Adani Mining Pty Ltd

NORTH GALILEE BASIN RAIL PROJECT

Environmental Impact Statement

Chapter 11 Greenhouse gas

November 2013

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11. Greenhouse gas

11.1 Purpose of chapter

The objective of this chapter is to assess greenhouse gas (GHG) emissions (N_2O, CH_4, CO_2) from the North Galilee Basin Rail Project (NGBR Project) and provide an inventory of total and annual GHG emissions. The scope of this GHG assessment was defined by the following tasks:

- Identification of sources of emissions
- Quantification of emissions
- Development of strategies to avoid, minimise and mitigate emissions.

This GHG chapter was prepared in accordance with the Terms of Reference (TOR) for the NGBR Project. A table that cross-references the contents of this chapter and the TOR is included as Volume 2 Appendix A TOR cross-reference table.

All mitigation and management measures identified within this chapter are included within Volume 2 Appendix P Environmental management plan framework.

11.2 Methodology

11.2.1 Study area

The study area for this GHG assessment was defined by the final NGBR Project footprint, including the final rail corridor and all ancillary infrastructure (refer to Volume 1 Chapter 2 Project description). The assessment of some types of GHG emissions necessarily refer to offsite sources (i.e. Scope 2 emissions relating to electricity generation); however these were not considered part of the study area, as Scope 2 emissions were calculated from estimated electricity usage within the final NGBR Project footprint.

11.2.2 Data sources

The GHG assessment relied on the following data sources:

- North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013)
- National Greenhouse Accounts (NGA) Factors 2013 (Commonwealth of Australia 2013a).

11.2.3 Legislation and guidelines

The GHG assessment was prepared in accordance with the following guidelines:

- The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard developed by the World Resource Institute and the World Business Council for Sustainable Development (GHG Protocol)
- The Commonwealth Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSTE) National Greenhouse Accounts (NGA) Factors, July 2013 (DIICCSTRE, 2013)

- Australia's National Carbon Accounting System (DCCEE, 2005).

A discussion of the legislated requirements of the NGBR Project under the *Energy Efficiency Opportunities Act 2006*, *National Greenhouse and Energy Reporting Act 2007*, and *Clean Energy Act 2011* is provided in Volume 1 Chapter 20 Legislation and approvals.

11.2.4 Desktop assessment

This GHG assessment has been undertaken in accordance with the TOR for the NGBR Project, and therefore includes an assessment of Scope 1 and Scope 2 emissions, an excludes consideration of Scope 3 emissions.

Scope 1 emissions

Scope 1 emissions are GHG that is released into the atmosphere as a direct result of an activity or series of activities. Scope 1 emissions for the NGBR Project include the combustion of fuels such as diesel at the construction site and by vehicles and plant and equipment which Adani owns and/or has operational control over. Note that only the direct combustion of the fuels by equipment utilised within the NGBR Project is considered a Scope 1 emissions.

Scope 2 emissions

Scope 2 emissions are GHG that is released into the atmosphere as a direct result of the generation of electricity, heating, cooling or steam that is consumed during the course of carrying out an activity or series of activities. Scope 2 emissions from the NGBR Project will arise from the consumption of electricity generated outside the study area and in plant and equipment that is operated by Adani.

Scope 3 emissions

Scope 3 emissions are downstream GHG emissions, including emissions from waste disposal, transporting coal overseas, and burning of coal. Scope 3 emissions are not required by the TOR and have therefore not been considered in this assessment.

Global warming potential

The GHG considered in this assessment are listed in Table 11-1. The global warming potential for each GHG has also been provided (in terms of carbon dioxide equivalents), which provides a relative measure of how much heat each GHG traps in the atmosphere.

Table 11-1 Global warming potential

Greenhouse gas	Global Warming Potential (t/CO2-e)[1]
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 – 9,200
Sulphur hexafluoride (SF6)	23,900

[1] National Greenhouse Accounts Factors (Commonwealth of Australia 2013)

Calculation procedure

The data for the GHG assessment was derived from the North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013). Where required due to the unavailability of data, assumptions and approximations have been made in order to obtain a reasonable estimate of activity levels. Table 11-2 stages and activities were assessed and considered as part of the scope 1 and 2 emissions for the GHG assessment.

