Hyder

Greenhouse Gas Assessment

SIMTA SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 3A Concept Plan Application

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Hyder Consulting Pty Ltd
ABN 76 104 485 289
Level 5, 141 Walker Street
Locked Bag 6503
North Sydney NSW 2060
Australia
Tel: +61 2 8907 9000
Fax: +61 2 8907 9001
www.hyderconsulting.com

SIMTA

Part 3A Concept Plan Application

Greenhouse gas assessment

Author	Ken Lunty & Shannon Blackmore	
Checker	Brad Searle & Ken Lunty	
Approver	Rebecca Sommer	

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Executive Summary

This greenhouse gas assessment for the SIMTA Moorebank Intermodal Terminal Facility was required for the following section of the Director Generals Requirements:

Director General's requirements	Where addressed
Air Quality Impacts – including but not limited to direct and indirect greenhouse gas emissions.	Section 7.4.2

An assessment of greenhouse gas (GHG) emissions was undertaken using the best available data at concept plan stage, where detailed information on construction and operation is limited.

This report investigated the following measurement boundaries and emissions sources.

Site preparation
- Decomposition of cleared vegetation off-site
- Operation of mobile equipment
- Operation of stationary equipment
- Transport of fill to site
- Transport of materials to site
- Demolition of buildings on existing site

Construction phase
- Operation of mobile equipment
- Operation of stationary equipment
- Electricity use
- Transport of materials onto site

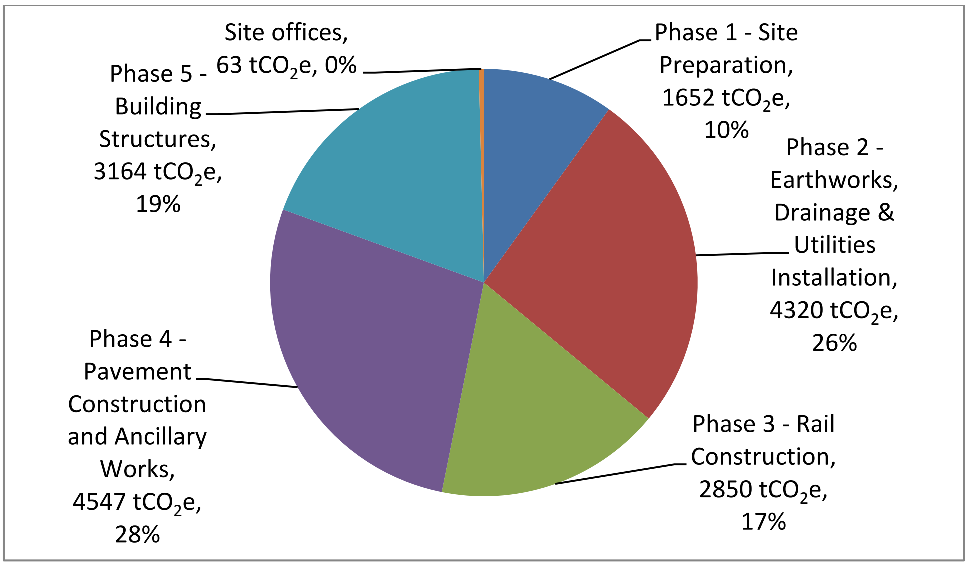
Embodied emissions in materials

Operation
- Estimated electricity consumption of buildings
- Estimated electricity consumption of cranes
- Estimated natural gas consumption
- Estimated emissions from alternative scenario

Freight transport emissions
- SIMTA facility vs Alternative scenario

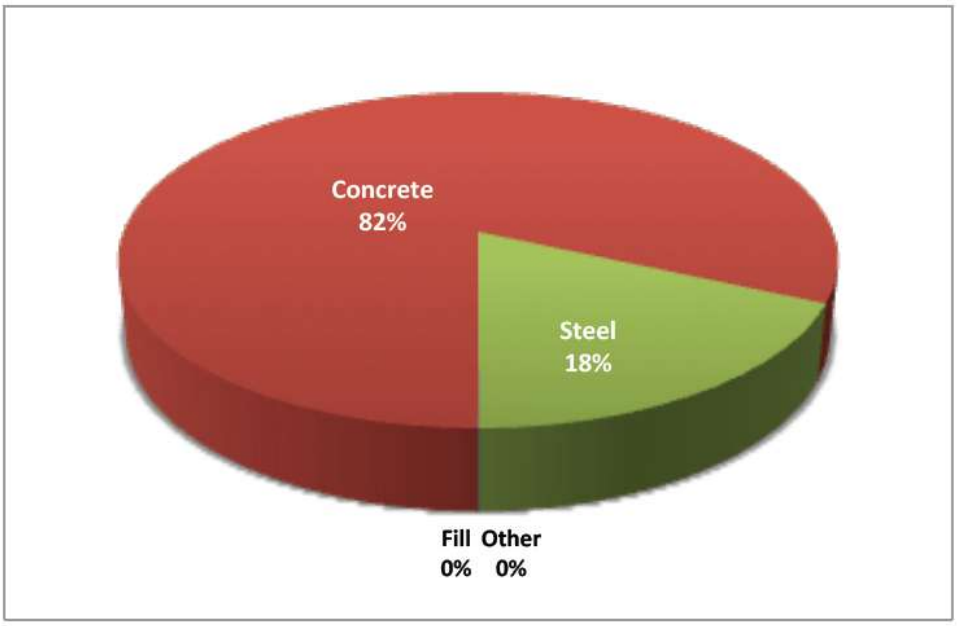
Site preparation and construction – SIMTA facility

Emissions from the construction and preparation phases were calculated, the breakdown of which is shown below. Emissions estimates from construction were based on estimated machinery types, days used and fuel use and areas of clearing and construction required. Emissions from the transport of material to and from site were also included, based on truck fuel use and distances to the closest waste facilities and materials providers. Approximately 16,597 tCO2e is expected to be emitted during site preparation and construction.



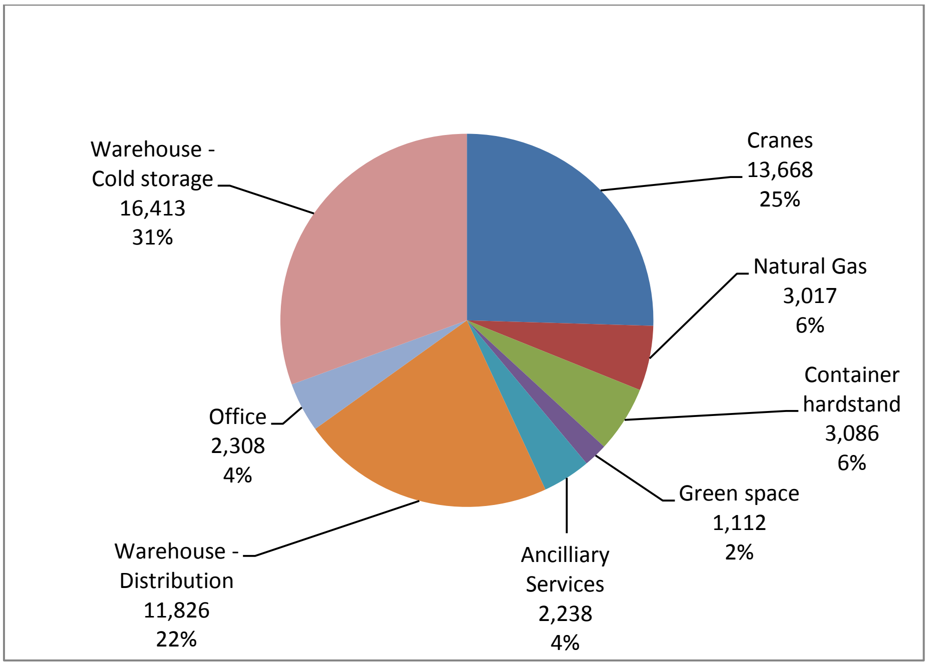
Embodied emissions of materials – SIMTA facility

Hyder consulting contracted Edge Environment who estimated the embodied GHG emissions in construction material and products to be used on the project. It was estimated that 196,201 tCO2e is embodied in materials, predominantly within steel and concrete. This is illustrated in the figure below.



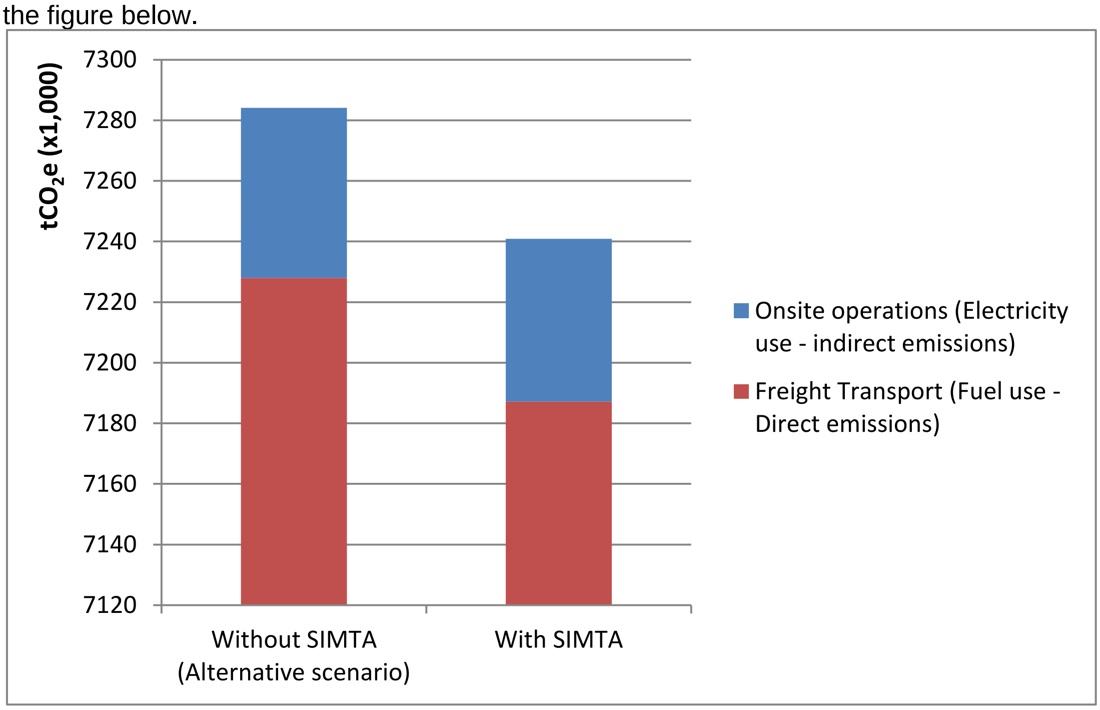
- ### *Operation – SIMTA facility & Rail corridor/link*

Emissions from on site energy use, once the site is fully operational, was calculated to be 53,668 tCO2e per annum. Operational emissions were based on electricity and gas demand estimates developed during concept planning. The breakdown of operational emissions per annum is shown in the following figure.

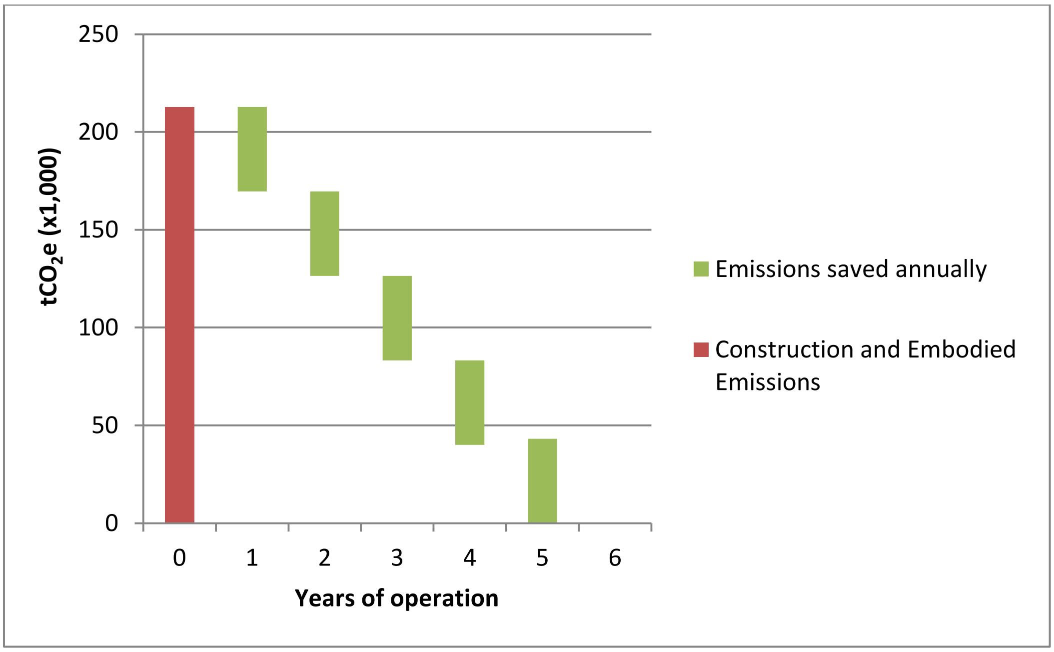


- Emissions associated with the operation of the rail corridor/link are considered to be negligible as there is no lighting or other energy use associated with this part of the development. Emissions associated with the operation of the rail corridor/link are limited to those from diesel combustion in the freight trains. This has been included in the alternative scenario estimations in the following section.
- ***Alternative scenario - SIMTA facility & Rail corridor/link***

  A feasible alternative scenario was developed to determine an emissions profile of the area if the SIMTA facility were not developed. The alternative scenario was developed using the Liverpool Local Environmental Plan 2008 and the projected freight demand in the area. A comparison between the SIMTA proposal and the alternative scenario showed that there was an annual GHG saving of 43,206 tCO2e per annum which can be achieved through operational and transport efficiencies through the implementation of the SIMTA proposal. This illustrated in the figure below.



It is estimated that the annual emissions savings from operation of the SIMTA facility will equalise the emissions associated with construction and those embodied within construction materials within 6 years of operation. This is shown in the following figure.



GHG management and mitigation

Regular monitoring of emissions is recommended throughout the project to assess the effectiveness of emissions mitigation actions. The following actions are recommended for mitigation of GHG emissions ***during construction***:

- Where possible, use locally sourced materials to reduce emissions associated with transport;
- Recycle/compost waste wherever possible;
- When importing fill source from nearby construction sites, wherever possible aim to reduce transport related emissions;
- Plan construction works to avoid double handling of materials;
- Make use of recycled emissions to reduce emissions associated with embodied energy (not estimated in this report);
- Develop construction/transport plans to minimise the use of fuel during each construction stage. For example throttling down and switching off construction equipment when not in use;
- Assess the fuel efficiency of the construction plant/equipment prior to selection, and where practical, use equipment with the highest fuel efficiency which use lower GHG intensive fuel (e.g. gas, ethanol); and
- Regular maintenance of equipment to maintain optimum operations and fuel efficiency.

The following actions are recommended for mitigation of GHG emissions ***during the operation*** of the facility:

- Incorporate energy efficiency design aspects wherever possible to reduce energy demand. More information on this can be found in the Hyder ESD report. Examples could include energy efficient lighting systems, natural ventilation, insulation and other renewable forms of energy (e.g. co-generation/tri-generation on site);

- Investigate the procurement of energy efficient equipment for the site (i.e. cranes, forklifts, street lighting etc);
- Investigate the feasibility of on-site renewable energy, such as photo-voltaics to reduce demand from the grid; and
- Tune buildings during commissioning to optimise energy performance.

The main GHG emissions embodied in the materials are from production of concrete for the site pavement and structural steel for warehouses. There is significant scope to reduce construction emissions by, for example, replacing Portland cement with, for example, fly ash, silica fume, ground granulated blast furnace slag. However, the overall focus in terms of reducing GHG emissions should focus on minimising energy related emissions from operation of the facility. The following recommendations are suggested for the mitigation of GHG emissions embodied in materials:

- Investigate the feasibility to use supplementary cementitious materials for the concrete pavement;
- Source concrete from suppliers who are able to demonstrate low embodied GHG emissions using LCA methodology (could for example be certified by eco-label bodies);
- Avoid using recycled content in steel products as a single indicator for low GHG intensity as this has been proven to be misleading;
- Achieve high steel scrap recycling rates;
- Use low GHG intensive energy in production (i.e. renewable energy for electricity); and
- Minimize GHG emissions from steel making by sourcing from suppliers who are able to demonstrate low embodied GHG emissions using LCA methodology (could for example be certified by eco-label bodies).

1 Background

The Sydney Intermodal Terminal Alliance (SIMTA) is a joint venture between Stockland, Qube Logistics and QR National. The SIMTA Moorebank Intermodal Terminal Facility (SIMTA proposal) is proposed to be located on the land parcel currently occupied by the Defence National Storage and Distribution Centre (DNSDC) on Moorebank Avenue, Moorebank, south-west of Sydney. SIMTA proposes to develop the DNSDC occupied site into an intermodal terminal facility and warehouse/distribution facility, which will offer container storage and warehousing solutions with direct rail access

The SIMTA site is located in the Liverpool Local Government Area. It is 27 kilometres west of the Sydney CBD, 16 kilometres south of the Parramatta CBD, 5 kilometres east of the M5/M7 Interchange, 2 kilometres from the main north-south rail line and future Southern Sydney Freight Line, and 0.6 kilometres from the M5 motorway.

The SIMTA site, approximately 83 hectares in area, is currently operating as a Defence storage and distribution centre. The SIMTA site is legally identified as Lot 1 in DP1048263 and zoned as General Industrial under Liverpool City Council LEP 2008. The parcels of land to the south and south-west that would be utilised for the proposed rail corridor are referred to as the rail corridor. The proposed rail corridor covers approximately 65 hectares and adjoins the Main Southern Railway to the north. Existing land use includes vacant land, golf course, extractive industries, and a waste disposal depot. Native vegetation includes woodland, forest and wetland communities in varying condition. Georges River and Anzac Creek intersect the proposed rail corridor. The proposed rail corridor to the south of the SIMTA site, north of the existing East Hills Rail Line are part of Lot 3001 DP1125930 and Lot 1 DP1125930. To the west of the Georges River, the Glenfield Waste Disposal site comprises several lots that are currently all used for the purposes of the waste facility.

The project will be undertaken as a staged development and it is intended that an overall Master Plan, for the entire site, be undertaken for the purpose of applying for Concept Plan approval under Part 3A of the *Environmental Planning and Assessment Act 1979*.

1.1 Site history

The DNSDC has been used as a major defence material, storage and distribution and maintenance site since the early 1900s. The original storage depot facilities were established in the northern portion of the site in the period 1910-1920, followed by expansion southward into vacant Defence land in 1944-1945. This expansion included the construction of large permanent warehouses and workshop facilities, where large areas of open land were utilised for vehicles and other field equipment storage on improved hard-stands.

A further upgrade of the site occurred in the late 1980s when the first of several stages of new facility construction took place, culminating in 1993-94 with the construction of new centralised distribution buildings and the re-cladding of many of the original storehouses. External hard-stands were also retained and improved.

1.2 Proposed land use

1.2.1 Proposed operation of SIMTA Moorebank Intermodal Terminal Facility

SIMTA is proposing to build an intermodal rail to truck freight terminal with the capability to process up to one million twenty-foot equivalent freight container units (TEU). The facility is to cater for port shuttle rail traffic from Port Botany. The design capacity is anticipated to be realised within a decade depending on the supply and demand of freighting services utilising the facility. The one million TEUs will generally be divided equally between inbound and outbound containers (loaded containers from Port Botany and a combination of loaded and empty containers to Port Botany) and is expected to involve the following:

- Inbound TEUs will be warehoused, unpacked and the contents distributed by trucks throughout south and south western Sydney with subsequent empty TEUs returned to Port Botany by return rail movements from the site; and
- Outbound TEUs will be processed through the terminal and forwarded to Port Botany by rail. Of the outbound TEUs, approximately a quarter will contain export freight whilst the remaining three quarters will be empty containers returned to Port Botany.

1.2.2 Operation description

The function of the SIMTA facility will be the transfer of container freight to and from Port Botany by rail and to facilitate the ongoing distribution of freight throughout south and south-western Sydney. Operations would involve the following:

- Unloading of containers from rail onto stacks within the intermodal facility;
- Transportation of containers to warehouses within the intermodal facility, or directly onto trucks for transport offsite; and
- Loading of containers onto trains for export or return to Port Botany.

Operations within the facility would function 24 hours a day, seven days a week.

1.3 Context of greenhouse gas

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released its fourth assessment report on climate change. It stated that warming of the climate system is unequivocal, as is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. It also states that most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas (GHG) concentrations (IPCC 2007).

