas emissions.

The Project's estimated annual Scope 1 and Scope 2 operation emissions are estimated to contribute the equivalent of 0.014% of Victoria's and 0.003% of Australia's annual greenhouse gas emissions. However, operation of the Project is predicted to lead to efficiency gains in the overall Victorian gas supply network, leading to a net reduction in total greenhouse gas emissions across the VTS. The net reduction in state and national emissions would equate to

10,110 t CO_2-e per annum, which equates to a reduction of 0.010% and 0.002% of state and national totals respectively.

Key environmental management measures to further reduce construction and operation emissions include:

- Low embodied energy materials will be considered and used where they are of comparable quality, utility, availability and cost (EMM GG1(a))
- Fuel efficient plant and equipment will be considered and used where practicable during construction (EMM GG1(b))
- Locally sourced materials, including those provided by suppliers, will be considered and implemented where they are of comparable quality, utility, availability and cost. (EMM GG1(c))
- The amount of vegetation removal along the pipeline alignment will be reduced as far as reasonably practicable (EMM GG1(d))
- Implementation of the Protocol for Environmental Management (PEM): Greenhouses Gas Emissions and Energy Efficiency in Industry 2001 for the operation of the compressor station including consideration of energy efficiency best practice (EMM GG2(a))

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Appendices

Appendix A – Risk assessment

The scoping requirements require a risk-based approach to be adopted during the design of EES studies, so that a greater level of effort is directed at investigating and managing those matters that pose relatively higher risk of adverse effects.

The risk assessment as part of the assessment framework for the EES, is described in Chapter 5 Evaluation and assessment framework.

The risk pathways define the cause and effect topics relevant to greenhouse gas emissions based on an understanding of the existing conditions and the Project activities. The risk pathways are provided in Table A4. Each pathway shows the initial risk rating based on standard management measures, and a residual risk rating based on additional management measures (if required) recommended through the assessment process.

The consequence of the risk occurring were assigned using a consequence guide specific for each technical discipline. The consequence guide is provided in Table A1.

The likelihood was assigned using a likelihood guide applied to all technical disciplines. The likelihood guide is provided in Table A2.

The risk rating was determined using the risk matrix developed for this EES. The risk matrix is shown in Table A3.

Table A1 Consequence approach

Level	Qualitative and/or quantitative description
Insignificant	Construction or operation greenhouse gas emissions p.a. are insignificant; that is, the Project is near to or on par with the 'no project' scenario.
Minor	Construction or operation incremental greenhouse gas emissions p.a. is below the NGER Scheme reporting requirements
Moderate	Construction or operation incremental greenhouse gas emissions p.a. triggers, or is over, the NGER Scheme reporting requirements
Major	Construction or operation Scope 1 and Scope 2 greenhouse gas emissions p.a. represents a non-negligible proportion of Victoria's total greenhouse gas emissions (e.g. >1%)
Severe	Construction or operation Scope 1 and Scope 2 greenhouse gas emissions p.a. represents a non-negligible proportion of Victoria's total greenhouse gas emissions (e.g. >10%)

Table A2 Likelihood approach

Level		Description
1	Rare	The event is conceivable and may occur only in exceptional circumstances
2	Remote	The event could occur but is not anticipated and may occur if certain abnormal circumstances prevail
3	Unlikely	The event is unlikely but could occur if certain circumstances prevail
4	Likely	The event will probably occur in most circumstances
5	Almost certain	The event is expected to occur in most circumstances or is planned to occur

Table A3 Risk rating approach

		Consequence rating				
		Insignificant	Minor	Moderate	Major	Severe
Likelihood rating	Almost certain	Low	Medium	High	Very high	Very high
	Likely	Low	Low	Medium	High	Very high
	Unlikely	Negligible	Low	Medium	High	High
	Remote	Negligible	Negligible	Low	Medium	High
	Rare	Negligible	Negligible	Negligible	Low	Medium

Table A4 Risk pathways

Risk ID	Description	Pipeline/ MLV/ Compressor	Initial Environmental Management Measures	Initial risk			Additional Mitigation and Management Measures	Residual Risk		
				C	L	Risk		C	L	Risk
GG1	**Raw material consumption** Greenhouse gas emissions due to embedded emissions associated with the production of raw materials consumed during construction.	All	GG1(a) – Low embodied energy materials GG1(c) – Locally sourced Materials GG1(e) – monitoring and reporting	Minor	Almost certain	Medium		Minor	Almost certain	Medium
GG2	**Construction fuel use** Greenhouse gas emissions due to fuel use for onsite equipment, transportation of materials and the consumption of electricity during construction.	All	GG1(b) – Fuel efficiency targets GG1(e) – monitoring and reporting	Minor	Almost certain	Medium		Minor	Almost certain	Medium
GG3	**Vegetation removal** Greenhouse gas emissions due to vegetation removal and associated loss of stored carbon during construction.	All	GG1(d) – Vegetation removal reduction GG1(f) – Mulching vegetation GG1(e) – monitoring and reporting	Minor	Almost certain	Medium		Minor	Almost certain	Medium