Table 11-2 Key activities assessed

Project stage	Project activity	Emission source resulting from activity
Construction	Vegetation stripping	Carbon emissions resulting from vegetation removal
	General construction camp activities	Diesel usage and associated fuel combustion
	Operation of construction equipment	Diesel usage
Operations	Rail haulage	Diesel usage
	Maintenance yard and signalling/communications equipment	Electricity imported from the grid

GHG emissions due to vegetation clearing within the NGBR Project final rail corridor were quantified using the National Carbon Accounting Toolbox (NCAT). The NCAT provides access to the Full Carbon Accounting Model (FullCAM) and supporting data. FullCAM is the method used to quantify emissions due to land clearing in Australia's land systems for the purposes of international reporting.

The final NGBR Project footprint crosses a number of broad vegetation groups (refer Volume 1 Chapter 6 Nature conservation). The type and quantity of vegetation to be cleared within the final NGBR Project footprint were quantified by geographic information system (GIS) analysis. The areas and types of vegetation considered are provided in Table 11-3.

GHG emissions resulting from this clearing were estimated by multiplying the results returned by the FullCAM model by the ratio of the mass of a carbon atom to a carbon dioxide molecule (i.e. 3.67), in order to convert to carbon dioxide equivalent.

All energy consumption and emissions data was converted into quantities of carbon dioxide equivalent. The emission values have been summed to reach an estimate of the total GHG emissions.

Calculation procedures used to estimate the activity levels and associated GHG emissions resulting from the construction and operation of the NGBR Project are listed in Table 11-3 and Table 11-4. The assessment was based on emission factors available at the time and future changes in emission factors were not considered.

Table 11-3 Construction calculation procedures

Emission source	Calculation procedure
Diesel – construction	Stationary diesel usage was estimated as 100,000 kL based on the diesel powered plant and machinery requirements during construction. This quantity is based on an average of the two figures taken from the Surat Basin Rail Project and the Alpha Coal Project. This figure equates to 325 kL per km of track laid. Emission factor was sourced from NGA Factors July 2013, Table 3.
Vegetation removal	Carbon content per hectare was determined at the following six locations along the final rail corridor, based on FullCAM classification of the vegetation types and areas to be cleared for the final rail corridor. - 3.5 km chainage - 60.7 km chainage - 126.5 km chainage - 182.1 km chainage - 242.8 km chainage - 306.9 km chainage The location at 126.5 km chainage returned the highest carbon contents of the six locations. This location with the highest carbon content per hectare compared to the other five locations was used in the assessment to provide the most conservative estimate of GHG emissions for vegetation removal. Calculating a worst case scenario value to estimate GHG emissions for vegetation removal is in line with standard greenhouse accounting practices as a conservative estimate is used when the actual value is unknown. In calculating existing carbon for the NGBR Project, no fires or management (thinning, harvesting or pruning) events in the vegetation's history were simulated. Modelling was based on mature vegetation at the site and as such, provided the most conservative estimate of emissions. It was assumed that all carbon from the above ground vegetation, roots and soil carbon pools would be removed by the NGBR Project and would not regrow following construction. In the absence of FullCAM categories for each vegetation community identified at the site, it was assumed that the existing FullCAM tree species groups represent the types of vegetation existing in the area. The following conservative representation of regrowth and cleared areas was considered: - Acacia forest and woodland, 146.7 ha - Rainforest and vine thicket, 44.75 ha - Other grasslands, 118.39 ha - Acacia open woodland, 183.71 ha - Casuarina forest and woodland, 191.1 ha - Eucalyptus open woodland, 21.84 ha - Eucalyptus tall open forest, 72.48 ha

Emission source	Calculation procedure
	- Eucalyptus woodland, 1,689.75 ha - Mangroves/tidal mudflats, lagoons, 20.83 ha - Other forests and woodlands, 96.35 ha - Other shrubland, 0.42 ha - Non-remnant, 1,493,16 ha Non remnant vegetation was classified 'unclassified native vegetation' for the purposes of FullCAM modelling, based on the combination of regrowth, heavily thinned or logged and significantly disturbed vegetation. It was assumed all emissions are CO_2 and cleared vegetation does not undergo anaerobic decomposition.