In Australia and NSW, there are a number of policies, guidelines and regulations which have been developed to manage and reduce GHG emissions. These include the following:

- The Australian Government has committed to reduce its emissions by between 5 and 25 per cent below 2000 levels by 2020. It has also committed to a long term emissions reduction target of at least 60 per cent below 2000 levels by 2050;
- The National Greenhouse and Energy Reporting (NGER) Act was introduced in 2007 and requires corporations to register and report emissions, energy consumption or production that meets certain thresholds every year. For GHG emissions, thresholds are currently set at 25,000 tonnes carbon dioxide equivalent (tCO_2e) for a facility under a corporation and 50,000 tCO_2e for a corporation as a whole for 2010-2011 (DCC 2008); and
- The NSW Department of Infrastructure, Planning and Natural Resources – Department of Energy, Utilities and Sustainability *Guidelines for Energy and Greenhouse in EIA* provides guidance on the consideration of energy and greenhouse issues when developing projects and when undertaking environmental impact assessment (EIA) under the *Environmental Planning and Assessment Act 1979 (EP&A Act).*

In May 2010, the Commonwealth Department of Climate Change and Energy Efficiency published its *State and Territory Greenhouse Gas Inventories for 2008*. This document provides an overview of the latest available estimates of GHG emissions for the Australian States and Territories based on a Kyoto accounting basis. Table 1 outlines the 2008 emissions estimates for Australia and NSW broken down by sector; note that sectors relevant to this project are highlighted in blue. It can be seen that emissions from transport, waste and manufacturing and construction make up a significant proportion of emissions in Australia. This assessment will estimate the CO_2 emissions associated with the construction and operation of the proposed facility and identify actions to manage and minimise these emissions where feasible[1].

[1] The scope does not include decommissioning of the facility after its life.

Table 1: National and NSW emissions by sector in 2008 (DCCEE 2010)

Sector/key subsector	Australia	NSW	
	Emissions (Mt)	Emissions (Mt)	% Contribution to National Emissions
TOTAL NET EMISSIONS	575.8	164.7	28.5
ENERGY SECTOR	476.6	122.7	29.5
Stationary energy	296.4	81.2	37.4
Energy industries	226.4	67.6	29.9
Electricity generation	204.3	63.2	30.9
Other energy industries	22.1	4.4	20.1
Manufacturing and construction	48.7	9.0	18.5
Other sectors	21.4	4.6	21.3
Transport	80.2	21.8	27.2
Fugitive emissions	39.9	19.8	49.5
INDUSTRIAL PROCESSES	31.1	11.9	38.2
AGRICULTURE	87.4	16.5	18.9
Livestock	58.9	13.2	22.4
Other agriculture	28.5	3.4	11.8
WASTE	14.4	5.2	36.4
OTHER	N/A	N/A	N/A
LAND USE, LAND USE CHANGE AND FORESTRY	26.3	8.2	31.4
Afforestation and reforestation	-23.0	-2.3	10.1
Land use change (Deforestation)	49.3	10.6	21.5

Blue highlight indicates sectors relevant to the SIMTA facility

1.4 Scope of works

The scope of this GHG assessment is to develop an inventory of projected GHG emissions from construction and operation of the project. The inventory will be used to identify actions for mitigating or reducing emissions, where possible. The report will also compare the difference in GHG emissions associated with this proposal against an alternative development scenario. The scope of works for this assessment includes:

- Identify the main sources of emissions during construction (including embodied emissions in materials) and operational stages of the development;
- Scope and calculate the emissions from each source using factors and methods outlined in the *National Greenhouse Accounts (NGA) Factors*, published by the Australian

Government Department of Climate Change and Energy Efficiency (2009), the GHG Protocol published by the World Business Council for Sustainable Development (2001) and the BPIC/ICIP Project's Methodology Guidelines for the Materials and Building Products Life Cycle Inventory Database;

- Estimate the emissions associated with road and rail freight transport as a result of the SIMTA development;
- Assess the overall impact of the SIMTA development in relation the GHG emissions; and
- Investigate and recommend strategies for emissions mitigation to reduce GHG emissions associated with project development and operation.

Figure 1 illustrates the measurement boundaries and emissions sources investigated in this GHG assessment.

Site preparation

- Decomposition of cleared vegetation off-site
- Operation of mobile equipment
- Operation of stationary equipment
- Transport of fill to site
- Transport of materials to site
- Demolition of buildings on existing site

Construction phase

- Operation of mobile equipment
- Operation of stationary equipment
- Electricity use
- Transport of materials onto site

Embodied emissions in materials

Operation

- Estimated electricity consumption of buildings
- Estimated electricity consumption of cranes
- Estimated natural gas consumption
- Estimated emissions from alternative scenario

Freight transport emissions

- SIMTA facility vs Alternative scenario

Figure 1: GHG emissions boundary for construction of this project

The scoping processes used within this report for the operation of the facility are adapted from the 'The Greenhouse Gas Protocol' (WBCSD 2001). Under this protocol, the projects direct and indirect emissions sources can be delineated into three 'scopes' (Scope1, Scope 2 and Scope 3) for GHG accounting and reporting purposes. This method of scoping helps to improve transparency, and assists in setting emissions reduction objectives.

The GHG protocol definitions for each scope are presented in Figure 2 and described in further detail below.

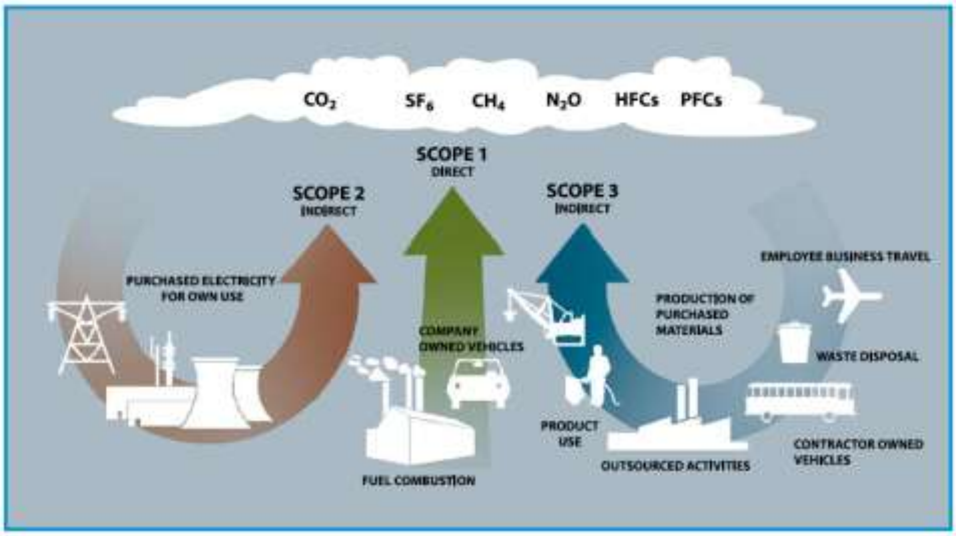


Figure 2: Overview of scopes and emission sources (Source: World Business Council for Sustainable Development, 2001)

- **Scope 1 – Direct GHG emissions:** Scope 1 emissions are direct emissions that occur from sources on site. This would include emissions arising from the combustion of fuels in equipment on-site (e.g. boilers, furnaces, generators, vehicles, machinery, fugitive emissions etc).
- **Scope 2 – Electricity indirect GHG emissions:** Scope 2 emissions account for GHG emissions arising from the generation of purchased electricity consumed on-site. Scope 2 emissions are considered indirect as they occur at an off-site facility where electricity is generated.
- **Scope 3 – Other indirect GHG emissions:** Scope 3 emissions are an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities on, but occur away from the development site.

This assessment has been undertaken using the best available data at concept plan stage, where detailed information on construction and operation will be incorporated into subsequent Project Applications for each stage of development and therefore details at this time are limited. Assumptions have been outlined, where appropriate, to maintain transparency. The estimates in this report may be refined as more information becomes available such as in detailed design stages of the project.

Assessment boundary

Sufficient design information to undertake this assessment was available for the SIMTA site only at the time of writing. Emissions associated with the operation of the SIMTA facility and associated rail corridor/link are included as part of this study. Operational emissions includes net emissions associated with transport of freight as well as those associated with the energy use within the intermodal facility and rail corridor/link

The design information was not available to undertake a GHG assessment to sufficient accuracy and precision for construction of the rail corridor/link development and therefore construction associated emissions on these areas are not included within this scope of work. Further assessments at the detailed design phase will include the rail corridor/link as sufficient design information becomes available.

2 Construction based GHG inventory

The construction of the proposed development will include the transport of materials on and off the site, decomposition of vegetation waste and the use of machinery and vehicles for preparation of the site, civil works and construction of the warehouses. These activities require the use of fuels and electricity which will result in the release of associated GHG emissions.

Accurately quantifying these emissions at the concept stage requires a number of assumptions to be made including distances travelled and hours of use for vehicles and machinery. Other factors which will affect GHG emissions during the construction phase include construction methods, time table, materials sources and transport methods.

Emissions were calculated by estimating fuel use, electricity consumption and vegetation decomposition using data available at concept stage. Emissions in tonnes CO_2 equivalent were calculated using factors and methods from the Australian Government *National Greenhouse Accounts Methods and Factors Workbook*. Specific assumptions were made with regard to fuel use, electricity consumption, construction schedules, material quantities, material transport and waste decomposition are outlined in detail in the following sections. These assumptions are based on Hyder's experience in similar construction projects and information in the civil engineering report associated with this project (Hyder 2011).

This assessment was undertaken using the indicative 5 phases of construction outlined in the civil engineering report undertaken for the site (Hyder 2011). This assessment also includes emissions estimates of warehouse construction (not included in the civil report) and from electricity use associated with site offices during the construction stage. These estimates were undertaken using information gained through communications with Hyder structural engineers. This GHG assessment was undertaken with best available data at concept plan stage and it is anticipated that this assessment will become more detailed as relevant information becomes available in the detailed design stage.

2.1 Phase 1 – Site preparation

The estimated emissions from Phase 1 of construction were ***1,652 tCO_2e***. The breakdown of these emissions is detailed in the following sections.

2.1.1 Construction activities and Emissions sources

Phase 1 includes the following construction activities:

- Site establishment;
- Demolition;
- Clearing and grubbing;
- Vegetation decomposition; and
- Contamination removal.

Figure 3 illustrates the GHG emissions quantities and relative proportions from each construction activity in Phase 1.

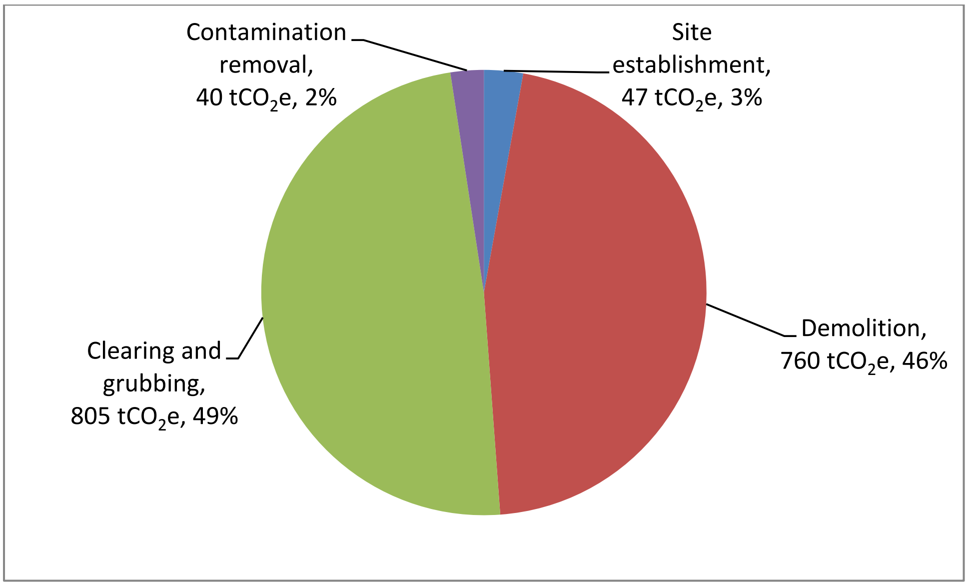


Figure 3: Emissions breakdown for site preparation phase by construction activity

These are detailed further in Table 2.

Table 2: Summary of GHG emissions from site preparation by construction activity

Construction activity	Emissions (tCO_2e)
Clearing and grubbing	805
Demolition	760
Site establishment	47
Contamination removal	40
TOTAL	**1,652**

For the purposes of this assessment, emissions from site preparation phase included the following direct emissions sources:

- Compost of removed vegetation[2];
- Fuel use from transport of materials; and
- Fuel use from construction activities

Figure 4 illustrates the breakdown of emissions sources during the site preparation phase.

[2] This study assumes that all vegetation waste is sent to a composting facility and not to landfill. The emissions estimates would increase to approximately 2,754 tCO_2e if the waste was sent to traditional landfill.

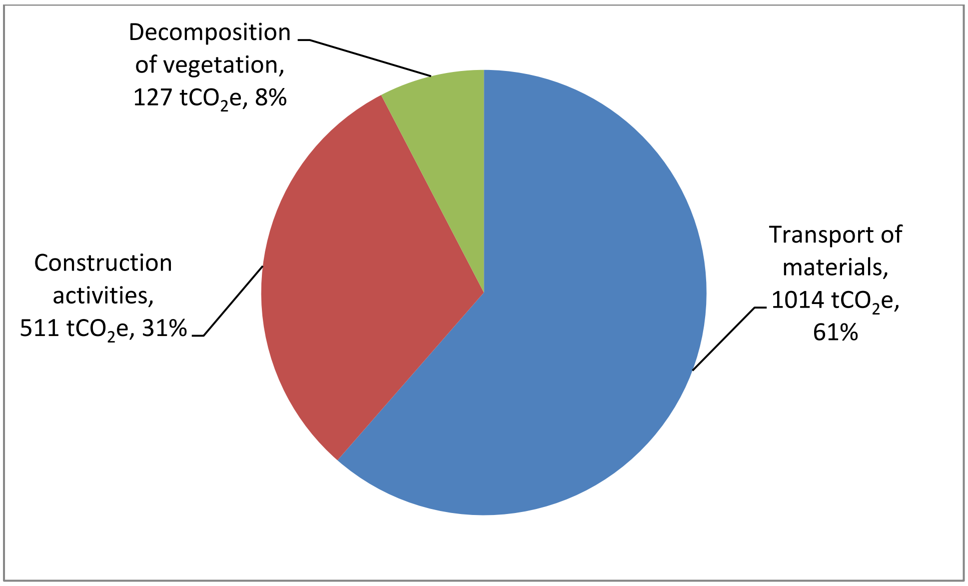


Figure 4: Emissions breakdown for site preparation phase by emissions source

These are detailed further in Table 3.

Table 3: Summary of GHG emissions from site preparation by emissions source

Construction activity	Emissions (tCO_2e)
Transport of materials	1,014
Construction activities	511
Decomposition of vegetation	127
TOTAL	**1,652**

Assumptions used in calculating the above emissions are set out below:

- The site preparation phase is expected to take approximately 18 months;
- It was assumed that all machinery and vehicles were re-fuelled every 2 days on average;
- It was assumed that the cleared vegetation was 50,000m^2 of grass at 0.15m depth as outlined in the Civil Engineering Report (Hyder 2011). This results in a volume of approximately 8,250m^3 of grass equating to a mass of approximately 1,980 tonnes (Tchobanoglous *et al.* 1993); and
- It was assumed that all cleared vegetation was transported and composted at the Eastern Creek waste facility.

The machinery and relative fuel capacity of the vehicles used during Phase 1 are assumed to be as set out in the following tables:

Table 4: Specifications for machines/vehicles used during site preparation

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
20 tonne truck	12.5	410
Backhoe	N/A	170
Static Roller	N/A	100

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
Mobile crane	N/A	400
Delivery trucks	N/A	150
Excavators	N/A	410
Concrete crushing plant	N/A	230
Air compressor	N/A	300
Dozer	N/A	909

The estimated program for the site preparation phase of the project along with estimated machine/vehicle days and associated fuel use are outlined in Table 5:

Table 5: Summary of assumptions for machinery use associated with site preparation

Construction activity	Estimated works time (machine days)	Estimated fuel use (L)	Fuel type
Site establishment	132	17,340	Diesel
Demolition	1440		Diesel
Clearing and grubbing	1008		Diesel
Contamination removal	72		Diesel

*Construction work days were assumed to be 8 hours a day and 6 days a week

2.2 Phase 2 – Earthworks, Drainage and Utilities Installations

The estimated emissions from Phase 2 of construction were ***4,320 tCO_2e***. The breakdown of these emissions is detailed in the following sections.

2.2.1 Construction activities and Emissions sources

Phase 2 includes the following construction activities:

- Bulk earthworks;
- Stormwater drainage; and
- Utility services

Figure 5 illustrates the GHG emissions quantities and relative proportions estimated from each construction activity in Phase 2.

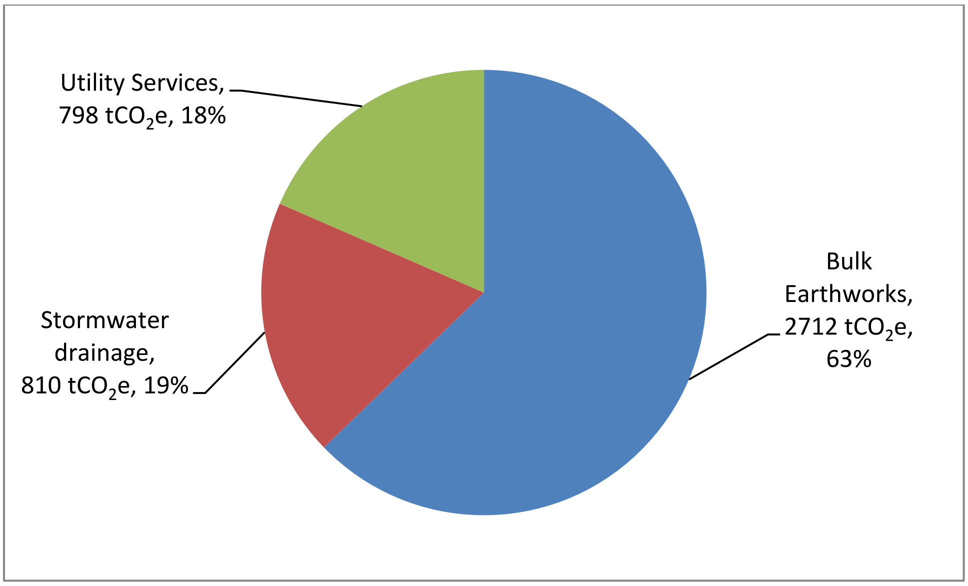


Figure 5: Emissions breakdown for earthworks, drainage and utilities installations phase by construction activity

These are detailed further in Table 6.

Table 6: Summary of GHG emissions from earthworks, drainage and utilities installations by construction activity

Construction activity	Emissions (tCO_2e)
Bulk earthworks	2,712
Stormwater drainage	810
Utility services	798
TOTAL	**4,320**

For the purposes of this assessment, emissions from earthworks, drainage and utilities installations phase included the following direct emissions sources:

- Fuel use from transport of materials; and
- Fuel use from construction activities.

Figure 6 illustrates the estimated breakdown of emissions sources during the earthworks, drainage and utilities installations phase.

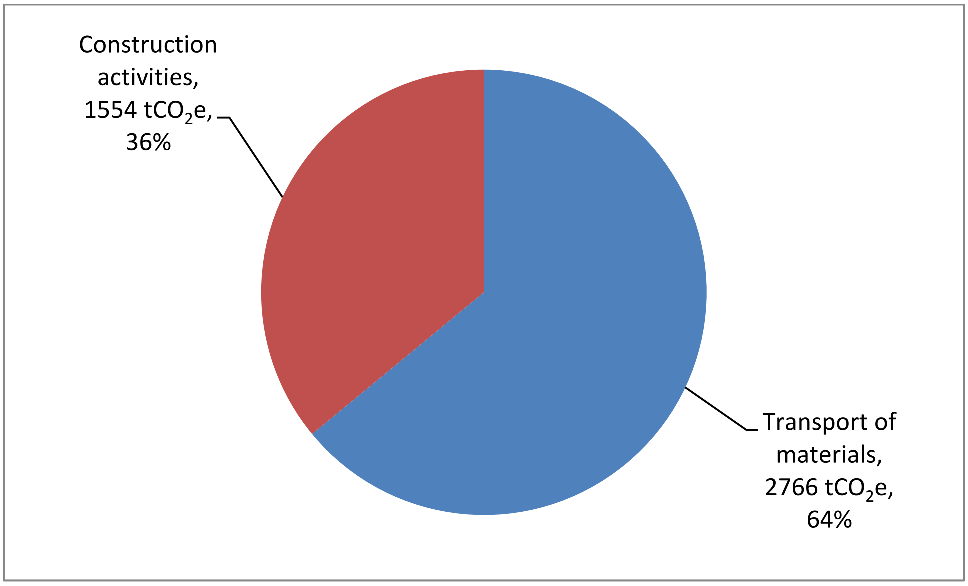


Figure 6: Emissions breakdown for earthworks, drainage and utilities installations by emissions source

These are detailed further in Table 7.