Risk ID	Description	Pipeline/ MLV/ Compressor	Initial Environmental Management Measures	Initial risk			Additional Mitigation and Management Measures	Residual Risk		
				C	L	Risk		C	L	Risk
GG4	**Explosive consumption** Greenhouse gas emissions due to the use of fossil fuel based explosives.	All	GG1(g) – Explosive consumption GG1(e) – monitoring and reporting	Minor	Likely	Low		Minor	Likely	Low
GG5	**Operational gas consumption** Greenhouse gas emissions due to gas consumption at the Wollert Compressor Station, fossil fuel use in vehicles and the use of electricity during operation.	Compressor	GG2(a) – Implementation of PEM GG2(b) – Compliance with licence conditions GG2(c) – monitoring and reporting	Minor	Almost certain	Medium		Minor	Almost certain	Medium
GG6	**Operational emergencies** Greenhouse gas emissions due to unplanned activity, incident or emergency leading to venting during operation	Pipeline and compressor	GG3 – Implement industry Standards	Moderate	Rare	Negligible		Moderate	Rare	Negligible
GG7	**Operational leaks** Fugitive emissions from venting and leaks associated with the pipeline infrastructure during operation.	Pipeline and MLVs	GG4 – Design Project to Standards	Insignificant	Likely	Low		Insignificant	Likely	Low

Appendix B – Construction emissions – inputs and outputs

Table B1 Construction emissions calculation inputs

Data inputs	Amount	Units	Comments
Stationary fuel consumption			
Diesel oil consumed by vehicles	1401.7	KL	All fuel assumed to be diesel oil
Diesel fuel – energy content factor – Scope 1	38.6	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor CO_2 – Scope 1	69.9	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor CH_4 – Scope 1	0.1	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor N_2O – Scope 1	0.2	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor CO_2 – Scope 3	3.6	Kg CO_2-e/GJ	National Greenhouse Accounts Factors August 2019
Transport Fuel Consumption			
Diesel oil fuel consumed by vehicles	836.8	KL	All fuel assumed to be diesel oil
Diesel oil fuel consumed by pipeline material transport trucks	34.5	KL	All fuel assumed to be diesel oil
Diesel fuel – energy content factor – Scope 1	38.6	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor CO_2 – Scope 1	69.9	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor CH_4 – Scope 1	0.1	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor N_2O – Scope 1	0.4	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Diesel fuel – emission factor CO_2 – Scope 3	3.6	Kg CO_2-e/GJ	National Greenhouse Accounts Factors August 2019

Data inputs	Amount	Units	Comments
Pipeline construction materials – embodied emissions			
Length of pipeline	51.045	Km	Provided by APA
Density of steel	197.14	Kg/m	Provided by APA
Density of steel	7,850	Kg/m^3	Provided by APA
Construction material emission factor for pipeline steel – Scope 3	2.97	t CO_2-e / t	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Volume of concrete	304.2	m^3	Provided by APA – Strength grade: 20 MPa SCM: 0%
Construction material emission factor for concrete – Scope 3	0.3	t CO_2-e / m^3	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Compressor station upgrade construction materials – embodied emissions			
Piping-Other	19.3	t	Provided by APA – Steel pipe and tube
Piping-Process	40.6	t	Provided by APA – Steel pipe and tube
Construction material emission factor for piping steel – Scope 3	3.0	t CO_2-e / t	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Steel (Equipment)	85	t	Provided by APA - Steel, Hot rolled structural sections, imported
Structural steel	20	t	Provided by APA - Steel, Hot rolled structural sections, imported
Turbine package	21.56	t	Provided by APA - Steel, Hot rolled structural sections, imported
Construction material emission factor for structural steel – Scope 3	3.8	t CO_2-e / t	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Steel (Concrete reinforcement)	3	t	Provided by APA
Construction material emission factor for concrete reinforcement steel – Scope 3	3.2	t CO_2-e / t	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Concrete	300	m^3	Provided by APA – Strength grade: 20 MPa SCM: 0%