Table 11-4 Operations calculation procedure

Emission source	Calculation procedure
Diesel – operations	Quantity of diesel for rail haulage was calculated based on the following: - Average diesel consumption being 2.5 L/tonne of coal - Tonnage profile ramp up to operational year 2026 (refer Volume 1 Chapter 2 Project description) - Maintenance of tonnage profile from 2026 to 2105 (end of NGBR Project) The resulting quantity of diesel for rail haulage is shown in Table 11-7. Emissions factors were sourced from NGA Factors July 2013 Table 4.
Imported electricity from the grid	Average annual quantity of electricity consumed at the site was estimated as 175,200 MWh/a. Based on the design life of 90 years, the total electricity usage for the NGBR Project was calculated as 15,768,000 MWh. The electricity estimate was based on comparison against a project of similar size and scale with electricity use limited to supply for signals and other associated communication infrastructure, a maintenance facility and passing loops. Emissions factors sourced from NGA Factors July 2013, Table 5 for Queensland.

11.2.5 Limitations

Emissions excluded from this assessment were as follows.

- Hydrofluorocarbons from air conditioning and refrigeration units

  These emissions were considered to be negligible compared with the emissions over the life of the NGBR Project.

- Sulphur hexafluoride from electrical equipment

  These emissions were considered to be negligible compared with the emissions over the life of the NGBR Project.

- Perfluorocarbons

It was considered that perfluorocarbons would not be used or stored during construction or operation of the NGBR Project.

- Emissions from wastewater treatment at aerobic wastewater treatment plant during construction.

  Wastewater will be treated at an aerobic wastewater treatment plant. Carbon dioxide from biological sources such as this do not require assessment.

- Scope 3 emissions

  Scope 3 emissions are not required by the TOR and have therefore not been considered in this assessment.

Sequestration calculations were not carried out, due to the absence of a detailed revegetation plan for the NGBR Project. As such, this GHG assessment does not consider the ameliorating effect of sequestration on the emissions of the NGBR Project. The assessment is therefore considered to be conservative, as a progressive rehabilitation program is proposed during and following completion of construction activities.

11.3 Emissions inventory

11.3.1 Construction

The GHG emissions for the construction phase of the NGBR Project were calculated based on estimated energy usage from plant and machinery and vegetation removal.

The total GHG emissions for the construction phase of the NGBR Project were estimated to be 1,070 kt CO_2-e.

Removal of vegetation for the final NGBR Project footprint was estimated to be the largest emission source for the construction phase of the NGBR Project, accounting for 74.9 per cent of emissions, followed by diesel use associated with the operation of plant and machinery accounting for 25.1 per cent.

A construction GHG emissions inventory is provided in Table 11-5 and summarised in Figure 11-1.

Figure 11-1 GHG inventory breakdown (construction)