Table 7: Summary of GHG emissions from earthworks, drainage and utilities installations by emissions source

Construction activity	Emissions (tCO_2e)
Transport of materials	2,766
Construction activities	1,554
TOTAL	**4,320**

Assumptions used in calculating the above emissions are set out below:

- The site preparation phase is expected to take approximately 18 months;
- It was assumed that all machinery and vehicles were re-fuelled every 2 days on average;
- Calculations at concept design stage have determined that there is an excess of approximately 35,400m^3 of fill from the site. However, as stated in the Civil Engineering report, it is currently intended that there be no import or export of bulk earthworks from the site, therefore emissions associated with fill transport were not included as part of this assessment; and
- It was assumed that concrete will be used to pave the site to an average thickness of 0.5m.

The machinery and relative fuel capacity of the vehicles used during Phase 2 are assumed to be as set out in the following table:

Table 8: Specifications for machines/vehicles used during earthworks, drainage and utilities installations

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
20 tonne truck	12.5	410
Backhoe	N/A	170
Static Roller	N/A	100

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
Graders	N/A	344
Delivery trucks	N/A	150
Excavators	N/A	410
Concrete agitators	N/A	410
Water trucks	N/A	125
Air compressor	N/A	300
Compaction equipment	N/A	672
Dozer	N/A	909

The estimated program for the earthworks, drainage and utilities installations phase of the project along with estimated machine/vehicle days and associated fuel use are outlined in Table 9:

Table 9: Summary of assumptions for machinery use associated with earthworks, drainage and utilities installations

Construction activity	Estimated works time (machine days)	Estimated fuel use (L)	Fuel type
Bulk earthworks	5,088	1,004,280	Diesel
Stormwater drainage	1,800	300,420	Diesel
Utility services	1,890	295,470	Diesel

*Construction work days were assumed to be 8 hours a day and 6 days a week

2.3 Phase 3 – Rail construction

The estimated emissions from Phase 3 of construction were ***2,850 tCO2e***. The breakdown of these emissions is detailed in the following sections.

2.3.1 Construction activities and Emissions sources

Phase 3 includes the following construction activities:

- Rail siding construction; and
- Gantry rail construction.

Figure 7 illustrates the estimated GHG emissions quantities and relative proportions from each construction activity in Phase 3.

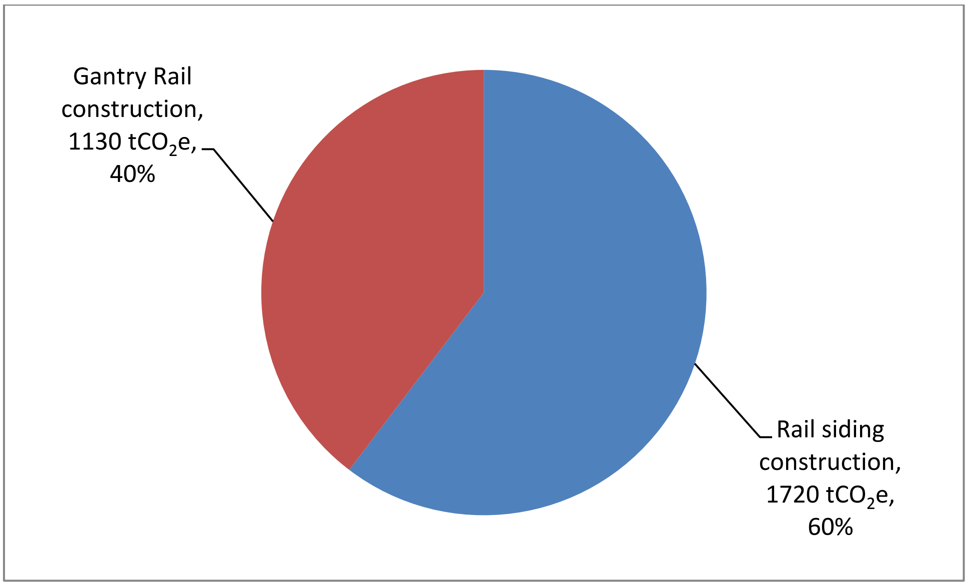


Figure 7: Emissions breakdown for rail construction phase by construction activity

These are detailed further in Table 10.

Table 10: Summary of GHG emissions from rail construction by construction activity

Construction activity	Emissions (tCO_2e)
Rail siding construction	1,720
Gantry rail construction	1,130
TOTAL	**2,850**

For the purposes of this assessment, emissions from rail construction phase included the following direct emissions sources:

- Fuel use from transport of materials; and
- Fuel use from construction activities.

Figure 8 illustrates the breakdown of emissions sources during the rail construction phase.

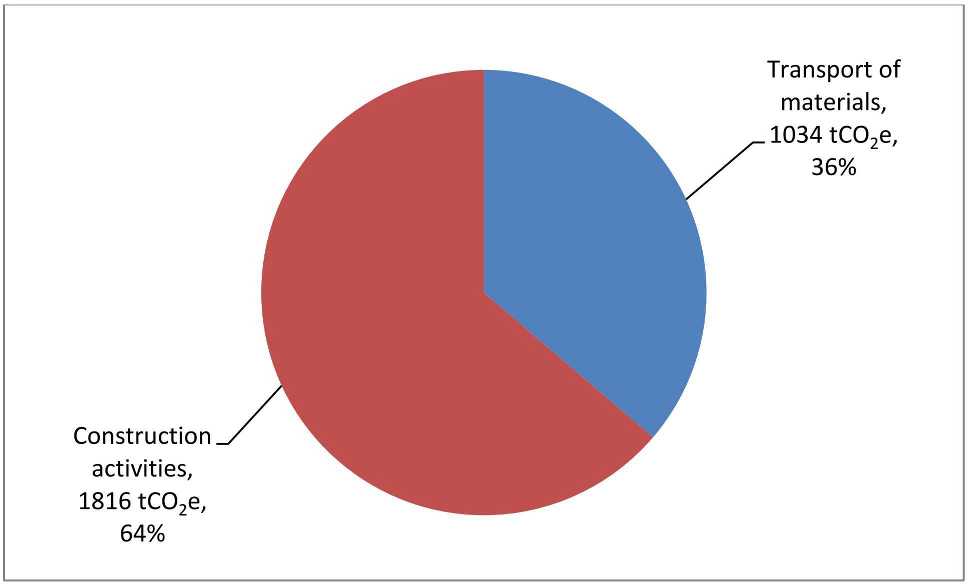


Figure 8: Emissions breakdown for rail construction by emissions source

These are detailed further in Table 11.

Table 11: Summary of GHG emissions from rail construction by emissions source

Construction activity	Emissions (tCO_2e)
Transport of materials	1,034
Construction activities	1,816
TOTAL	**2,850**

Assumptions used in calculating the above emissions are set out below:

- It was assumed that all machinery and vehicles were re-fuelled every 2 days on average.

The machinery and relative fuel capacity of the vehicles used during Phase 3 are assumed to be as set out in the following tables:

Table 12: Specifications for machines/vehicles used during earthworks, drainage and utilities installations

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
20 tonne truck	12.5	410
Backhoe	N/A	170
Static Roller	N/A	100
Piling drilling rig	N/A	1100
Delivery trucks	N/A	150
Concrete agitators	N/A	410
Concrete pumping equipment	N/A	300
Mobile cranes	N/A	400
Air compressor	N/A	300

The estimated program for the earthworks, drainage and utilities installations phase of the project along with estimated machine/vehicle days and associated fuel use are outlined within Table 13.

Table 13: Summary of assumptions for machinery use associated with earthworks, drainage and utilities installations

Construction activity	Estimated works time (machine days)	Estimated fuel use (L)	Fuel type
Rail siding construction	3,360	636,960	Diesel
Gantry rail construction	2,232	418,680	Diesel

*Construction work days were assumed to be 8 hours a day and 6 days a week

2.4 Phase 4 – Pavement construction and ancillary works

The estimated emissions from Phase 4 of construction were ***4,547 tCO2e***. The breakdown of these emissions is detailed in the following sections.

2.4.1 Construction activities and Emissions sources

Phase 4 includes the following construction activities:

- Pavement construction; and
- Ancillary works.

Figure 9 illustrates the estimated GHG emissions quantities and relative proportions from each construction activity in Phase 4.

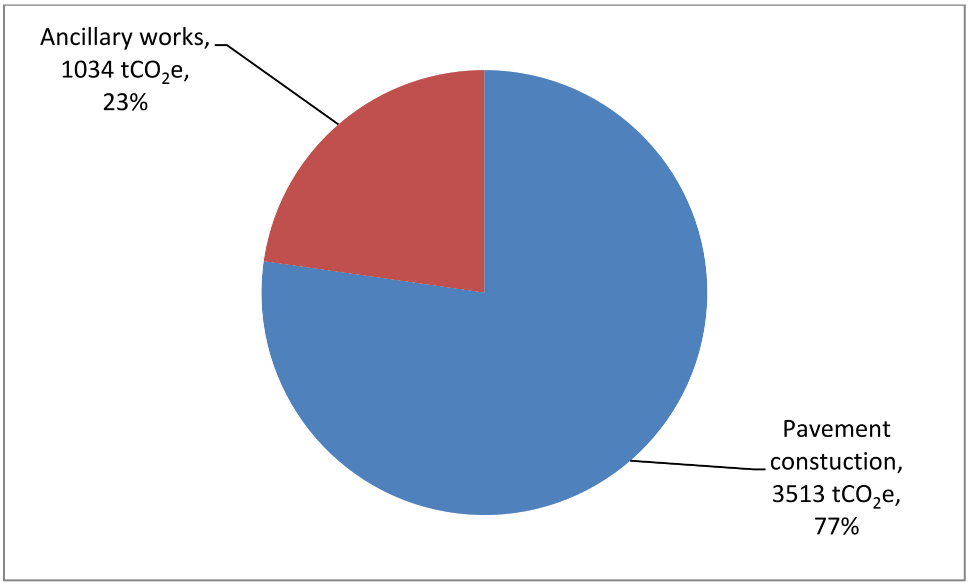


Figure 9: Emissions breakdown for pavement construction and ancillary works phase by construction activity

These are detailed further in Table 14.

Table 14: Summary of GHG emissions from pavement construction and ancillary works by construction activity

Construction activity	Emissions (tCO_2e)
Pavement construction	3,513
Ancillary works	1,034
TOTAL	**4,547**

For the purposes of this assessment, emissions from pavement construction and ancillary works phase included the following direct emissions sources:

- Fuel use from transport of materials; and
- Fuel use from construction activities.

Figure 10 illustrates the breakdown of emissions sources during the pavement construction and ancillary works phase.

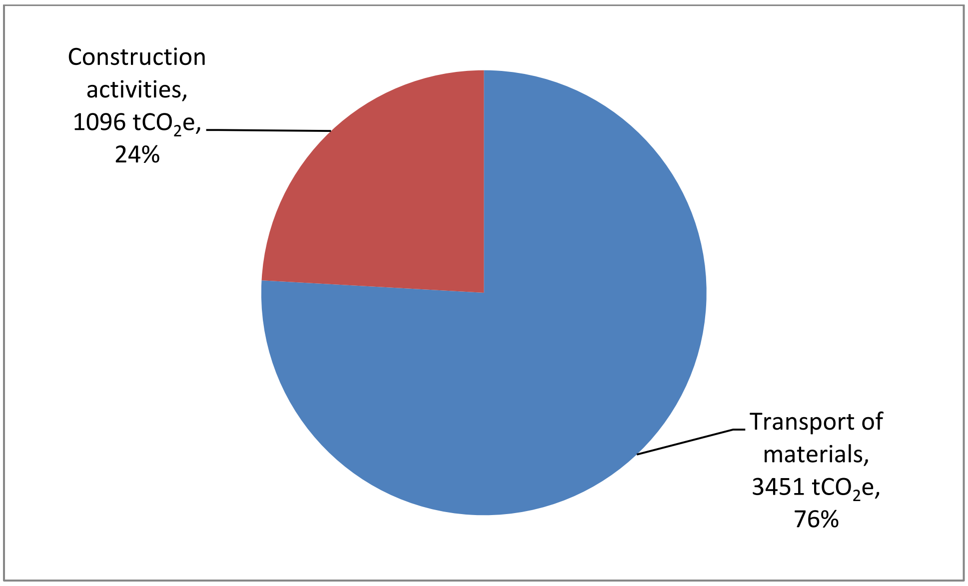


Figure 10: Emissions breakdown for pavement construction and ancillary works by emissions source

These are detailed further in Table 15.

Table 15: Summary of GHG emissions from pavement construction and ancillary works by emissions source

Construction activity	Emissions (tCO_2e)
Transport of materials	3,451
Construction activities	1,096
TOTAL	**4,547**

Assumptions used in calculating the above emissions are set out below:

- It was assumed that all machinery and vehicles were re-fuelled every 2 days on average.

The machinery and relative fuel capacity of the vehicles used during Phase 4 are assumed to be as set out in the following tables:

Table 16: Specifications for machines/vehicles used during pavement construction and ancillary works

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
20 tonne truck	12.5	410
Backhoe	N/A	170
Static Roller	N/A	100
Mobile crane	N/A	400
Delivery trucks	N/A	150
Concrete agitators	N/A	410
Concrete pumping equipment	N/A	300
Excavator	N/A	410

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
Air compressor	N/A	300

The estimated program for pavement construction and ancillary works along with estimated machine/vehicle days and associated fuel use are outlined within Table 17.

Table 17: Summary of assumptions for machinery use associated with pavement construction and ancillary works

Construction activity	Estimated works time (machine days)	Estimated fuel use (L)	Fuel type
Pavement construction	8,424	1,301,040	Diesel
Ancillary works	2,736	383,040	Diesel

*Construction work days were assumed to be 8 hours a day and 6 days a week

2.5 Phase 5 – Building structures

The estimated emissions from Phase 5 of construction were ***3,164 tCO2e***. The breakdown of these emissions is detailed in the following sections.

2.5.1 Construction activities and Emissions sources

Phase 5 includes the following construction activities:

- Building construction; and
- Warehouse construction.

Figure 11 illustrates the estimated GHG emissions quantities and relative proportions from each construction activity in Phase 5.

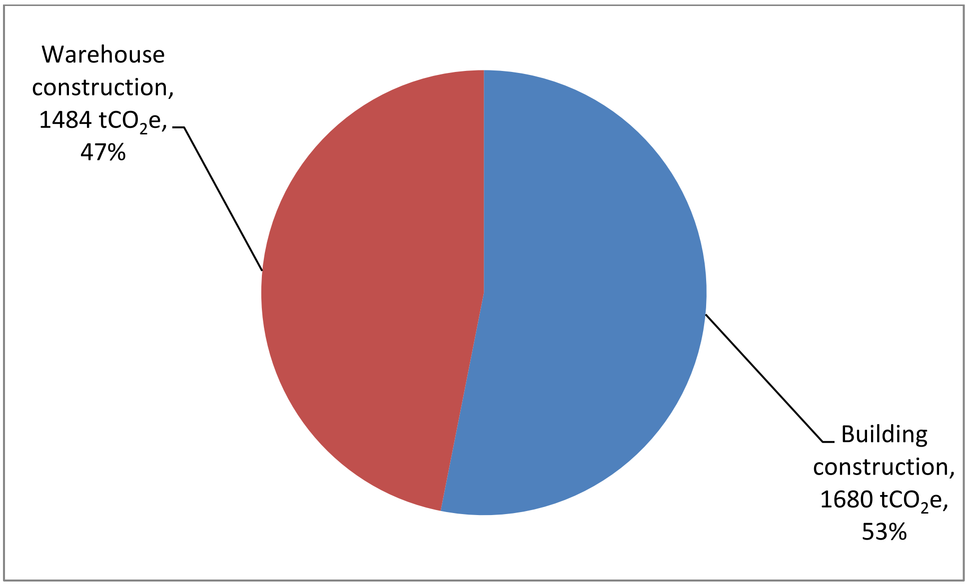


Figure 11: Emissions breakdown for building structures by construction activity

These are detailed further in Table 18.

Table 18: Summary of GHG emissions from building structures by construction activity

Construction activity	Emissions (tCO_2e)
Building construction	1,680
Warehouse construction	1,484
TOTAL	**3,164**

For the purposes of this assessment, emissions from building structures phase included the following direct emissions sources:

- Fuel use from transport of materials
- Fuel use from construction activities

Figure 12 illustrates the breakdown of emissions sources during the building structures phase.

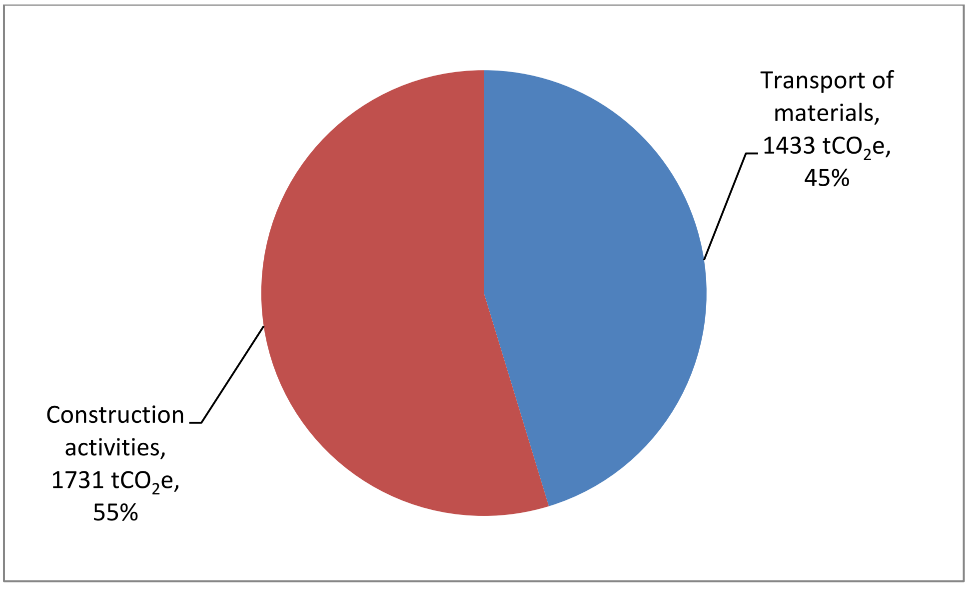


Figure 12: Emissions breakdown for building structures by emissions source

These are detailed further in Table 19.

Table 19: Summary of GHG emissions from building structures by emissions source

Construction activity	Emissions (tCO_2e)
Transport of materials	1,433
Construction activities	1,731
TOTAL	**3,164**

Assumptions used in calculating the above emissions are set out below:

- It was assumed that all machinery and vehicles were re-fuelled every 2 days on average;

- It was assumed that approximately 22kg/m^2 of steel is required in the construction of a typical warehouse and 24kg/m^2 of steel is required in the construction of the cold storage warehouse. These assumptions include structural steel elements and purlins/girts supporting the roof/wall sheeting and also cladding of the entire warehouse. The reinforcement in concrete was assumed as 6kg/m^2; and
- The steel provider was assumed to be in Greystanes at a distance of 20km from the site and is assumed to be transported using a 20 tonne semi-trailer. Table 20 and 21 summarises the total distance to be covered to transport concrete and steel, the number of truck days and the associated fuel consumption.

The machinery and relative fuel capacity of the vehicles used during Phase 5 are assumed to be as set out in the following table.

Table 20: Specifications for machines/vehicles used during building structures

Machine and model required	Capacity (m^3)	Fuel tank capacity (L)
20 tonne truck	12.5	410
Backhoe	N/A	170
Static Roller	N/A	100
Mobile crane	N/A	400
Delivery trucks	N/A	150
Concrete agitators	N/A	410
Concrete pumping equipment	N/A	300
Cherry picker	N/A	150
Air compressor	N/A	300

The estimated program for building structures and ancillary works along with estimated machine/vehicle days and associated fuel use are outlined within Table 21.