Data inputs	Amount	Units	Comments
Construction material emission factor for concrete – Scope 3	0.3	t CO_2-e / m^3	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Cable	5	t	Provided by APA
Construction material emission factor for cabling – Scope 3	2.7	t CO_2-e / t	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Crushed Rock	300	t	Provided by APA
Construction material emission factor for crushed rock – Scope 3	0.011	t CO_2-e / t	Adopted from IS Materials Calculator v. 2.0 2019-05-31
Land Clearing			
Area of land cleared – Vegetation Class D	6.72	Hectares	Made up of: - Plains Grassy Woodlands - Riparian Woodland
Area of land cleared – Vegetation Class I	102.31	Hectares	Made up of: - Plains Grassland - Non-native vegetation
Area of land cleared – Vegetation Class G	1.61	Hectares	Made up of: - Stony Knoll Shrubland - Aquatic Herbland
Land clearing emission factor - Vegetation Class D – Scope 1	307	t CO_2-e / ha	Adopted from the Carbon Gauge GHG Calculator for Roads Projects v 01.130612
Land clearing emission factor - Vegetation Class I – Scope 1	110	t CO_2-e / ha	Adopted from the Carbon Gauge GHG Calculator for Roads Projects v 01.130612
Land clearing emission factor - Vegetation Class G – Scope 1	113	t CO_2-e / ha	Adopted from the Carbon Gauge GHG Calculator for Roads Projects v 01.130612

Table B2 Construction emissions calculation outputs

Data outputs	Amount	Units
Fuel consumption		
Scope 1 GHG emissions – stationary fuel consumption	3,798.5	t CO_2-e
Scope 3 GHG emissions – stationary fuel consumption	194.8	t CO_2-e
Scope 1 GHG emissions – transport fuel consumption	2,277.4	t CO_2-e
Scope 3 GHG emissions – transport fuel consumption	116.3	t CO_2-e
Pipeline construction - materials		
Steel	29,887.1	t CO_2-e
Concrete	268.0	t CO_2-e
Compressor station upgrade construction - materials		
Steel	57.50	t CO2-e
Piping-Other	120.80	t CO2-e
Piping-Process	321.30	t CO2-e
Steel (Equipment)	92.20	t CO2-e
Concrete	9.60	t CO2-e
Steel (Concrete reinforcement)	13.70	t CO2-e
Cable	3.27	t CO2-e
Crushed Rock	75.60	t CO2-e
Structural steel	81.50	t CO2-e
Land clearance		
Scope 1 GHG emissions – clearing vegetation class D	2,062.0	t CO_2-e
Scope 1 GHG emissions – clearing vegetation class I	11,254.0	t CO_2-e
Scope 1 GHG emissions – clearing vegetation class G	181.6	t CO_2-e

Appendix C – Operation emissions – inputs and outputs

Table C1 Operational emissions calculation inputs

Data inputs	Amount	Units	Comments
Stationary fuel consumption emissions			
Natural gas consumption	1334.4	GJ/day	Provided by APA
Operational days	200	Days	Provided by APA
Operating capacity	100	%	Provided by APA
Natural gas – energy content factor – Scope 1	39.30	GJ/m^3	NGER (Measurement) Determination 2008, July 2020
Natural gas – emission factor CO_2 – Scope 1	51.40	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Natural gas – emission factor CH_4 – Scope 1	0.10	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Natural gas – emission factor N_2O – Scope 1	0.03	Kg CO_2-e/GJ	NGER (Measurement) Determination 2008, July 2020
Natural gas – emission factor CO_2 – Scope 3	3.60	Kg CO_2-e/GJ	National Greenhouse Accounts Factors August 2019
Fugitive Emissions			
Pipeline length	51.045	Kilometres	Provided by APA
Natural gas transmission – emission factor CO_2 – Scope 1	0.02	t CO_2-e / km pipeline	NGER (Measurement) Determination 2008, July 2020
Natural gas transmission – emission factor CH_4 – Scope 1	11.6	t CO_2-e / km pipeline	NGER (Measurement) Determination 2008, July 2020

Table C2 Operation emissions calculation outputs

Data outputs	Amount	Units
Scope 1 GHG emissions – stationary energy emissions	13,752.3	t CO_2-e
Scope 3 GHG emissions – stationary energy emissions	1,040.8	t CO_2-e
Fugitive emissions		
Scope 1 GHG emissions – pipeline fugitive emissions	593.1	t CO_2-e

GHD

Level 9 180 Lonsdale Street
Melbourne VIC 3000
T: 61 3 8687 8000 F: 61 3 8732 7046 E: melmail@ghd.com

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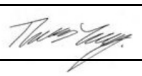
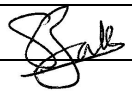
0	J Finkelstein	T Young		S Brattle		06/05/2021

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