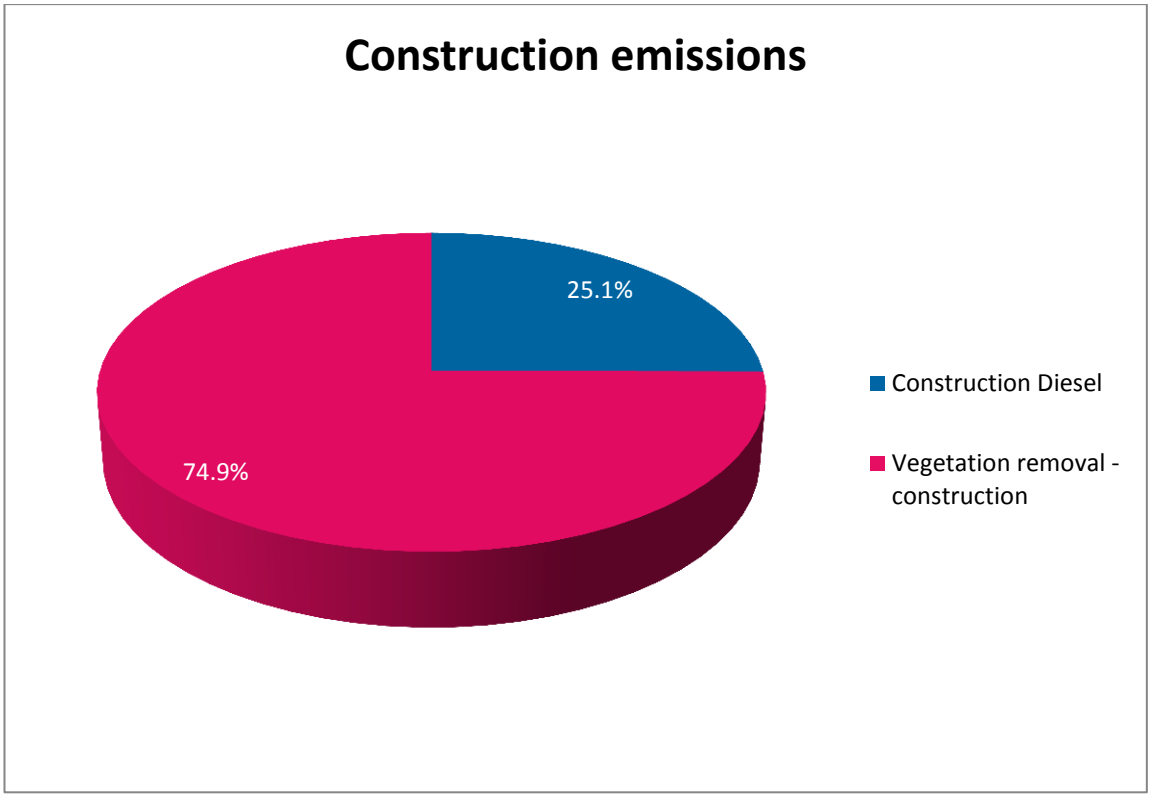

Table 11-5 GHG inventory (construction)

Emissions source	CO_2 Emissions (t CO_2-e)	CH_4 Emissions (t CO_2-e)	N_20 Emissions (t CO_2-e)	Scope 1 emissions (t CO_2-e)	Scope 2 emissions (t CO_2-e)	Total emissions (t CO_2-e)	Proportion of total inventory (%)
Diesel – stationary energy purposes	267,112	386	772	268,270	-	268,270	25.1 %
Vegetation removal	802,014	-	-	802,014	-	802,014	74.9 %
Total	**1,069,126**	**386**	**772**	**1,070,284**	**-**	**1,070,284**	**100%**

11.3.2 Operations

The GHG emissions for the operations phase of the NGBR Project were calculated based on estimated energy usage from plant and machinery, operation of the rail line and electricity requirements.

The total scope 1 and scope 2 GHG emissions for the operations phase of the NGBR Project were estimated to be 70,454 kt CO_2-e over the 90 year design life of the NGBR Project. Scope 1 emissions were estimated to be 57,524 kt CO_2-e and scope 2 emissions were estimated to be 12,930 kt CO_2-e. Based on a 90 year design life, average annual operational emissions were calculated to be 782,824 t CO_2-e per annum.

An operations GHG emissions inventory is provided in Table 11-6 and summarised in Figure 11-2. Diesel usage for the life of the NGBR Project, on which operational diesel emissions were based, is provided in Table 11-7.