Table 21: Summary of assumptions for machinery use associated with building structures and ancillary works

Construction activity	Estimated works time (machine days)	Estimated fuel use (L)	Fuel type
Transport of materials	4,320	622,440	Diesel
Construction activities	3,600	549,453	Diesel

*Construction work days were assumed to be 8 hours a day and 6 days a week

2.6 Operation of site offices

Six site offices are assumed to be on the site during phase 1 - 4. Each office is assumed to have an area of about 18m^2 with a demand of 50VA/m^2. It is assumed that these offices are powered by mains energy with a power factor of 0.95. This results in electricity consumption of approximately 16,370.5 kWh which equates to estimated emissions of 15 tCO_2e during these phases. During Phase 5 of construction, it is estimated that twenty site offices are required with an area of 18m^2 with a demand of 50VA/m^2. It is assumed that these offices are powered by mains energy with a power factor of 0.95 for a further 18 months of construction, resulting in electricity consumption of approximately 54,568.4 kWh. This equates to an estimated emissions of 48 tCO_2e. During the entire construction phase, the total estimated emissions are approximately ***63 tCO2e***.

2.7 Total GHG emissions: site preparation and construction

Figure 13 illustrates the breakdown of emissions from the construction phase. It can be seen that phase 2 and 4 are the most significant emissions sources during the construction phase. This is closely followed by emissions resulting from phase 3 and 5. It is important to note that composting of the vegetation waste significantly reduces the resulting emissions from the decomposition of vegetation waste.

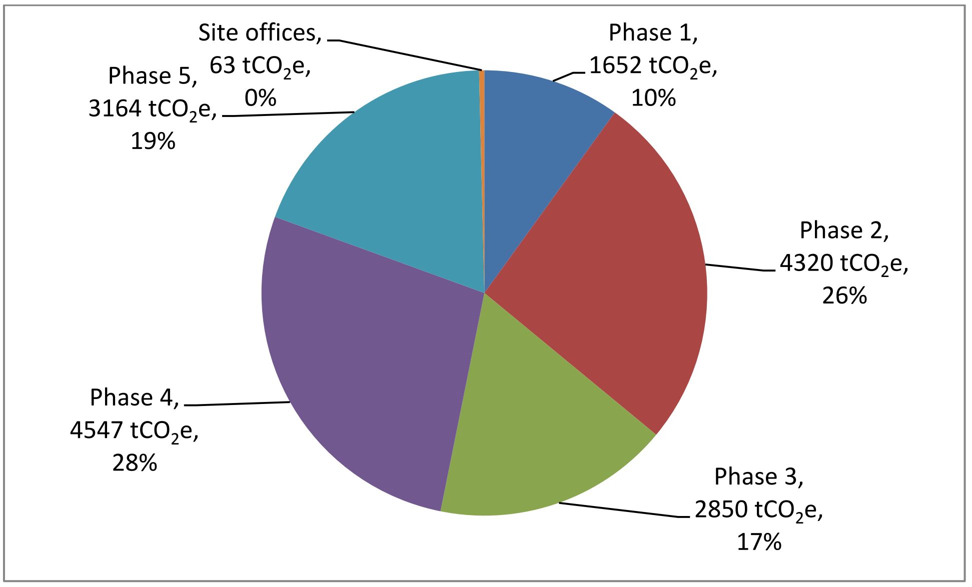


Figure 13: Emissions breakdown by construction phase

3 Embodied emissions of materials

This section of the report has been prepared by Edge Environment on behalf of Hyder Consulting to estimate embodied greenhouse gas emissions (GHGs) in construction material and products used in this project. The following sections are taken from Edge Environments full report which is available in Appendix A

3.1 Background and methodology

3.1.1 Life cycle assessment

Life cycle assessment (LCA) addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave).

Australian life cycle inventory database

The Australian Life Cycle Inventory (AusLCI) Data Guidelines are being developed to provide the rules for data collection for the AusLCI Database. The Guidelines have been developed by the Guidelines committee of the AusLCI data project after a consultative session held in the latter half of 2008. The development has been informed by the Ecoinvent data guidelines (a Swiss global database project) and the US LCI guidelines.

The ultimate objective of the project is to develop publicly available LCI data modules for commonly used, generic materials, products and processes. This is important to support public, private, and non-profit sector efforts to undertake product LCAs and LCA-based decision support systems and tools such as eco-labels, environmental impact calculators and simplified design tools.

The AusLCI database was launched at the 7th Australian LCA Conference in Melbourne in March 2011. AusLCI resources are available at www.auslci.com.au.

Australian LCA dataset

The Australian LCA Dataset supplied with the SimaPro software has traditionally been the most widely used LCA data in Australia. This data mostly originates from research undertaken by Royal Melbourne Institute of Technology (RMIT) and CSIRO. Where required data are not available, Edge Environment has used data from the Ecoinvent database, which originates from the Ecoinvent Centre in Switzerland and compiles data for most European countries. The Australian LCA Dataset comes with the Australasian version of the SimaPro software.

Building products life cycle inventory (BP LCI)

To facilitate the reduction of environmental impacts of buildings in Australia, the building and construction materials and products sector, represented by the Building Products Innovation Council (BPIC), are committed to help the Australian community make informed, research based and level playing field decisions about the environmental impact of building material and products. The method used to facilitate this outcome is based on a whole of life or full LCA methodology, as guided by international standards, and enables access to Life Cycle Inventory (LCI) data for the purposes of conducting LCAs.

It is the intention of the building and construction materials and products industry sector that the LCI data will be widely used by LCA professionals to make informed decisions that can assist in the reduction of CO_2 and other building environmental impacts.

To facilitate this, the publically available BP LCI tool kit includes:

- Methodology Guidelines for the Materials and Building Products Life Cycle Inventory Database, adapted from the AusLCI Guidelines Committee Draft Guidelines for Data Development for an Australian Life Cycle Inventory Database. The adaptations interprets consensus from the BPIC Project's Technical Working Group and input from BPIC contributing member associations facilitated to discuss LCI/LCA methodology;
- The Methodology Guidelines describe how life cycle inventory data will be consistently compiled for Australian construction materials and building products, the Protocol describes how the data is to be used appropriately to represent and evaluate building products, systems and materials. Uses of the building and construction materials and products life cycle inventory data that do not comply with this Protocol are not considered to be appropriate uses of the data; and
- The life cycle impact assessment (LCIA) reports recommending methodology and factors for impact assessment.

These documents and additional components in the BP LCI tool kit are available on: http://www.bpic.asn.au/LCIMethodology.htm

3.1.2 Methodology

The embodied GHG assessment has been conducted according to the following methodology:

1. Goal and scope workshop between Edge Environment and Hyder project teams.
2. Compile 'bill of materials' based inputs/outputs and processes included in the assessment.
3. Determine quantities of inputs/outputs and processes from drawings and consultation with Hyder to estimate material quantities.
4. Model the inventory data in accordance with the *BPIC/ICIP Project's Methodology Guidelines for the Materials and Building Products Life Cycle Inventory Database*. Economic allocation was used to determine the impacts between primary (e.g. steel production) and retained burden (if any) in recycled or re-used products.
5. Carbon Footprint assessment: Edge Environment modelled the inventory flows in the SimaPro LCA database system (v7.2.4), linking it to existing life cycle environmental impact for upstream and downstream components. Edge Environment will use:
   - **a** Generic Australian life cycle data
   - **b** Generic International life cycle data where Australian data is not available
   - **c** Generic life cycle data for analogous processes where specific process data are not available
   - **d** Best estimates of life cycle impacts by analogy to similar processes where no data is available
6. Sensitivity analysis and scenario modelling will be used to demonstrate the influence of key assumptions to the overall result and conclusions.

3.2 Assumptions

The following assumptions were used as part of this assessment.

3.2.1 System diagram and major emission sources

Figure 14 shows the main input, outputs and project activities in terms of GHG emissions.

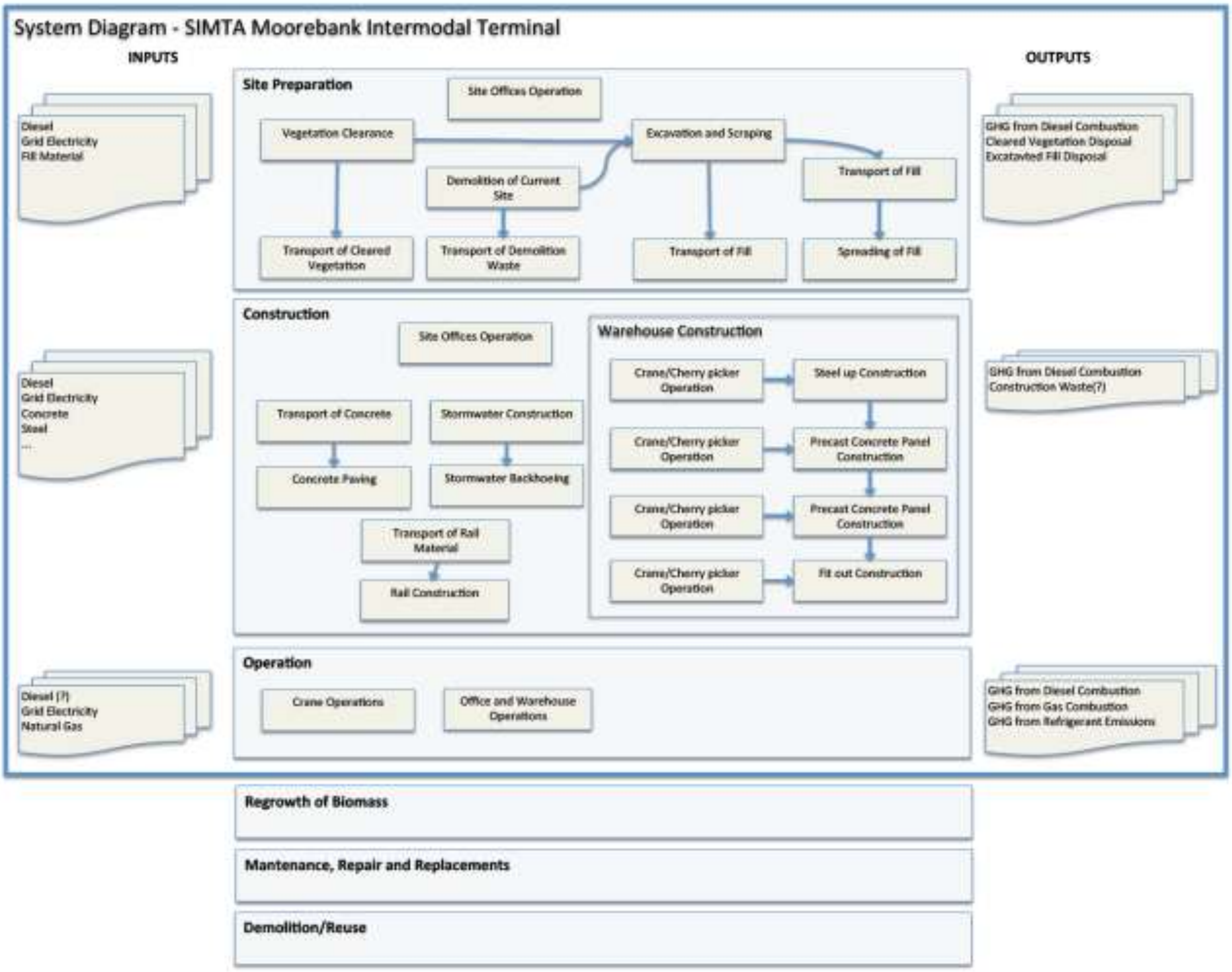


Figure 14: Schematic overview of the project GHG assessment system

Hyder Consulting undertook an assessment of the GHG emissions associated with:

- On-site fuel combustion and electricity consumption from site preparation, construction and operation;
- Transport of material, products and waste to and from site; and
- Decomposition of organic waste on- and off-site.

The proposed scope for assessing embodied construction material and product GHG emissions includes:

- Permanent piping material for stormwater infrastructure;
- Concrete paving, including mesh and bar reinforcement;
- Rail lines; and
- Warehouse structure, including steel frame, roof and wall sheets and insulated panels.

Note: GHG emissions from end of life of Moorebank Intermodal Terminal Facility have been excluded from the assessment due to large uncertainties in terms of degree of re-use of facilities and infrastructure, as well as degree of re-use, recycling and disposal of construction materials.

3.2.2 Project material quantities and use scenarios

The following scenarios are modelled in order to explore key data sensitivities and embodied greenhouse gas emission reduction potential:

1. Baseline scenario based on best available conservative data;
2. Cement substitution material scenario exploring 20% of Portland cement substituted with fly ash in the concrete; and
3. Concrete pavement slab thickness reduction by 20%.

3.2.3 Scenario 1: Baseline

The following assumptions (all subject to refinement/confirmation by the design team) have been used to establish the project construction material inventory:

- Surplus of on-site cut to fill will be used on site with assumed negligible import and disposal impact;
- 32MPa concrete for pavement, with no cement substitution materials (CSM);
- Mesh reinforcement of concrete pavement, i.e. no bar reinforcement;
- Added 500m of PVC plastic pipe for stormwater infrastructure;
- Added Steel sheet warehouse walls (1.6kg/m^2) and roof (5.0kg/m^2);
- Added reinforced concrete wall sections for the warehouse; and
- Added rail line material quantities for an estimated 3km rail line track for the project[3].

Table 22: Project construction material quantities

Phase	Material	Quantity (t)	Quantity (m3)	Quantity (m2)	Density (t/m3)	Density (t/m2)	Density (t/m)	Length (m)
Site Preparation								
	Fill material							
Construction								
	Pavement							
	Concrete 32MPa	996,000	415,000		2.4			
	Mesh Reinforcing Steel	2,158						

[3] Based on information from the following sources:

Review of CO2-e Emissions from Concrete versus Timber Sleepers, Energy Strategies, last viewed 16 November 2010, <http://www.enerstrat.com.au/lib/documents/Review-of-CO2-Emissions-from-Concrete-versus-Timber-Sleepers.pdf>.

Concrete Sleepers (Heavy Duty) – Design, Australian Rail Track Corporation Ltd, last viewed 16 November 2010, <http://extranet.artc.com.au/docs/engineering/common_standards/track/etd_02_03_concrete_sleepers_heavy_design.pdf>.

Railway and Tramway Sleepers, Queensland Government Department of Primary Industries and Fisheries, last viewed 16 November 2010, <http://www.cqfa.com.au/documents/1181619278_sleepers_fact_sheet.pdf>.

AS1085.1-2002 Railway and Track Materials Part 1: Steel Rails, Australian Standard, last viewed 16 November 2010, <http://www.saiglobal.com/PDFTemp/Previews/OSH/as/as1000/1000/1085.1-2002(+A1).pdf>.

Phase	Material	Quantity (t)	Quantity (m3)	Quantity (m2)	Density (t/m3)	Density (t/m2)	Density (t/m)	Length (m)
Stormwater								
	Plastic Pipe	15			30.0			0.5
Warehouse								
	Structural Steel (typical)	5,072						
	Structural Steel (cooling)	480						
	Mesh Reinforcing Steel	1,383						
	Steel Sheet (walls)	1,253				0.0050		
	Steel Sheet (roof)	401				0.0016		
	Precast Concrete Panels (Wall)	23,227				0.0927		
	Precast Concrete Panel (Wall reinf.)	376				0.0015		
	Insulated Panel							
Rail Line								3,000
	Steel Rail	180					0.060	
	Sleeper Reinforcement	22					0.0072	
	Sleepers (concrete)	855					0.285	
	Aggregate	5,970					1.990	

3.2.4 Scenario 2: Cement substitution material

In this scenario 20% of Portland cement in the concrete pavement is substituted by fly ash from NSW coal fired power station. See section 7.1.1 below for more details on cement substitution.

3.2.5 Scenario 3: Pavement thickness

In this scenario the concrete pavement is reduced by an average of 20% to explore the overall sensitivity to a key project parameter affecting the overall embodied greenhouse gas emission assessment.

3.3 Embodied GHG impact results

3.3.1 Scenario 1: Baseline

- The total embodied GHG emissions in construction materials were calculated as 196 or approximately 27 times the previously estimated GHG emissions from the construction phase (excluding material impacts). However, the embodied construction material impacts only account to approximately the equivalence of three years of operation.

Embodied GHG emissions by construction activity/phase are presented in Figure 15 and Table 23**.**

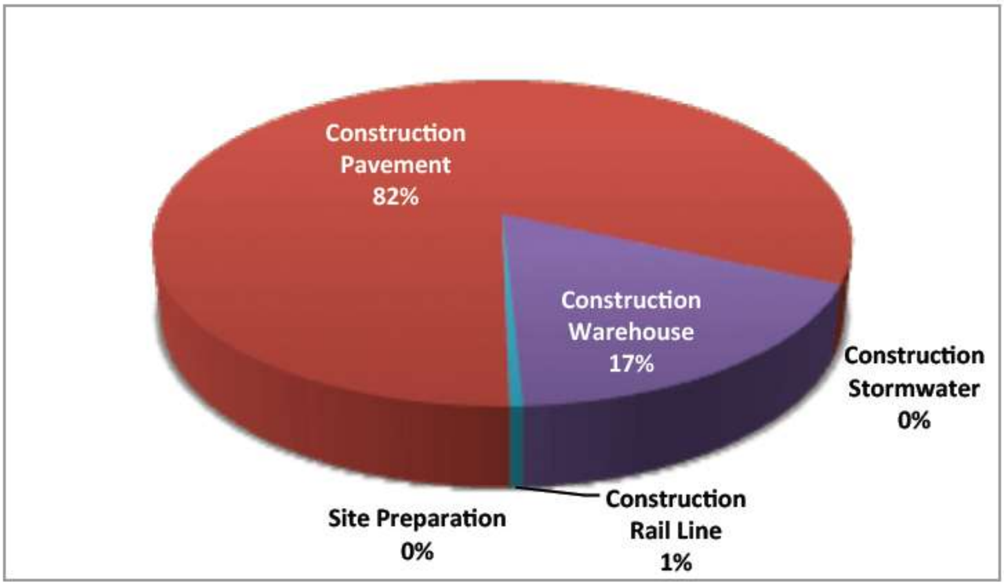


Figure 15: Embodied material GHG emissions by construction activity

Table 23: Embodied construction material GHG emissions by construction activity

Construction Activity/Phase	tCO_2-e
Site Preparation	0
Construction Pavement	161,022
Construction Stormwater	33
Construction Warehouse	34,134
Construction Rail Line	1,012

Figure 16 and Table 24 show GHG emissions by construction material category/type.

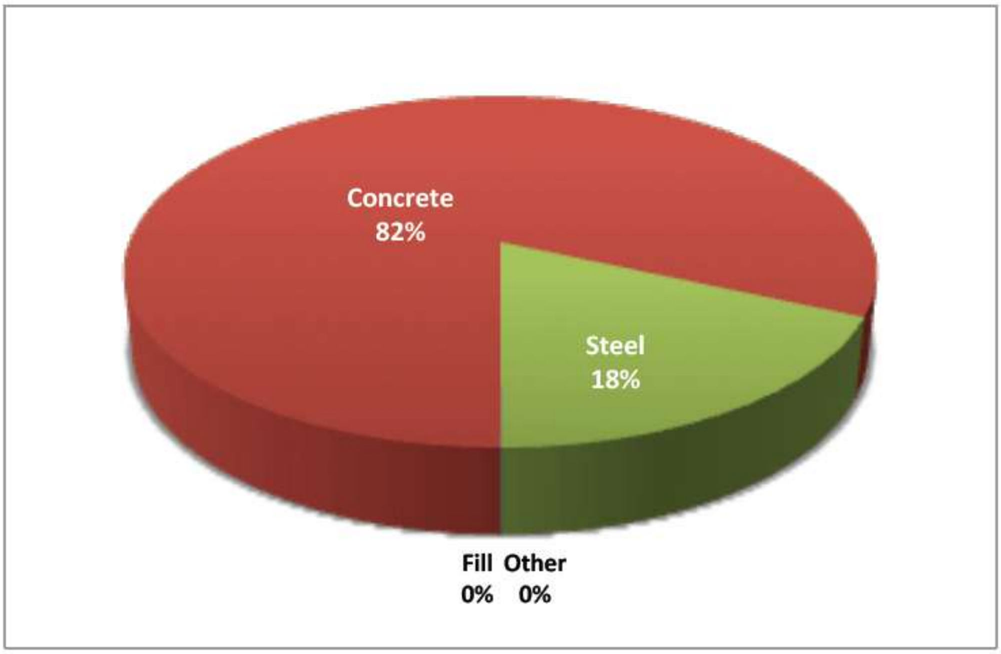


Figure 16: Embodied GHG emissions by material category

Table 24: Embodied construction material GHG emissions by material type

Material Category/Type	tCO_2-e
Fill	24
Concrete	160,337
Steel	35,808
Other	24

Figure 17 and Table 25 show GHG emissions by steel type/use.

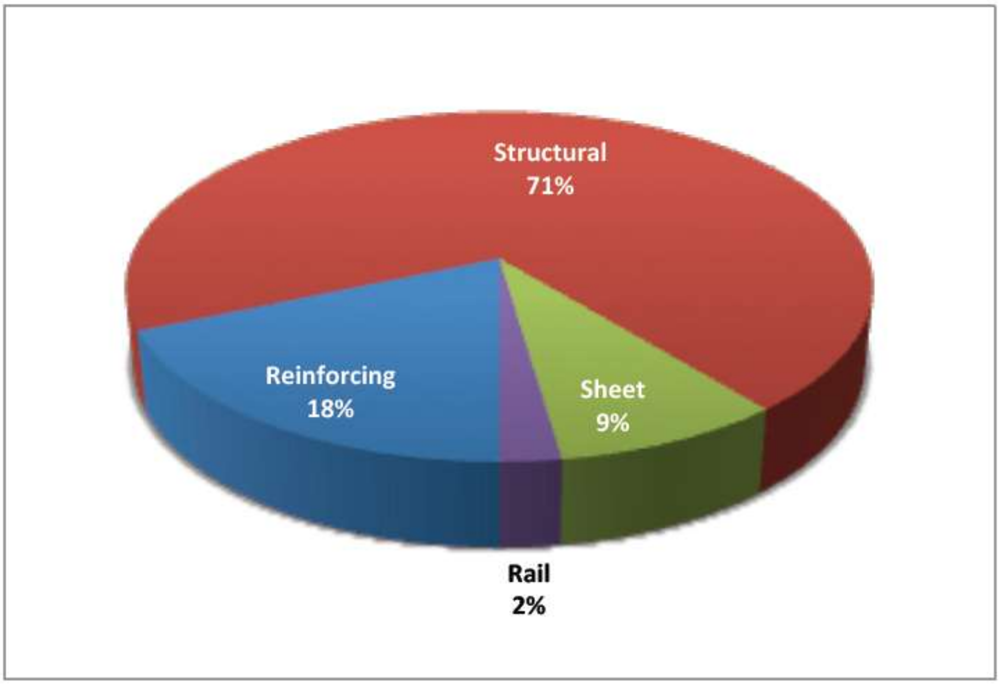


Figure 17: Embodied GHG emissions by steel type/use

Table 25: Embodied steel GHG emissions by type/use

Steel type/Use	tCO_2-e
Reinforcing	6,619
Structural	25,286
Sheet	3,084
Rail	820

Further GHG breakdown and detail from concrete use will be added if/when more details are available on concrete grades used for the project construction elements.

Scenario 2 and 3

The embodied GHG results from scenario 2 and 3 described above show:

- 172 ktCO2-e in scenario 2; and
- 165 ktCO2-e in scenario 3.

Overall the scenario have 12% and 16% reduction in overall GHG embodied emission, and 15% and 20% reduction of GHG emissions in the concrete pavement by replacing 20% of Portland cement with fly ash and reducing the pavement thickness by 20% respectively.

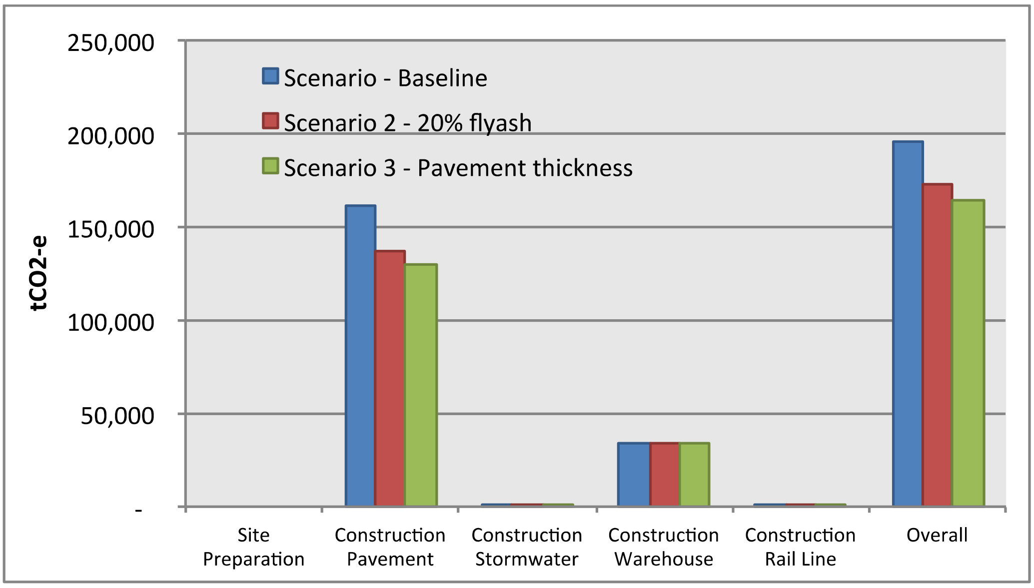


Figure 18: Embodied GHG emission scenario comparison.

4 Operational Greenhouse Gas Emissions

This section will outline the GHG emissions associated with the operation of the specific site. The intermodal terminal is expected to house the following facilities:

- Container hardstand areas;
- Ancillary facilities;
- Warehousing areas (including cold storage);
- Office spaces; and
- Green space.

The main sources of GHG emissions emitted from the operational activities within these areas are expected to be from:

- Electricity use (including lighting, heating, cooling, ventilation and crane use); and
- Natural gas use on-site.

This section will also estimate the electricity demand of an alternative scenario where the SIMTA facility has not been developed. The alternative scenario is based on a number of assumptions which are detailed in the relevant section.

4.1 Electricity use – SIMTA facility

The range of activities (along with details and assumptions) to be conducted on the site during the operational phase is shown in Table 26, along with a description of each activity and the assumptions applied in determining the GHG emissions. Where applicable, the average energy demand stipulated in AS3000:2007 was applied. Where the standard was not applicable, an estimate of energy demand was provided by Hyder's electrical engineers based on similar projects.

Although the site will be operating 24 hrs/day it will not be at full capacity across all activities. The hours of operation per day for each type of activity are based on the number of hours that the activity will occur at full demand.

During the operational phase, the total GHG emissions from electricity use on the site have been calculated to be ***50,651 tCO_2 per annum***.

Table 26: Activities using electricity and the GHG emissions

Operational activity	Details & assumptions	Emissions (tCO_2e)
Container hardstand area	▪ The container hardstand areas are the areas where containers are transferred and stored. ▪ Area of site = 90,251 m^2 ▪ VA/m^2 = 10 ▪ PF = 0.95 ▪ Hrs operation/day = 10	▪ Per day = 8.5 ▪ Per annum = 3,086
Green space	▪ Green spaces include energised, landscaped and non-paved areas ▪ Area of site = 65,013 m^2 ▪ VA/m^2 = 5 ▪ PF = 0.95 ▪ Hrs operation/day = 10	▪ Per day = 3.0 ▪ Per annum = 1,112
Ancillary facilities	▪ Ancillary facilities include food courts and other	▪ Per day = 6.1

Operational activity	Details & assumptions	Emissions (tCO_2e)
	commercial areas ▪ Area of site = 13,090 m^2 ▪ VA/m^2 = 50 ▪ PF = 0.95 ▪ Hrs operation/day = 10	▪ Per annum = 2,238
Warehousing – distribution	▪ Warehousing areas are all the warehouse except for the cold storage ▪ Area of site = 230,560m^2 ▪ VA/m^2 = 15 ▪ PF = 0.95 ▪ Hrs operation/day = 10	▪ Per day = 32.4 ▪ Per annum = 11,826
Office space	▪ Office space includes all the office spaces associated with the intermodal facility ▪ Area of site = 9,000 m^2 ▪ VA/m^2 = 75 ▪ PF = 0.95 ▪ Hrs operation/day = 10	▪ Per day = 6.3 ▪ Per annum = 2,308
Warehouse cold storage	▪ This includes one warehouse which is planned to be a cold storage warehouse ▪ Area of site = 20,000m^2 ▪ VA/m^2 = 100 ▪ PF = 0.95 ▪ Hrs operation/day = 24	▪ Per day = 45.0 ▪ Per annum = 16,413
Crane operation	▪ Ten cranes will be in use on the site; five large and five small ▪ Energy use was calculated based on the motors associated with all crane components (i.e. hoist, trolley travel and slewing) & the power rate ▪ Hrs operation/day = 5	▪ *5 x large per day = 25.0* ▪ *5 x small per day = 12.48* ▪ Total per day = 37.4 ▪ Total per annum = 13,668
TOTAL		▪ **Per day = 138.8** ▪ **Per annum = 50,651**

PF = power factor

4.2 Natural gas use – SIMTA facility

The activities using natural gas on the site include domestic hot water and food preparation. (note: room heating will be provided for by reverse cycle air conditioning).

Table 27: Energy usage from the use of natural gas

	Estimated population and their daily usage	mJ/hr
Hot water	▪ 4,051.2 staff using 5L hot water/day ▪ 256 hotel guests using 110L hot water/day ▪ 160 office staff using 75L hot water/ day ▪ Total hot water = 60,416L/ day	12,687mJ/hr based on a temperature rise of 50^{o}C.
Food preparation	▪ 256 patrons using 5mJ/hr ▪ 160 office staff using 20mJ/hr	3,413mJ/hr
Subtotal		16,100.8mJ/hr
TOTAL	▪ **Assuming 10hrs usage/day**	**161,008mJ/day**

The GHG emissions from 161,008 mJ/day of natural gas are equivalent to 8.3 tCO_2e/day or **3,017 tCO_2e/annum.**

4.3 Summary – SIMTA facility

The total estimated GHG emissions from operations based on the above boundary at the site is **147.0 tCO_2e/day** or ***53,668 tCO_2e per annum.*** The breakdown of these emissions is illustrated in Figure 19.

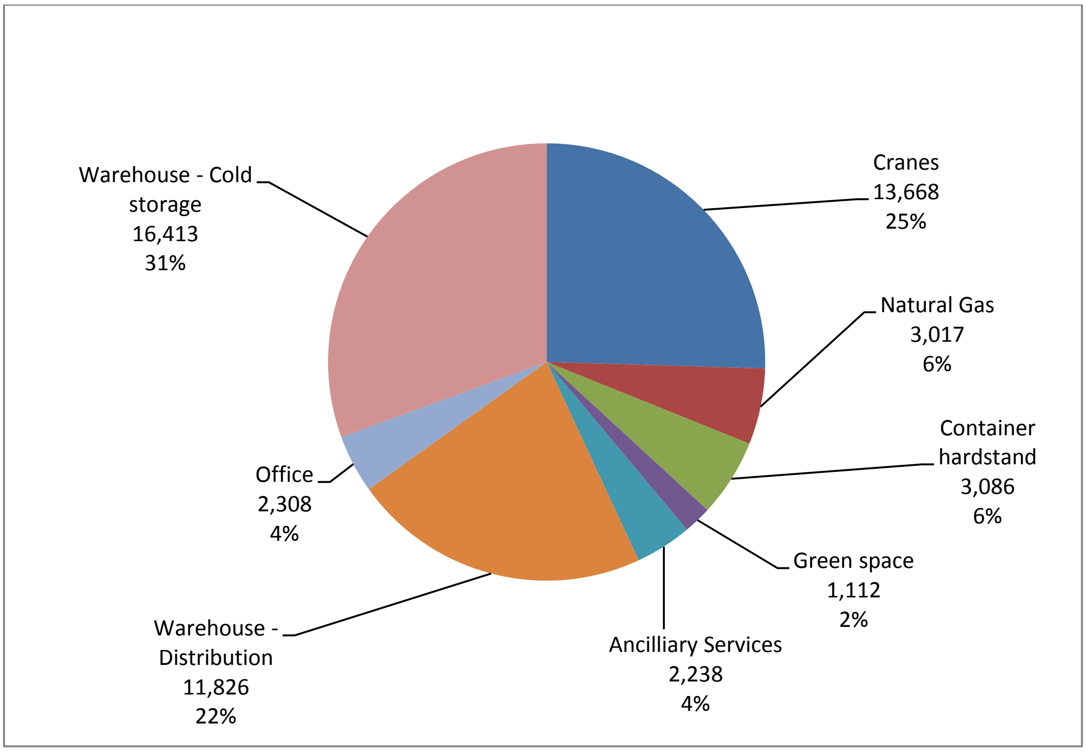


Figure 19: Emissions breakdown for SIMTA operations

Operational emissions of over 25,000 tCO2e/year at a facility will trigger reporting requirements under the National Greenhouse and Energy Reporting (NGER) Act 2007. Emissions from the SIMTA Moorebank ITF are likely to trigger the corporate reporting threshold of 50,000 tCO2e/year and responsible parties should be aware of the requirements under this legislation. The NGER act is based on corporate emissions and ownership of those emissions is based on operational control. All corporations with operational control of the SIMTA ITF should seek legal advice on liability under the NGER Act.

4.4 Operational emissions - Alternative scenario

The proposed SIMTA site has been zoned as 'General Industrial' (IN1) under the Liverpool Local Environmental Plan 2008. This is illustrated in Figure 20. Using the current LEP and the projected freight demand in the area, a feasible alternative scenario is that the site would be developed into industrial warehousing and distribution facilities rather than the proposed SIMTA intermodal freight transfer facility. This section estimates the emissions from such an alternative scenario for comparison with the proposed project.

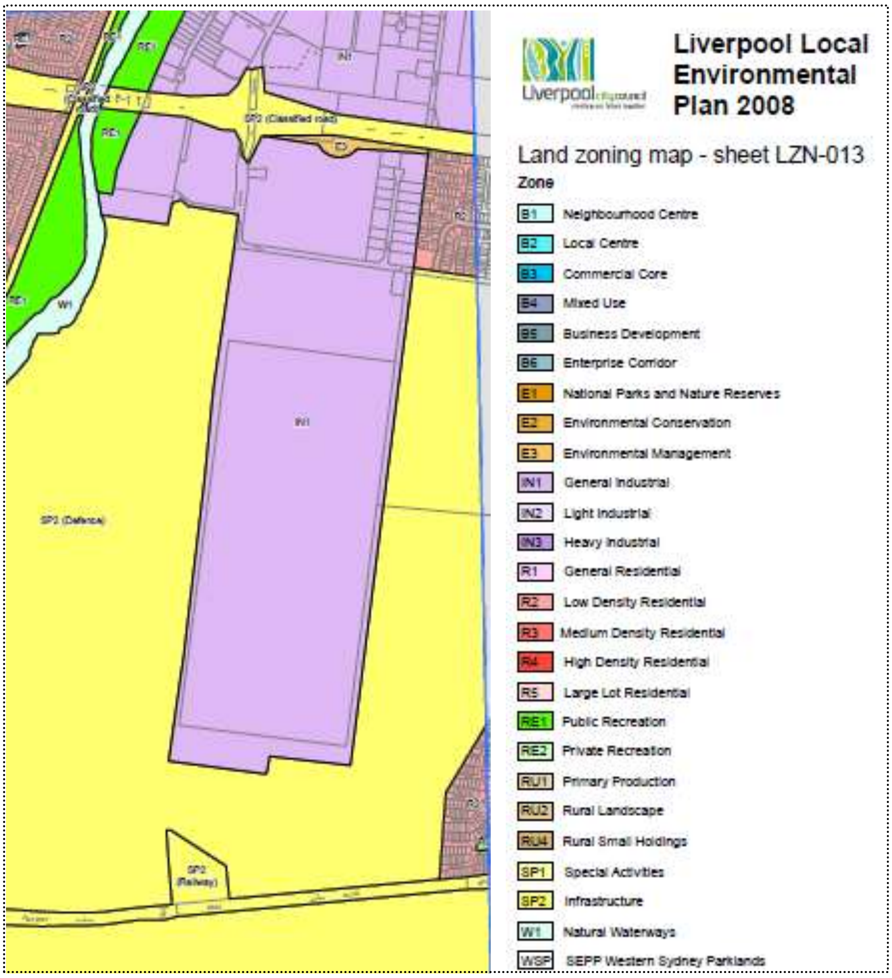


Figure 20: Current zoning of the proposed SIMTA site according to the Liverpool LEP 2008

In the alternative scenario it was assumed that 65% (54 hectares) of the site would be developed into industrial sites and 10% (8.3 hectares) would be offices associated with the industrial facilities. Under this scenario, the remaining 25% would remain undeveloped. The potential emissions from this alternative scenario can be estimated using the same electricity demands and power factor (PF) used for office space and industrial warehousing in the SIMTA proposal. The hours of operation were assumed to be 10 hours a day. The estimated emissions[4] and the associated assumptions for the alternative scenario are summarised in Table 28. The estimated emissions from electricity use in the alternative scenario are ***56,054 tCO_2e.***

Table 28: Estimated emissions from electricity use of the alternative scenario

Site type	Area (m^2)	Average demand (VA/m^2)	Power Factor (PF)	Total VA	kW	kWh/day (based on 10 hour days)	tCO_2e per annum
Industrial	539,500	15	0.95	8,092,500	8518	85184	27,672
Office	83,000	100	0.95	8,300,000	8737	87368	28,382
						Total Emissions	***56,054***

[4] Emissions were estimated using the DCCEE NGA factors and methods 2009

5 Freight transport operations

The proposed intermodal facility at Moorebank is intended to improve freight transport efficiency within the Moorebank freight catchment. Transporting freight by rail from Port Botany to the intermodal facility will result in a significant reduction in road transport from Port Botany to the Moorebank freight catchment. One train can capacitate transport of up to 81 TEU from Port Botany to the proposed facility, whereas one truck will accommodate 2 TEU of freight per trip. The consolidation of freight distribution facilities within the Moorebank freight catchment will also result in a central distribution point where freight can be efficiently delivered to end points within the catchment. The benefits of this consolidation are expected to be twofold:

1 A significant reduction in road traffic both within the local Moorebank area and surrounding associated region; and

2 A significant reduction in transport related emissions associated with the transfer of road transport to more efficient rail transport.

The logistical improvements as a result of the consolidation of freight distribution through the SIMTA facility are illustrated in the schematic diagram in Figure 21.

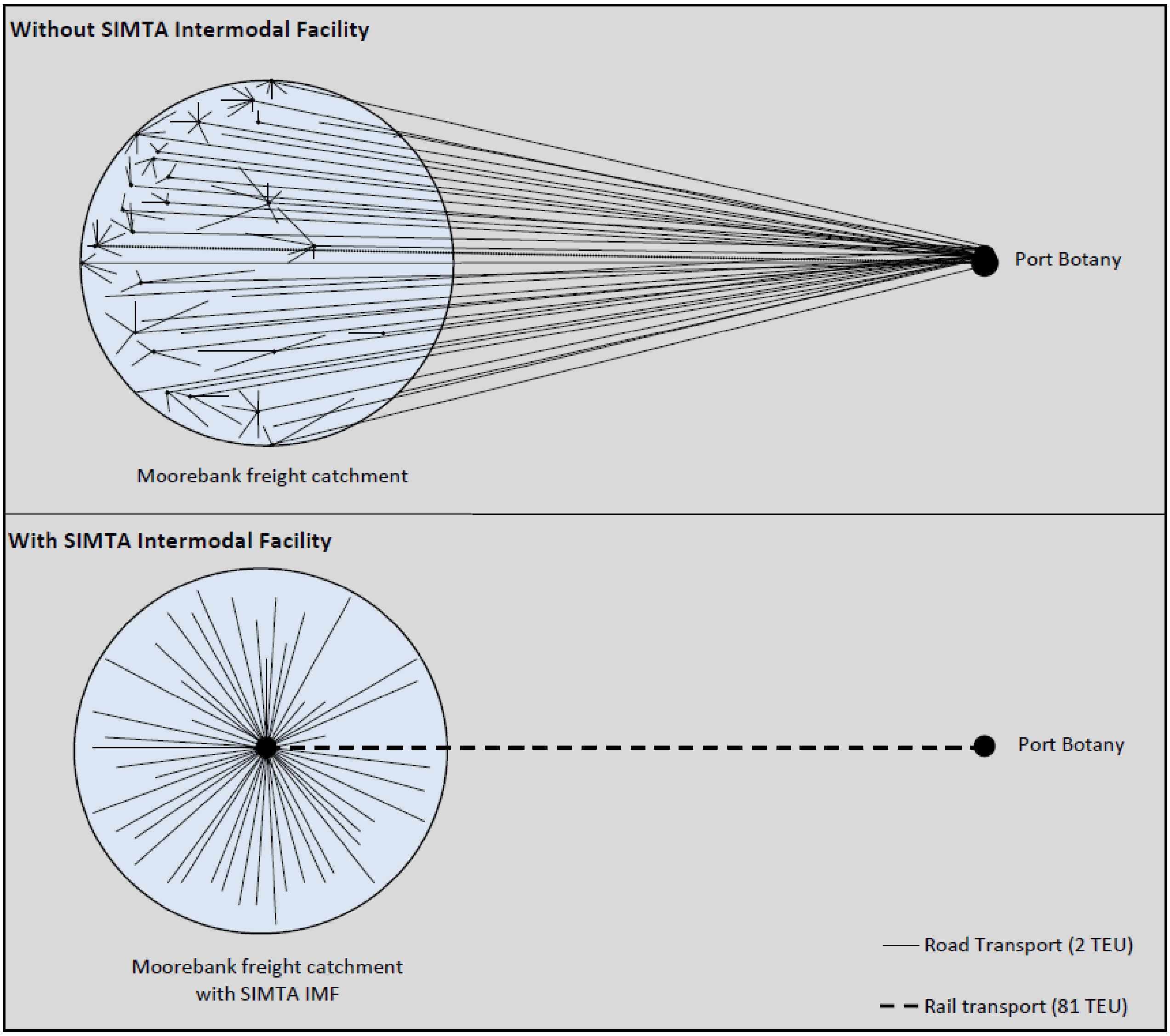


Figure 21: Schematic diagram showing freight transport from Port Botany without and with the proposed SIMTA intermodal facility.