Figure 11-2 GHG inventory breakdown (operations)

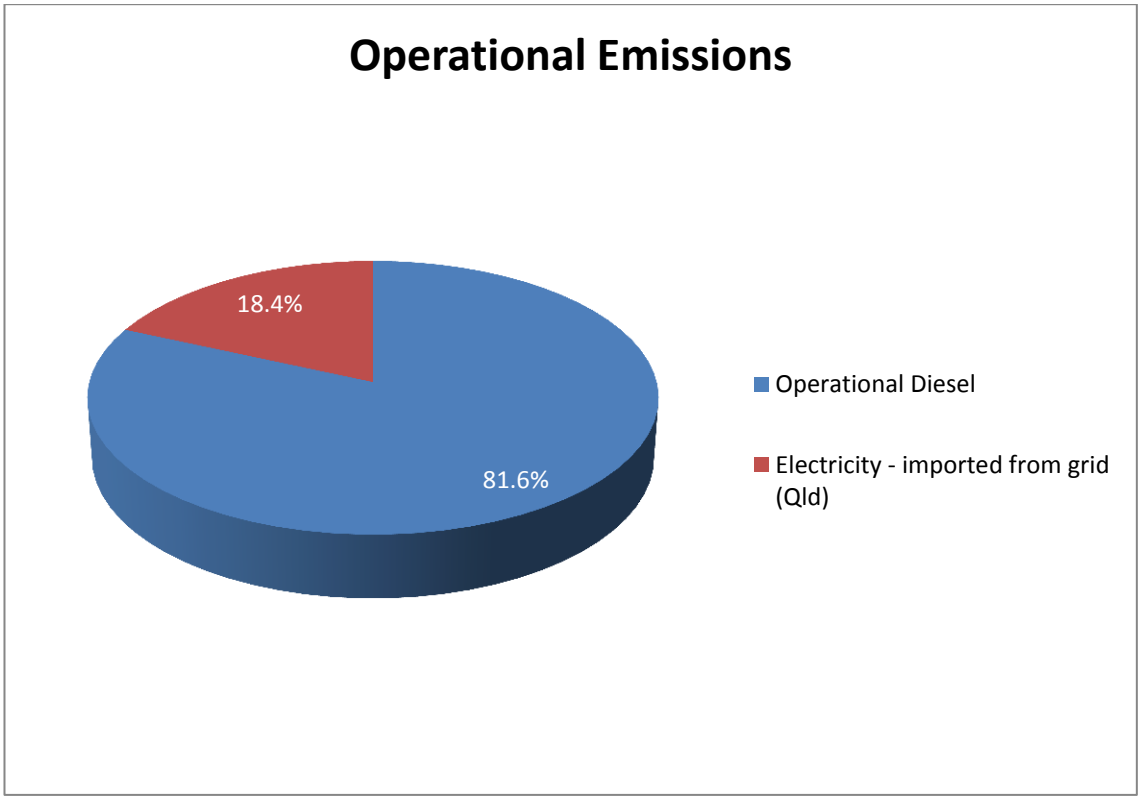

Table 11-6 GHG inventory (operations)

Emissions source	CO_2 Emissions (t CO_2-e)	CH_4 Emissions (t CO_2-e)	N_20 Emissions (t CO_2-e)	Scope 1 emissions (t CO_2-e)	Scope 2 emissions (t CO_2-e)	Total emissions (t CO_2-e)	Proportion of total inventory (%)
Electricity - imported from the grid	-	-	-	-	12,929,760	12,929,760	18.4%
Diesel - transport energy purposes[1]	57,021,734	8,240	494,408	57,524,382	-	57,524,382	81.6%
Total	**57,021,734**	**8,240**	**494,408**	**57,524,382**	**12,929,760**	**70,454,142**	**100%**

[1] Refer Table 11-7.