The vehicle kilometres travelled (VKT) for road and rail freight were projected for 2031 when the intermodal facility is expected to be at full operational capacity. These projections have been made based on expected increases in freight demand by 2031. The 'without SIMTA' projection uses freight demand projections to estimate the VKT required using unconsolidated distribution facilities. The 'with SIMTA' projections use the same freight demand but estimates VKT required using the consolidated distribution centre proposed in this project. The projections are summarised in Table 29

Table 29: Comparison of VKT required to meet freight demands in the Moorebank catchment with and without the SIMTA facility

Freight Transport Type	Projected annual vehicle kilometres (VKT) required to meet freight demands in 2031		Difference
	Without SIMTA facility	With SIMTA facility	
Road	1,979,579,000	1,966,579,000	***13,000,000 (savings)***
Rail	0	332,000	***332,000 (increase)***

The traffic projections suggest that freight road transport from Port Botany will be reduced by approximately 13,000,000 VKT per annum regionally by the time the facility is fully operational. The resulting increase in rail transport as a result of the facility is projected to be approximately 332,000 VKT. Table 30 outlines the equivalent GHG savings from the reduction in road transport and the corresponding emissions increase due to increased rail transport using methods and factors from the greenhouse gas protocol (WBCSD 2011). The net emissions reduction from freight transport as a result of the SIMTA facility has been estimated at ***40,820 tCO2e***

Table 30: GHG estimates from freight transport as a result of the proposed intermodal facility

Freight Transport Type	Projected GHG emissions from estimated VKT in 2031 (tCO_2e)		Difference
	Without SIMTA facility	With SIMTA facility	
Road	7,228,013	7,180,546	***47,467(savings)***
Rail	0	6,647	***6,647(increase)***
		Net GHG savings/increase	***40,820 (savings)***

Use of rail to transport freight from Port Botany through the intermodal terminal to the Moorebank freight catchment can be considered approximately 40 times more efficient than transport by road to the same catchment area. This is due to the efficiencies gained from transporting much larger quantities of freight (81 TEU) by a single train journey as opposed to a single truck journey (2 TEU). Figure 22 demonstrates the GHG emissions savings that the SIMTA proposal will produce through the use of rail for freight transport to a consolidated intermodal facility compared to road freight transport to a number of distribution facilities dispersed around the catchment. It shows that the savings generated from reduced road transport significantly outweighs the increase in emissions from rail transport.

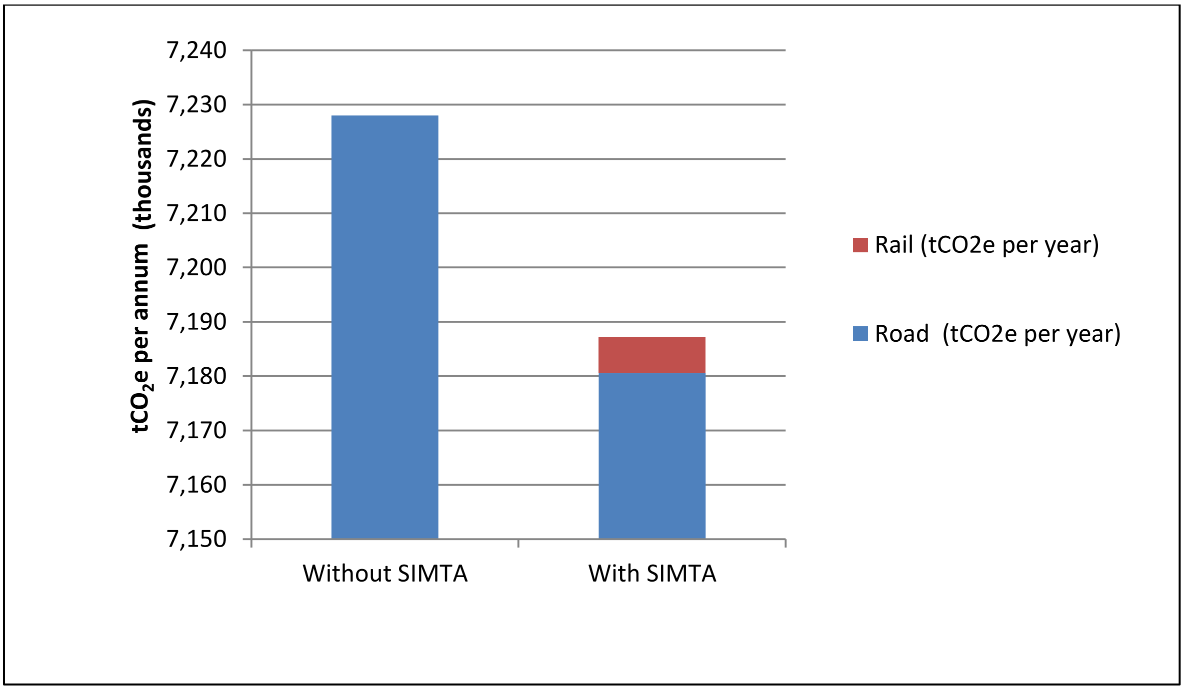


Figure 22: Estimated GHG emissions from freight transport with SIMTA site fully operational (2031)

6 Assessment of GHG Impact of Proposal

This section will summarise the overall GHG emissions from the SIMTA proposal. This will be compared against the emissions projected from an alternative scenario where the SIMTA facility is not developed, with the same freight demand and LEP zoning.

6.1 Summary of SIMTA GHG emissions

Figure 23 illustrates the comparison between the estimated emissions from the embodied emissions of materials, the construction phase and operation phase of this development. The emissions from operations are represented as annual emissions.

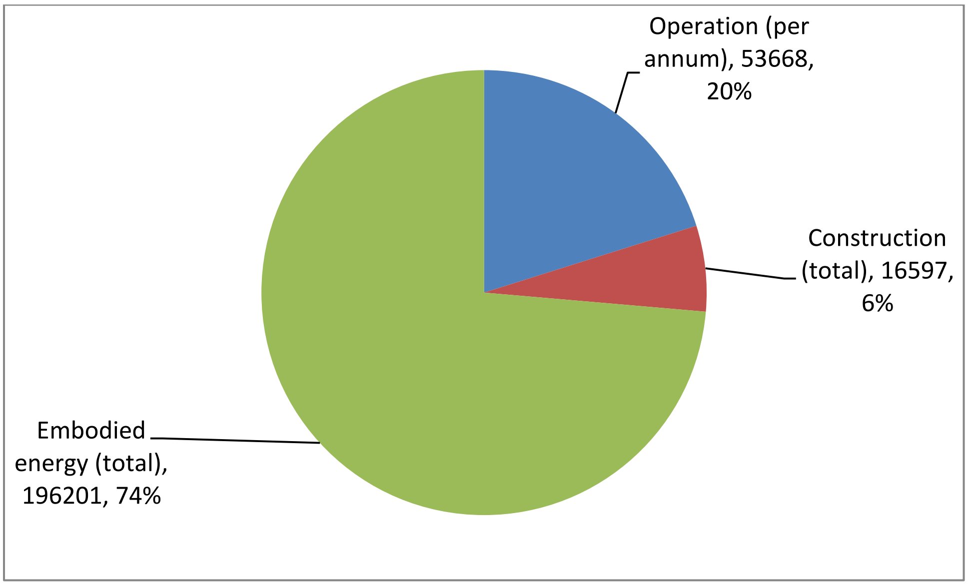


Figure 23: Emissions breakdown from construction and operational phases.

The construction emissions of 16,597 tCO_2e represents approximately 0.1% of emissions produced by the manufacturing and construction sector in NSW in 2007 (see Table 1). It is also likely that these emissions will be emitted over the course of several years which is the expected timeline of the development. The operational emissions of 53,668 tCO_2e/annum represents approximately 0.3% of emissions produced by the transport sector in NSW in 2007 (see Table 1).

6.2 Assessment against alternative scenario

Freight demand in the Moorebank area and the Liverpool LEP 2008 were used to develop an alternative scenario if the SIMTA site was not developed and operating. Table 31 summarises the emissions projected from the alternative scenario compared to those estimated from the SIMTA development. Embodied emissions and emissions associated with construction could not be determined for the alternative scenario with the available information. The consolidated SIMTA proposal results in a reduction of approximately 2,386 tCO_2e of GHG emissions when compared to the alternative scenario for site operations. For freight transport, the SIMTA proposal results in an annual emissions reduction of 40,820 tCO_2e due to efficiencies gained from switching freight transport from road to rail. Figure 24 illustrates the annual emissions savings as a result of the SIMTA proposal. Note that most of the operations emissions are a result of electricity use. These are indirect emissions as they are emitted at site of power production. The freight emissions are a direct result of burning diesel in the transport vehicles. The more significant savings are in the emissions associated with freight transport.

Table 31: Comparison of emissions between the SIMTA proposal and the alternative scenario

Scenario	Embodied Emissions tCO_2e	Emissions from construction tCO_2e	Emissions from site operation (per annum) tCO_2e	Total emissions from freight transport (per annum) tCO_2e
Alternative Scenario	N/A	N/A	56,054	7,228,013
SIMTA Proposal	196,201	16,597	53,668	7,187,193
Emissions savings from SIMTA proposal	***None***	***None***	***2,386***	***40,820***

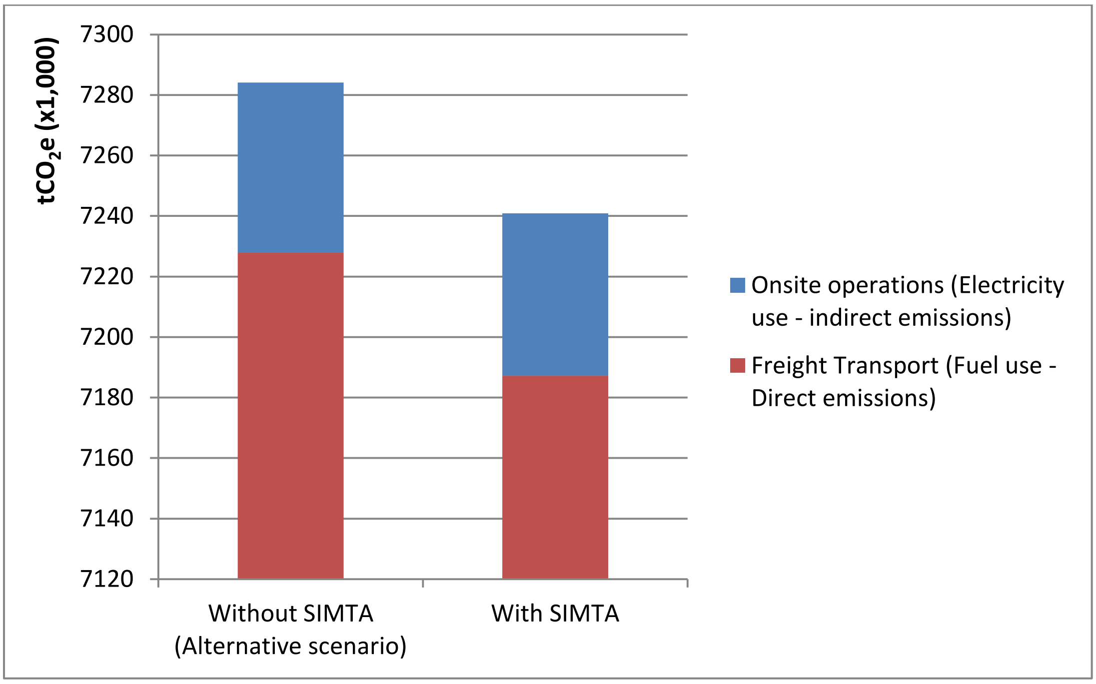


Figure 24: Comparison of emissions between the SIMTA proposal and the alternative scenario

The overall emissions savings from the SIMTA proposal over the alternative scenario is approximately ***43,206 tCO_2e per annum.*** Figure 25 shows the estimated annual emissions savings over a 6 year period where the savings will equalise the emissions from both the construction of the SIMTA facility and those embodied in the construction materials. Further emissions savings can be made during construction and operation of the SIMTA site through the implementation of GHG management and mitigation actions. These are described in further detail in the next section.

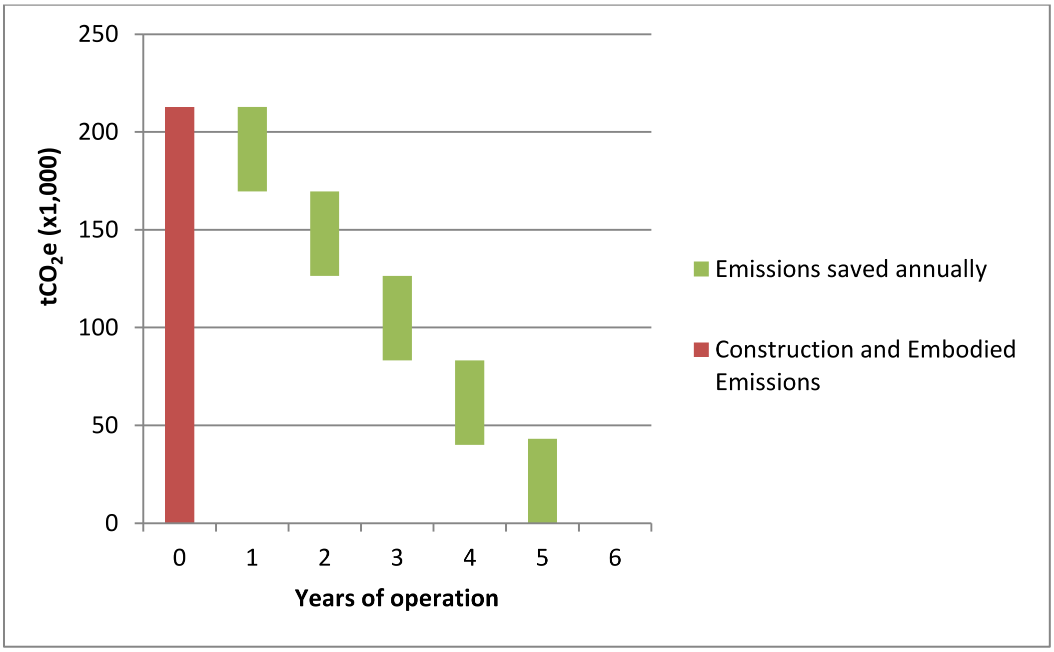


Figure 25: Annual emissions savings from the SIMTA development equalising construction and embodied emissions in approximately 6 years of operation compared to the alternative scenario.

7 GHG management and mitigation options

The carbon management principles (shown in Figure 26) provide a robust framework for the management and reduction of GHG emissions.

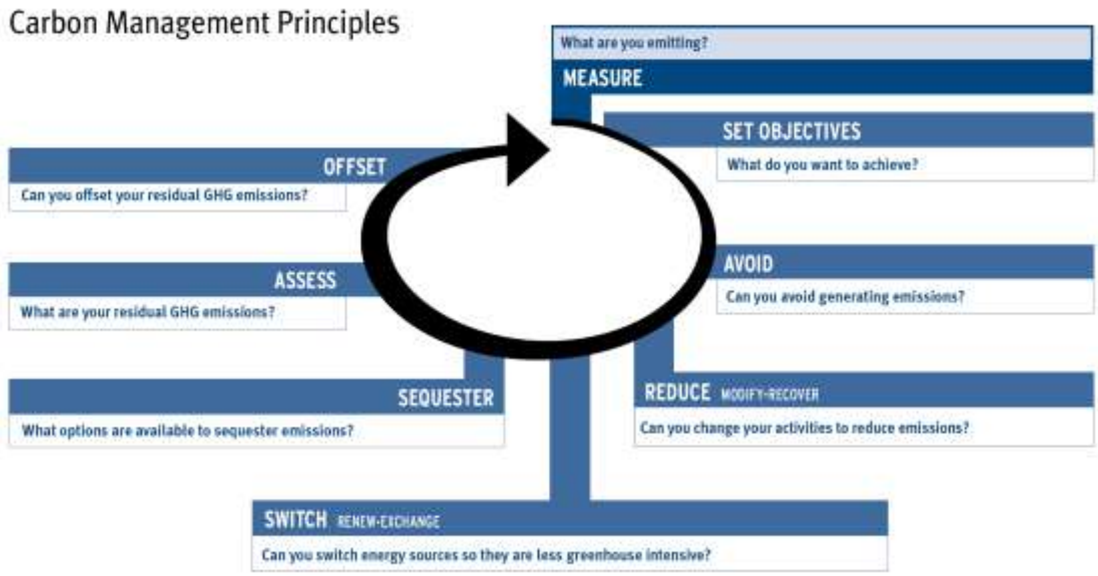


Figure 26: Carbon management principles for emissions reduction (Victorian EPA)

The earlier sections in this assessment represent the emissions measurement and setting objectives components of the carbon management principles. This section recommends actions to further reduce emissions throughout the project development. GHG emissions reduction actions should ideally be prioritised according to the carbon management principles.

- **Avoid**: Actions which avoid emissions, in the first instance, should be considered as a priority;
- **Reduce**: Actions which result in a reduction of emissions should be considered next;
- **Switch**: Actions which switch energy sources to reduce emissions should be the next considered;
- **Sequester**: Actions which sequester GHG emissions do not reduce emissions but store them; and
- **Offset**: Offsetting of emissions through the purchase of offsets. This should be considered as a last resort.

Regular monitoring of emissions is recommended throughout the project to assess the effectiveness of emissions mitigation actions. The following actions are recommended for mitigation of GHG emissions ***during construction***:

- Where possible, use locally sourced materials to reduce emissions associated with transport;
- Recycle/compost waste wherever possible;
- When importing fill source from nearby construction sites wherever possible to reduce transport related emissions;
- Plan construction works to avoid double handling of materials;
- Make use of recycled emissions to reduce emissions associated with embodied energy (not estimated in this report);

- Develop construction/transport plans to minimise the use of fuel during each construction stage. For example throttling down and switching off construction equipment when not in use;
- Assess the fuel efficiency of the construction plant/equipment prior to selection, and where practical, use equipment with the highest fuel efficiency which use lower GHG intensive fuel (e.g. gas, ethanol); and
- Regular maintenance of equipment to maintain optimum operations and fuel efficiency.

The following actions are recommended for mitigation of GHG emissions ***during the operation*** of the facility:

- Incorporate energy efficiency design aspects wherever possible to reduce energy demand. More information on this can be found in the Hyder ESD report. Examples could include energy efficient lighting systems, natural ventilation, insulation and other renewable forms of energy (e.g. co-generation/tri-generation on site);
- Investigate the procurement of energy efficient equipment for the site (i.e. cranes, forklifts, street lighting etc);
- Investigate the feasibility of on-site renewable energy, such as photo-voltaics to reduce demand from the grid; and
- Tune buildings during commissioning to optimise energy performance.

7.1 Operational versus embodied GHG emissions

Provided GHG emissions from operation will dominate the overall life cycle emissions, design and material selection should be optimized for operational energy efficiency and GHG emission performance over life. This could include:

- Optimizing building thermal performance, or even surface colour and reflectance to reduce lighting requirements; and
- Sourcing electricity and fuels with low GHG intensity.