Table 11-7 Diesel usage

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026-2105
Mtpa	4	20	30	40	50	60	70	80	90	95	100
Subtotal (kl)[1]	10,000	50,000	75,000	100,000	125,000	150,000	175,000	200,000	225,000	237,5000	20,000,000
Total (kl)											**21,347,500**

[1] Based on assumed 2.5 litres of diesel per tonne of coal

11.4 Emissions abatement

11.4.1 Overview

The approach for mitigation of GHG emissions by the NGBR Project will be as follows:

- Avoid activities that generate GHG in the first instance, if practicable
- Reduce the scale of the activity where it cannot be avoided, if practicable
- Substitute emission-intensive plant, equipment, fuel and power for energy-efficient alternatives, if practicable
- Maintain plant and equipment to maximise their efficiency
- Sequester GHG emissions through
  - Revegetation
  - Purchase of carbon offsets.

Proposed emissions abatement measures for the construction and operation of the NGBR Project are provided in Table 11-8.

Table 11-8 Emissions abatement measures

Phase	Mitigation
Construction	The following measures will be implemented to mitigate generation of GHG due to clearing: • Place temporary infrastructure in areas that were previously cleared, degraded or have naturally lower aboveground biomass, to avoid unnecessary clearing-related emissions. • Stage vegetation clearing to coincide with construction works, to reduce the volume of clearing occurring at one time • Clearly identify clearing limits, to reduce incidental clearing.
	A cut and fill balance will be maintained wherever possible to minimise haulage of cut and fill material.
	Consider alternative fuels and energy sources such as biodiesel and solar power.
	The following measures will be implemented mitigate generation of GHG due to electricity use: • Consider energy efficient wastewater treatment units, including pumps and other associated equipment. • Optimise efficiency of electrical equipment, through regular maintenance, prompt repair of malfunctioning equipment (to reduce inefficiency), and selection of equipment appropriate to the required task, in order to reduce electricity use.

Phase	Mitigation
Operation	The following measures will be considered to mitigate generation of GHG due to fuel use: • Optimise operational activities and logistics, to avoid unnecessary vehicle movements. • Prefer current model locomotives, or engines, to older models, to reduce fuel use. • Consider substitution of locomotives with hybrid models, with rechargeable energy storage systems and regenerative braking. • Consider fitting locomotives and wagons with electronically controlled pneumatic braking, to maximise braking efficiency and thereby reduce fuel use. • Consider implementing anti-idling engine management software, to optimise the balance of energy demands and fuel use. • Investigate the opportunity to substitute diesel for liquid natural gas, compressed natural gas, or biodiesel blends.
	An energy efficiency review will be undertaken at the commencement of operations and every five years following, to identify further initiatives and technology that may be integrated into the NGBR Project, including: • Use of engine management systems to determine optimal power output. • Use of consistent management systems to optimally distribute the train loads. • Parked train management, focussing on efficient load and temperature management.

11.5 Conclusion

The estimated scope 1 and scope 2 GHG emissions (CO_2, N_20 and CH_4) of the NGBR Project are as follows:

- 1,070 kt of scope 1 and scope 2 CO_2-e, over the two year construction period
- 782.82 kt of scope 1 and scope 2 CO_2-e, each year of operation
- 71,524 kt of scope 1 and scope 2 CO_2-e, over the 90 year life of the NGBR Project.

The primary source of emissions during construction was found to be vegetation clearing, totalling 74.9 per cent of the construction inventory. The primary source of emissions during operation was found to be diesel usage, totalling 81.6 per cent of the operations inventory.

While GHG emissions are an unavoidable consequence of the construction and operation of the NGBR Project, a number of mitigation measures are proposed that will reduce these emissions as much as practicable.

As explained in section 11.2.5, sequestration through revegetation is excluded from this GHG assessment. The assessment is therefore considered to be conservative, as a progressive rehabilitation program is proposed during and following completion of construction activities. Further sequestration through securement or purchase of offsets will be considered in the future stages of the NGBR Project, with preference given to offsets certified under the Commonwealth Government National Carbon Offset Standard.

Mitigation of GHG will be supported by an overall approach to energy efficiency, including development of an energy efficiency review that will identify additional initiatives and technology that may be integrated into the NGBR Project.