7.1.1 Concrete

A significant opportunity to minimize GHG emissions from concrete consumption is to substitute Portland cement with substitute materials such as local fly ash and blast furnace slag.

Several efforts are in progress to reduce the use of Portland cement in concrete. These include the utilisation of supplementary cementitious materials such as fly ash, silica fume, ground granulated blast furnace slag, rice-husk ash and metakaolin, and the development of alternative binders to Portland cement (Your Building, 2009) [5].

A brief literature review was undertaken to determine the current knowledge on the use of cementitious materials for structural cement. Some of the research recently undertaken on the properties, benefits and potential limitations of the use of blast furnace slag as supplementary cementitious material for structural concrete. Generally, the majority of the studies did not rule out the use of a significant proportion of for example Blast Furnace Slag for structural concrete.

Further investigations should be undertaken, with more project specific information related to the level and type of exposure expected for the concrete structures of the project. The research suggests that close attention be paid to the processes of curing and covering of reinforcement when substituting cementitious material.

Additionally, transport of concrete contributes significantly to the overall impact of the project. The impacts of the sand and aggregate components of concrete are dominated by their transport, representing up to 90% of the mass of the concrete.

Recommendations:

- Investigate the feasibility to use supplementary cementitious materials for the concrete pavement; and
- Source concrete from suppliers who are able to demonstrate low embodied GHG emissions using LCA methodology (could for example be certified by eco-label bodies).

[5] The uses of supplementary cementitious materials do not come without associated embodied environmental impacts in a LCA. AusLCI and BP LCI use economic values to allocate environmental impacts between products and co-products. For instance in the case of fly ash, the greenhouse gases (and other environmental impacts) from burning coal for electricity are shared between the electricity generated and the fly ash produced based on, and proportionate to, the market value of electricity and fly ash respectively. The fly ash would come free of embodied CO_2 at the gate of the power station, only if there would be no market value for fly ash.

7.1.2 Steel

The building and construction industry accounts for about half of the steel used in Australia. From a resource recovery and material stewardship point of view, the proportion of steel that is recycled and re-used at the end of its life is more relevant than the recycled content in production at a particular point in time (Crucible, 2006). Based on 2003 tonnages for recycled scrap and an estimate of steel deposited in landfills, the Australian steel recovery rate at end of life is calculated to be above 80%.

However, even with 100% recovery, scrap steel would not meet steel demand. Furthermore, there is a time lag: the scrap arising today comes from a period when steel production was lower (Crucible, 2006). The environmental benefits of prescribing recycled content rates needs to be evaluated carefully, taken into consideration the integrated international steel market and scrap trade.

The steel industry has articulated views against mandating 100% recycled steel, as follows:

- ASI: The drive to increase recycling is understandable and for many materials this kind of incentive may act to prevent post-consumer product, such as glass, paper, and plastic (etc) going to landfill. However, in the case of steel, recycling of scrap has been maximised worldwide and the development of efficient low-cost electric arc furnace (EAF) technology has put a premium on it (ASI, 2009); and
- US Steel Recycling Institute: Understanding the recycled content of BOF and EAF steels, one should not attempt to select one steel producer over another on the basis of a simplistic comparison of relative scrap usage or recycled content. Rather than providing an enhanced environmental benefit, such a selection could prove more costly in terms of total life cycle assessment energy consumption or other variables. Steel does not rely on 'recycled content' purchasing to incorporate or drive scrap use. It already happens because of the economics. Recycled content for steel is a function of the steelmaking process itself (US Steel Recycling Institute, 2009).

As opposed to concrete where transport can be a major factor in the GHG profile, for steel, the energy and greenhouse gas emission impacts of transport amount to approximately 2% of the impacts of the product (combining all routes for integrated steelmaking in Australia) (Crucible, 2006).

Recommendations

The keys to producing low impact steel are:

- Avoid using recycled content in steel products as a single indicator for low GHG intensity as this has proven to be misleading;
- Achieve high steel scrap recycling rates;
- Use low GHG intensive energy in production (i.e. renewable energy for electricity); and
- Minimize GHG emissions from steel making by sourcing from suppliers who are able to demonstrate low embodied GHG emissions using LCA methodology (could for example be certified by eco-label bodies).

8 References

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Appendix A

Edge Environment Embodied Energy Report

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Embodied Greenhouse Gas Emission Assessment of the Moorebank Development

16 August 2011

edge environment

For: Hyder Consulting Pty Ltd

Locked Bag 6503
Level 5, 141 Walker Street
North Sydney NSW 2060, Australia
T +612 8907 8254
Ken Lunty, Senior Environmental Consultant
ken.lunty@hyderconsulting.com
www.hyderconsulting.com

By: Edge Environment Pty Ltd
L5, 39 East Esplanade, Manly NSW 2095
T +61 (2) 9438 0100
Jonas Bengtsson, Director
jonas@edgeenvironment.com.au
edgeenvironment.com.au
ABN 941 301 116 16

edge environment

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1. Introduction

This report is prepared to complement Hyder Consulting's report "Stockland - SIMTA Moorebank Intermodal Terminal Facility - Greenhouse gas assessment" to include embodied greenhouse gas emissions (GHGs) in construction material and products.

2. Background

2.1 GHG policy and regulation

In Australia and NSW a number of policies and regulations have been introduced to manage and reduce GHG emissions to be released into the atmosphere. These include:

- The Australian Government has committed to reduce its emissions by between 5 and 15 per cent below 2000 levels by 2020. It has also committed to a long-term emissions reduction target of at least 60 per cent below 2000 levels by 2050.
- The National Greenhouse and Energy Reporting (NGER) Act was introduced in 2007 and requires corporations to register and report emissions, energy consumption or production that meets certain thresholds every year. For GHG emissions, thresholds are currently set at 25kt CO2e for a facility under a corporation and 50kt CO2e for a corporation as a whole for 2010-2011.
- The NSW Department of Infrastructure, Planning and Natural Resources – Department of Energy, Utilities and Sustainability Guidelines for Energy and Greenhouse in EIA provides guidance on the consideration of energy and greenhouse issues when developing projects and when undertaking environmental impact assessment under the Environmental Planning and Assessment Act 1979 (EP&A Act)

2.2 Moorebank intermodal terminal facility

The Defence National Storage and Distribution Centre (DNSDC) site is located in Moorebank Avenue, Moorebank in south-western Sydney. The site area is approximately 83 hectares and is located approximately 26 km south-west of Sydney's CBD. The site encompasses an area of 238,000 m^2 of existing low rise buildings comprising of warehouses and administrative offices.

Stockland and their joint venture partners intend to develop the site into an Intermodal Freight Terminal (IMT) and warehouse/distribution facility, including container storage and warehouse solutions with direct rail access.

2.3 Life cycle assessment

Life cycle assessment (LCA) addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave).

2.3.1 Australian life cycle inventory database

The Australian Life Cycle Inventory (AusLCI) Data Guidelines are being developed to provide the rules for data collection for the AusLCI Database. The Guidelines have been developed by the Guidelines committee of the AusLCI data project after a consultative session held in the latter half of 2008. The development has been informed by the Ecoinvent data guidelines (a Swiss global database project) and the US LCI guidelines.

The ultimate objective of the project is to develop publicly available LCI data modules for commonly used, generic materials, products and processes. This is important to support public, private, and non-profit sector efforts to undertake product LCAs and LCA-based decision support systems and tools such as eco-labels, environmental impact calculators and simplified design tools.

The AusLCI database was launched at the 7th Australian LCA Conference in Melbourne in March 2011. AusLCI resources are available at www.auslci.com.au.

2.3.2 Australian LCA dataset

The Australian LCA Dataset supplied with the SimaPro software has traditionally been the mostly widely used LCA data in Australia. This data mostly originates from research undertaken by Royal Melbourne Institute of Technology (RMIT) and CSIRO. Where required data are not available, Edge Environment has used data from the Ecoinvent database, which originates from the Ecoinvent Centre in Switzerland and compiles data for most European countries. The Australian LCA Dataset comes with the Australasian version of the SimaPro software.

2.3.3 Building products life cycle inventory (BP LCI)

To facilitate the reduction of environmental impacts of buildings in Australia, the building and construction materials and products sector, represented by the Building Products Innovation Council (BPIC), are committed to help the Australian community make informed, research based and level playing field decisions about the environmental impact of building material and products. The method used to facilitate this outcome is based on a whole of life or full LCA methodology, as guided by international standards, and enables access to Life Cycle Inventory (LCI) data for the purposes of conducting LCAs.

It is the intention of the building and construction materials and products industry sector that the LCI data will be widely used by LCA professionals to make informed decisions that can assist in the reduction of CO_2 and other building environmental impacts.

To facilitate this, the publically available BP LCI tool kit includes:

- *Methodology Guidelines for the Materials and Building Products Life Cycle Inventory Database*, adapted from the AusLCI Guidelines Committee Draft *Guidelines for Data Development for an Australian Life Cycle Inventory Database*. The adaptations interprets consensus from the BPIC Project's Technical Working Group and input from BPIC contributing member associations facilitated to discuss LCI/LCA methodology.
- The Methodology Guidelines describe how life cycle inventory data will be consistently compiled for Australian construction materials and building products, the Protocol describes how the data is to be used appropriately to represent and evaluate building products, systems and materials. Uses of the building and construction materials and products life cycle inventory data that do not comply with this Protocol are not considered to be appropriate uses of the data.
- The life cycle impact assessment (LCIA) reports recommending methodology and factors for impact assessment.

These documents and additional components in the BP LCI tool kit are available on: http://www.bpic.asn.au/LCIMethodology.htm

3. Methodology

The embodied GHG assessment have been conducted according to the following methodology:

1. Goal and scope workshop between Edge Environment and Hyder project teams (see section 4.1 below).
2. Compile “bill of materials”. Hyder is coordinating the delivery so should be able to provide Edge with lists of inputs/outputs and processes to be included in the assessment.
3. Determine quantities of inputs/outputs and processes. Edge will work from drawings and consulting with Hyder’s structural engineers where required to estimate material quantities.
4. Model the inventory data in accordance with the *BPIC/ICIP Project’s Methodology Guidelines for the Materials and Building Products Life Cycle Inventory Database*. Economic allocation will be used to determine the impacts between primary (e.g. steel production) and retained burden (if any) in recycled or reused products.
5. Carbon Footprint assessment: Edge Environment will model the inventory flows in the SimaPro LCA database system (v7.2.4), linking it to existing life cycle environmental impact for upstream and downstream components. Edge Environment will use:
    a. Generic Australian life cycle data;
    b. Generic International life cycle data where Australian data is not available
    c. Generic life cycle data for analogous processes where specific process data are not available
    d. Best estimates of life cycle impacts by analogy to similar processes where no data is available
6. Sensitivity analysis and scenario modelling will be used to demonstrate the influence of key assumptions to the overall result and conclusions.
7. Technical review of the greenhouse gas estimates for construction and operation of the facility. The estimate will be very basic and will use factors from the GHG protocol and the NGA factors, with any assumptions outlined.
8. Draft report to Hyder Consulting.
9. Final report incorporating Hyder’s feedback and comments

4. Results

4.1 Goal and scope

The goal and scope for the project “Embodied Greenhouse Gas Emissions of the Moorebank Development”, primarily based on a meeting between Ken Lunty of Hyder Consulting, and Jonas Bengtsson and Ben Kneppers of Edge Environment on the 21st of April 2011 and follow up email conversations.

Information Requirement	Definition
Reasons for LCA	Fulfil Director General’s requirements for GHG assessment section of environmental approval

	Complement Hyder's study with embodied material emissions "SIMTA Moorebank Intermodal Terminal Facility - Greenhouse gas assessment"
System definition and boundary	See section 4.1.1 below
Function of the system	Intermodal transport facility (Road and rail freight, including cold storage)
Functional unit	Whole of project – not going to be compared or benchmarked
Environmental impacts to be considered	**Global warming:** Characterised in 100 year global warming potential factors (GWP100) for carbon dioxide equivalents (kg CO_2-eq);
Allocation procedure	The allocation approach for this study is aligned with the BPIC/ICIP methodology http://www.bpic.asn.au/LCIMethodology.htm). Primary materials/products that are recyclable/reusable provide two services to humanity – firstly as a material/product for immediate use and secondly as a scrap material that has remaining utility by virtue of its recyclable/reusable properties. Essentially, recycled material may have a lower environmental impact than primary material, but it can only be available for recycling if, in the past, this material was produced from primary sources. The recycled material should therefore take a share of the primary production burdens. Equally, the primary material deserves some recognition for the fact that it has future potential to be recycled. Economic allocation is used to establish the life cycle impacts between primary production and recycled scrap. The economic allocation has been based on the nationally relevant average recycling rates for each material and average market prices for primary and recycled products (if the market price of a given scrap is zero, the scrap is treated a true waste and retains no burden from primary production).
Data interpretation method	Scenario modelling to explore sensitivity on the result to key assumptions

Data sources	• Material quantity and transport data from Hyder/Stockland based on:
	  o Moorebank Greenhouse Gas Assessment_FINAL DRAFT.docx
	  o GHG Assessmentv3.xlsx
	  o Additional data to be requested by Edge from Hyder/Stockland
	• Cradle to site background life cycle inventory data will be based on (in order of preference):
	  o Building Products Life Cycle Inventory
	  o AusLCI data (when available)

	- The Australian LCA dataset provided with SimaPro v7.2.4[1] - Peer reviewed Australian LCI/LCA studies - International data from the Ecoinvent (v2.2) database, adapted to Australian conditions when required following the BP LCI methodology and the AusLCI guidelines
Value choices and optional elements	None identified
Data limitations	Still in concept design – design not finalised
Data quality requirements	**Time related coverage:** Data as close as possible to the current conditions **Geographical coverage:** National/Australian average – identify overseas production/source when possible **Technology coverage:** National/Australian average **Completeness:** All major components of the development (as defined in section 4.1.1) should be included in accordance with concept drawings. It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold % of the total mass of the product, but with the exception that where the a small input/output has a “significant” impact it should be included. Procedure for modelling minor process flows will be adopted by using sensitivity analysis to test the dependence of the final impact assessment to certain inputs/outputs. This is done by changing individual inputs; by doubling and halving each data item, and observing the change to the overall impact. Provided the final environmental significance for the product varies by less than 10%, approximate values can be used. Where the variation is greater than 10%, further investigation of this parameter should be undertaken.

[1] Edge Environment have made adaptations to the data for this project (in accordance with the BP LCI methodology) were as follows:

- Universal and consistent application of economic allocation between all co-products and recycled wastes from all processes, including to end-of-life recycled materials going to recycled products. This affects all components and energy sources and feedstocks either directly (or indirectly from their upstream supply chain).
- Provision of discounts to the primary products that are recyclable on the basis of the value and quantity of scrap recycled compared to the value and quantity of primary product produced
- Transfer of this discount and spreading it between the recycled materials that derive from the primary product in proportion to their value and quantity
- Review of the unit process data for all material inputs to ensure consistency of feedstock emissions accounting.
- Review of the unit process data for all renewable material inputs (mainly timber, but also some vegetable oils) to ensure that the scope accounted for sequestered CO_2 and solar energy is consistent and appropriate.
- Numerous minor changes to maximise the consistency of the assessment.

	Capital equipment and buildings typically account for under 1% of nearly all life cycle inventory parameters and this is usually much smaller than the error in the inventory data itself. For this project, approximate estimates of the impacts of capital equipment and buildings will be made and provided these contribute to less than 5% of the normalized impacts, no further elaboration will be needed[2]. • **Representativeness:** Australian or state based average background data is deemed appropriate at this stage given limited availability of supplier or project specific data. • **Consistency:** Guided by the BPIC Building Products Life Cycle Inventory methodology • **Reproducibility:** The systems shall be modelled described in a manner which allows for reproduction of the study/results. • **Uncertainty of the information:** Concept design
Type of critical review	Final draft and final to be reviewed by Hyder Consulting and Urbis/Arden respectively
Type and format of the report required for the study	Project report and MS Excel based LCI/LCA tool.

4.1.1 System diagram and major emission sources

The diagram below shows the main input, outputs and project activities in terms of GHG emissions.

[2] Frischknecht et al (2007) found the contribution of greenhouse gas emissions from capital goods in construction material represent approximately 4% (0.7% - 7.7%) of the total footprint.

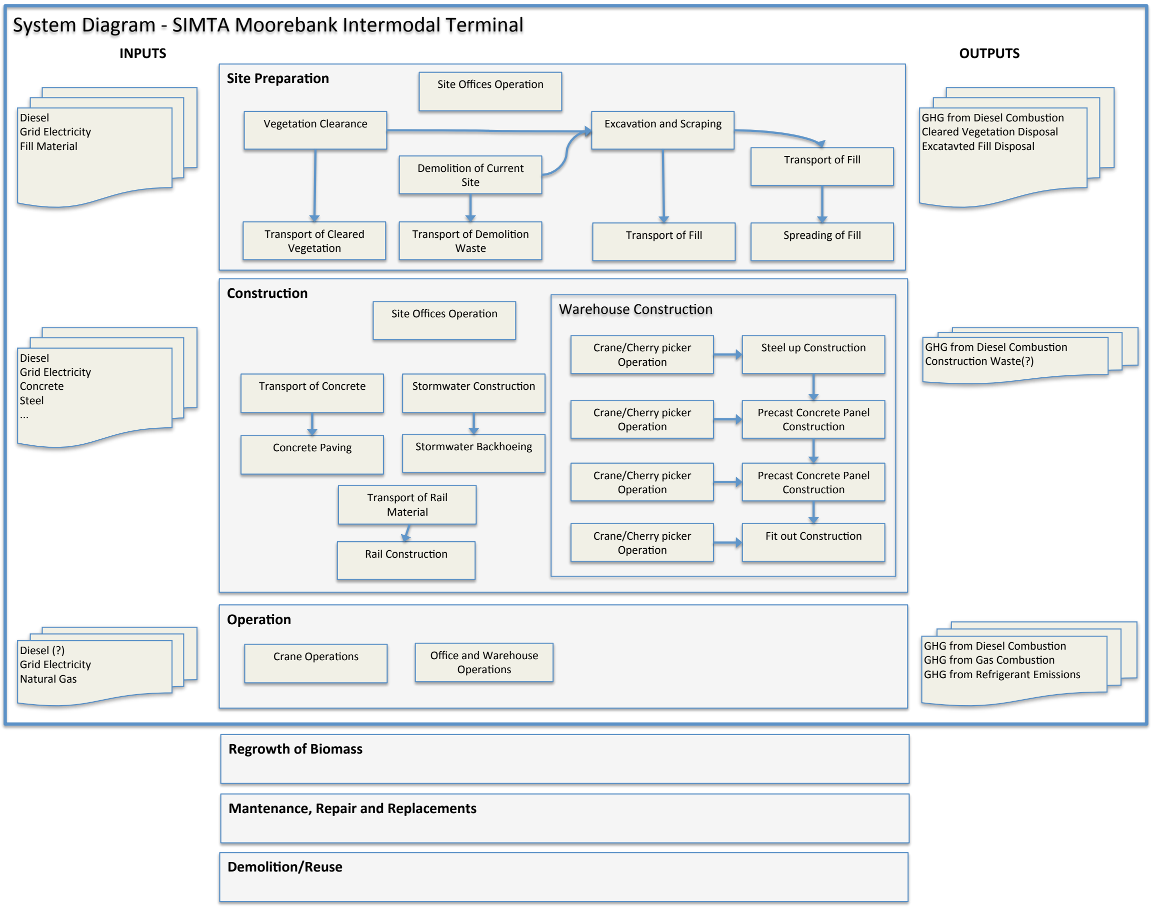

Figure 1: Schematic overview of the project GHG assessment system

Hyder Consulting have already assessed the GHG emissions associated with:

- Onsite fuel combustion and electricity consumption from site preparation, construction and operation
- Transport of material, products and waste to and from site;
- Decomposition of organic waste on and off site

The proposed scope for assessing embodied construction material and product GHG emissions include:

- Imported fill for site preparation;
- Permanent piping material for stormwater infrastructure;
- Concrete paving, including mesh and bar reinforcement;
- Rail lines; and
- Warehouse structure, including steel frame, roof and wall sheets and insulated panels.

Note: GHG emissions from end of life of Moorebank Intermodal Terminal Facility have been excluded from the assessment due to large uncertainties in terms of degree of reuse of facilities and infrastructure, as well as degree of reuse, recycling and disposal of construction materials.

4.2 Project material quantities

The following scenarios are modelled in order to explore key data sensitivities and embodied greenhouse gas emission reduction potential:

1. Baseline scenario based on best available conservative data
2. Cement substitution material scenario exploring 20% of Portland cement substituted with fly ash in the concrete
3. Concrete pavement slab thickness reduction by 20%

4.2.1 Scenario 1: Baseline

The following assumptions (all subject to refinement/confirmation by the design team) have been used to establish the project construction material inventory:

- Surplus of onsite cut to fill will be used on site with assumed negligible import and disposal impact.
- 32MPa concrete for pavement, with no cement substitution materials (CSM);
- Mesh reinforcement of concrete pavement, i.e. no bar reinforcement
- Added 500m of PVC plastic pipe for stormwater infrastructure
- Added Steel sheet warehouse walls (1.6kg/m^2) and roof (5.0kg/m^2)
- Added reinforced concrete wall sections for the warehouse
- Added rail line material quantities for an estimated 3km rail line track for the project[3]

Table 1: Project construction material quantities

Phase		Material	Quantity (t)	Quantity (m3)	Quantity (m2)	Density (t/m3)	Density (t/m2)	Density (t/m)	Length (m)
Site Preparation									
		Fill material							
Construction									
	Pavement								
		Concrete 32MPa	996,000	415,000		2.4			
		Mesh Reinforcing Steel	2,158						
	Stormwater								

[3] Based on information from the following sources:

Review of CO2-e Emissions from Concrete versus Timber Sleepers, Energy Strategies, last viewed 16 November 2010, <http://www.enerstrat.com.au/lib/documents/Review-of-CO2-Emissions-from-Concrete-versus-Timber-Sleepers.pdf>.

Concrete Sleepers (Heavy Duty) – Design, Australian Rail Track Corporation Ltd, last viewed 16 November 2010, <http://extranet.artc.com.au/docs/engineering/common_standards/track/etd_02_03_concrete_sleepers_heavy_design.pdf>.

Railway and Tramway Sleepers, Queensland Government Department of Primary Industries and Fisheries, last viewed 16 November 2010, <http://www.cqfa.com.au/documents/1181619278_sleepers_fact_sheet.pdf>.

AS1085.1-2002 Railway and Track Materials Part 1: Steel Rails, Australian Standard, last viewed 16 November 2010, <http://www.saiglobal.com/PDFTemp/Previews/OSH/as/as1000/1000/1085.1-2002(+A1).pdf>.

Phase		Material	Quantity (t)	Quantity (m3)	Quantity (m2)	Density (t/m3)	Density (t/m2)	Density (t/m)	Length (m)
		Plastic Pipe	15			30.0			0.5
	Warehouse								
		Structural Steel (typical)	5,072						
		Structural Steel (cooling)	480						
		Mesh Reinforcing Steel	1,383						
		Steel Sheet (walls)	1,253				0.0050		
		Steel Sheet (roof)	401				0.0016		
		Precast Concrete Panels (Wall)	23,227				0.0927		
		Precast Concrete Panel (Wall reinf.)	376				0.0015		
		Insulated Panel							
	Rail Line								3,000
		Steel Rail	180					0.060	
		Sleeper Reinforcement	22					0.0072	
		Sleepers (concrete)	855					0.285	
		Aggregate	5,970					1.990	

4.2.2 Scenario 2: Cement substitution material

In this scenario 20% of Portland cement in the concrete pavement is substituted by fly ash from NSW coal fired power station. See section 5.2 below for more details on cement substitution.

4.2.3 Scenario 3: Pavement thickness

In this scenario the concrete pavement is reduced by an average of 20% to explore the overall sensitivity to a key project parameter affecting the overall embodied greenhouse gas emission assessment.

4.3 Embodied GHG impact results

4.3.1 Scenario 1: Baseline

The total embodied GHG emissions in construction materials is calculated at **196ktCO_2-e**, or approximately 27 times the previously estimated GHG emissions from the construction phase (excluding material impacts). However, the embodied construction material impacts only account to approximately the equivalence of three years of operation.

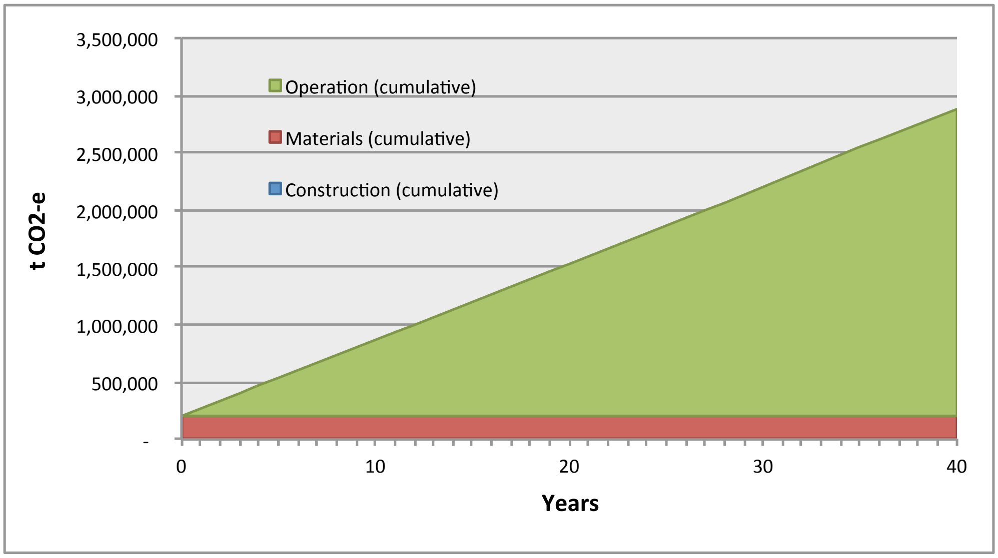

Figure 2: GHG emissions over 40 years of operation.

Embodied GHG emissions by construction activity/phase are presented in Figure 3 and Table 2.

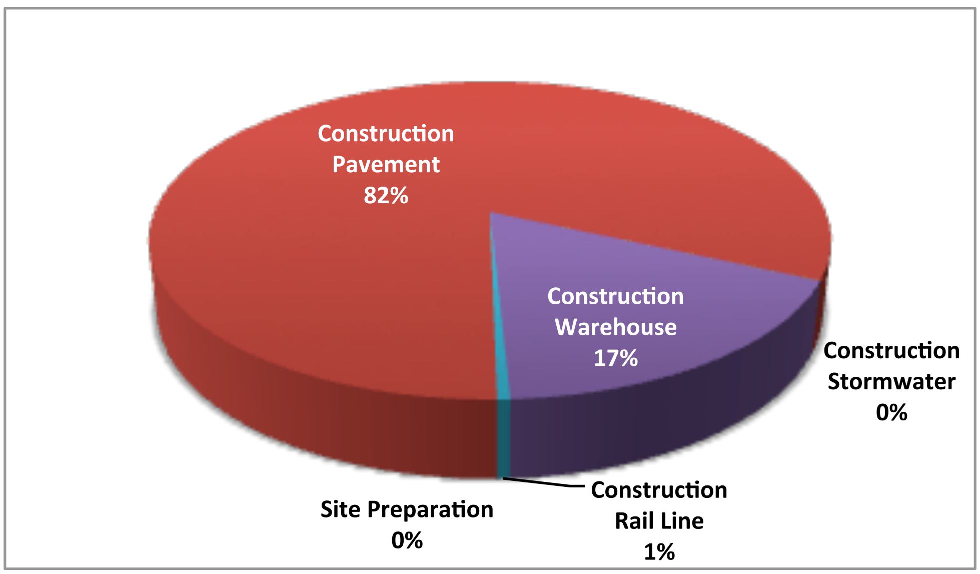

Figure 3: Embodied material GHG emissions by construction activity

Table 2: Embodied construction material GHG emissions by construction activity

Construction Activity/Phase	tCO_2-e
Site Preparation	0
Construction Pavement	161,022
Construction Stormwater	33
Construction Warehouse	34,134
Construction Rail Line	1,012

Figure 4 and Table 3 below show GHG emissions by construction material category/type.

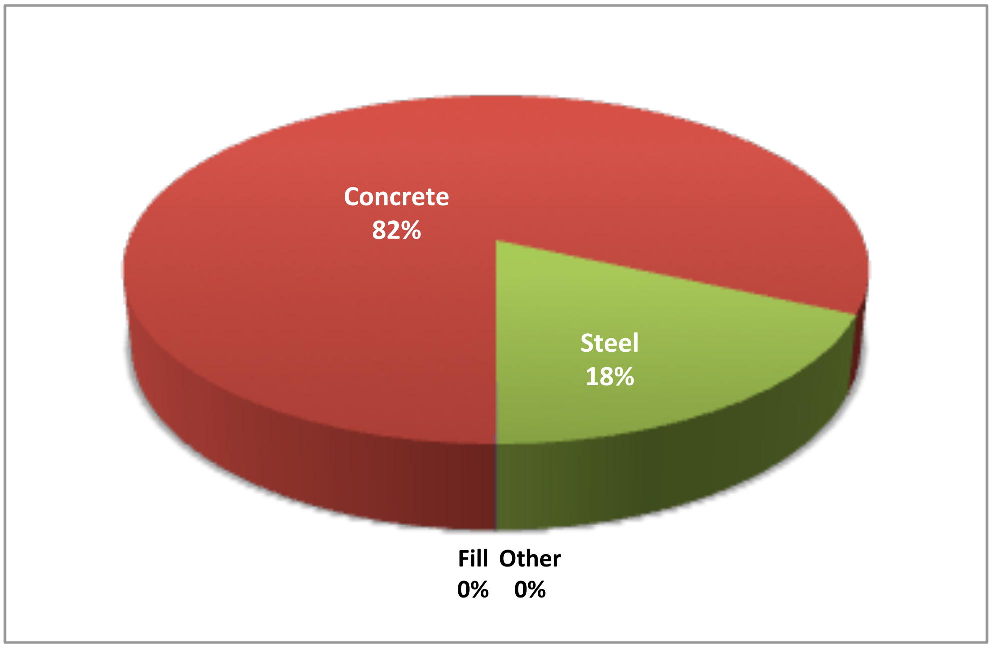

Figure 4: Embodied GHG emissions by material category

Table 3: Embodied construction material GHG emissions by material type

Material Category/Type	tCO_2-e
Fill	24
Concrete	160,337
Steel	35,808
Other	24

Figure 5 and Table 4 below show GHG emissions by steel type/use.

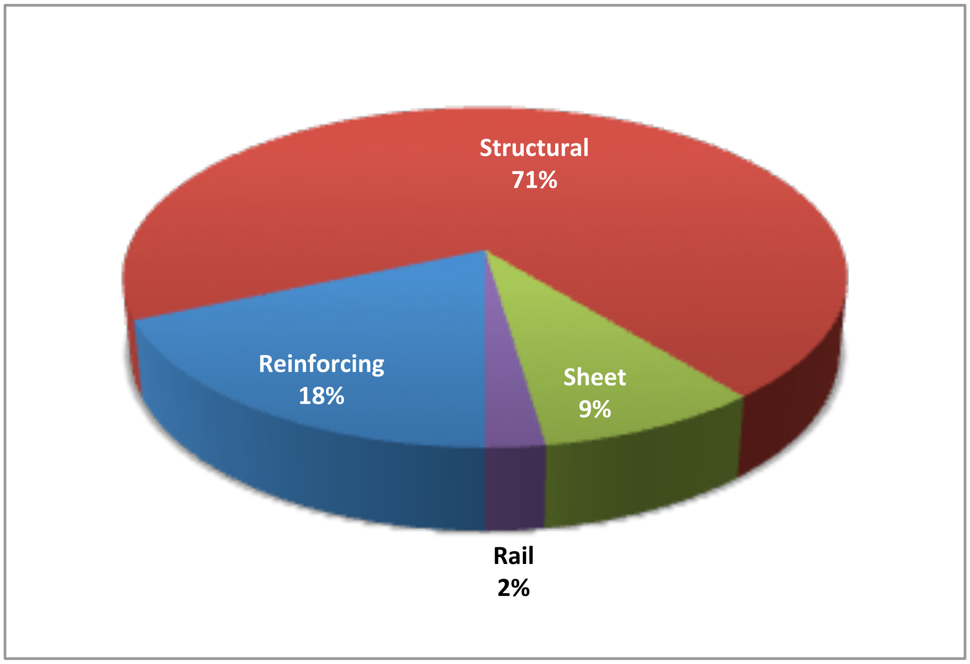

Figure 5: Embodied GHG emissions by steel type/use

Table 4: Embodied steel GHG emissions by type/use

Steel type/Use	tCO_2-e
Reinforcement	6,619
Structural	25,286
Sheet	3,084
Rail	820

Further GHG breakdown and detail from concrete use will be added if/when more details are available on concrete grades used for the project construction elements.

4.3.2 Scenario 2 and 3

The embodied GHG results from scenario 2 and 3 described above show:

- 172ktCO_2-e in scenario 2; and
- 165ktCO_2-e in scenario 3.

Overall the scenario have 12% and 16% reduction in overall GHG embodied emission, and 15% and 20% reduction of GHG emissions in the concrete pavement by replacing 20% of Portland cement with fly ash and reducing the pavement thickness by 20% respectively.

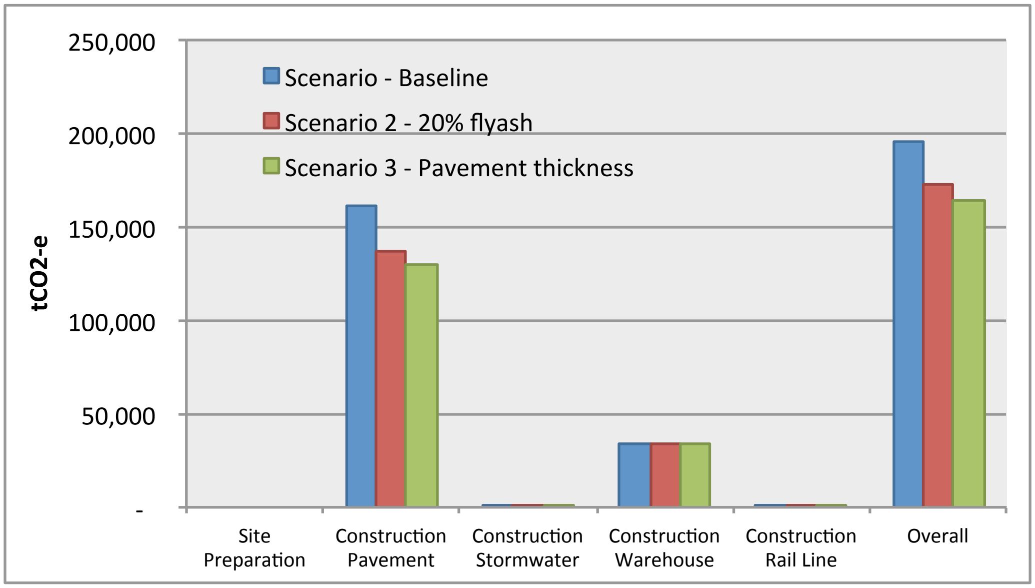

Figure 6: Embodied GHG emission scenario comparison.

5. Discussion and recommendations

5.1 Operational versus embodied GHG emissions

Provided GHG emissions from operation will dominate the overall life cycle emissions, design and material selection should be optimized for operational energy efficiency and GHG emission performance over life. This could include:

- Optimizing building thermal performance, or even surface colour and reflectance to reduce lighting requirements.
- Sourcing electricity and fuels with low GHG intensity

5.2 Concrete

A significant opportunity to minimize GHG emissions from concrete consumption is to substitute Portland cement with substitute materials such as local fly ash and blast furnace slag.

Several efforts are in progress to reduce the use of Portland cement in concrete. These include the utilisation of supplementary cementitious materials such as fly ash, silica fume, ground granulated blast furnace slag, rice-husk ash and metakaolin, and the development of alternative binders to Portland cement (Your Building, 2009) [4].

[4] The uses of supplementary cementitious materials do not come without associated embodied environmental impacts in a LCA. AusLCI and BP LCI use economic values to allocate environmental impacts between products and co-products. For instance in the case of fly-ash, the greenhouse gases (and other environmental impacts) from burning coal for electricity are shared between the electricity generated and the fly-ash produced based on, and proportionate to, the market value of electricity and fly-ash respectively. The fly-ash would come free of embodied CO_2 at the gate of the power station, only if there would be no market value for fly-ash.

A brief literature review was undertaken to determine the current knowledge on the use of cementitious materials for structural cement. Some of the research recently undertaken on the properties, benefits and potential limitations of the use of blast furnace slag as supplementary cementitious material for structural concrete. Generally, the majority of the studies did not rule out the use of a significant proportion of for example Blast Furnace Slag for structural concrete.

Further investigations should be undertaken, with more project specific information related to the level and type of exposure expected for the concrete structures of the project. The research suggests that close attention be paid to the processes of curing and covering of reinforcement when substituting cementitious material.

Additionally, transport of concrete contributes significantly to the overall impact of the project. The impacts of the sand and aggregate components of concrete are dominated by their transport, representing up to 90% of the mass of the concrete.

Project recommendations:

- Investigate the feasibility to use supplementary cementitious materials for the concrete pavement; and
- Source concrete from suppliers who are able to demonstrate low embodied GHG emissions using LCA methodology (could for example be certified by eco-label bodies)

5.3 Steel

The building and construction industry accounts for about half of the steel used in Australia. From a resource recovery and material stewardship point of view, the proportion of steel that is recycled and re-used at the end of its life is more relevant than the recycled content in production at a particular point in time (Crucible, 2006). Based on 2003 tonnages for recycled scrap and an estimate of steel deposited in landfills, the Australian steel recovery rate at end of life is calculated to be above 80%.

However, even with 100% recovery, scrap steel would not meet steel demand. Furthermore, there is a time lag: the scrap arising today comes from a period when steel production was lower (Crucible, 2006). The environmental benefits of prescribing recycled content rates needs to be evaluated carefully, taken into consideration the integrated international steel market and scrap trade.

The steel industry has articulated views against mandating 100% recycled steel, as follows:

- ASI: The drive to increase recycling is understandable and for many materials this kind of incentive may act to prevent post-consumer product, such as glass, paper, and plastic (etc) going to landfill. However, in the case of steel, recycling of scrap has been maximised worldwide and the development of efficient low-cost electric arc furnace (EAF) technology has put a premium on it (ASI, 2009).
- US Steel Recycling Institute: Understanding the recycled content of BOF and EAF steels, one should not attempt to select one steel producer over another on the basis of a simplistic comparison of relative scrap usage or recycled content. Rather than providing an enhanced environmental benefit, such a selection could prove more costly in terms of total life cycle assessment energy consumption or other variables. Steel does not rely on "recycled content" purchasing to incorporate or drive scrap use. It already happens because of the economics. Recycled content for steel is a function of the steelmaking process itself (US Steel Recycling Institute, 2009).

As opposed to concrete where transport can be a major factor in the GHG profile, for steel, the energy and greenhouse gas emission impacts of transport amount to approximately 2% of the impacts of the product (combining all routes for integrated steelmaking in Australia) (Crucible, 2006).

Project recommendations: The keys to producing low impact steel are:

- Avoid using recycled content in steel products as a single indicator for low GHG intensity as this has been proven to be misleading
- Achieve high steel scrap recycling rates; and
- Use low GHG intensive energy in production (i.e. renewable energy for electricity).
- Minimize GHG emissions from steel making by sourcing from suppliers who are able to demonstrate low embodied GHG emissions using LCA methodology (could for example be certified by eco-label bodies).

6. Summary

This GHG emission life cycle assessment has been prepared as an addition to Hyder Consulting's report "Stockland - SIMTA Moorebank Intermodal Terminal Facility - Greenhouse gas assessment" in order to fulfil the Director General's requirements for GHG assessment section of environmental approval.

The research calculates the total cradle to site embodied GHG emissions in construction materials to 196ktCO_2-e. The embodied material GHG emissions are the most significant emission source in the construction phase, approximately 27 times higher than the non-material GHG emissions estimated by Hyder Consulting. However, the construction phase impacts are modest compared to the projected emissions from operating the facilities, approximately equivalent to two years of operation.

The main GHG emissions from the construction phase are from production of concrete for the site pavement and structural steel for warehouses. There is significant scope to reduce construction emissions by for example replacing Portland cement with for example fly ash, silica fume, ground granulated blast furnace slag. However, the overall focus in terms of reducing GHG emissions should focus on minimising energy related emissions from operation of the facility.

The assessment presented is based estimates from early concept design. An Excel based assessment tool is provided with this report to allow for refinement of the modelling as more specific project details become available.

7. References

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