CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX AY: Greenhouse Gas Emission Calculations (2017)

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Cairns Shipping Development Revised Draft EIS

Greenhouse Gas Emission Calculations

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Appendices

1. Introduction

1.1 Scope

ASK Consulting Engineers Pty Ltd (ASK) has been commissioned by Flanagan Consulting Group to provide greenhouse gas calculations of the revised Cairns Shipping Development Project (CSD Project) for the Revised Draft Environmental Impact Statement (EIS).

This report describes the methodology and results of the calculations. The scope of work includes the following:

(1) Calculate emissions from clearance of vegetation using FullCAM.

(2) Prepare a greenhouse gas inventory for combustion sources including maximum annual greenhouse gas emissions from the proposed construction and operations based on current National Greenhouse Accounts Factors and NGER guidelines.

(3) Include scope 2 emissions (upstream fossil fuel combustion to supply electricity for the project).

(4) Provide results for two scenarios (with and without the project) for the years 2018 and 2028.

(5) Discuss the relative scale and implications of these emissions compared to state and national emissions.

Emission sources that were included in the assessment are:

- scope 1 greenhouse emissions including:
  - vegetation clearance
  - fuel combustion by tugs
  - fuel combustion by support vessels
  - fuel combustion by the dredger whilst dredging and moving to a pump-out point located offshore of Yorkeys Knob
  - fuel combustion by booster stations along the pipeline route between the above pump-out point and the Northern Sands DMPA
  - fuel combustion by construction vehicles and plant at the Northern Sands DMPA and the wharf
  - wharf-side cruise ship emissions
- scope 2 greenhouse emissions including:
  - electricity purchased from the grid.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

1.2 Greenhouse Gas Assessment Requirements

1.2.1 National Greenhouse and Energy Reporting (NGER)

The NGER Technical Guidelines (DEA 2016b) provide guidance and commentary to assist in estimating greenhouse gas emissions for reporting under the National Greenhouse and Energy Reporting (NGER) system. The emission factors used in these guidelines are consistent with those specified in the National Greenhouse Accounts Factors (DER 2016a).

Coverage of scope 1 emission sources includes fuel combustion, which deals with emissions released from fuel combustion as well as other sources not relevant to this development.

Scope 2 emissions are generally emissions that result from activities that generate power offsite for consumption onsite. The largest contributor to scope 2 emissions is consumption of electricity.

1.2.2 Greenhouse Gases

Gases addressed by the NGER Regulation (Department of Climate Change, 2008), are the six key greenhouse gases consistent with the Kyoto Protocol. These gases differ in their capacity to trap heat and contribute to the greenhouse effect. The capacity of each gas to contribute to global warming is referred to as its Global Warming Potential (GWP) relative to that of carbon dioxide. The GWP's of the six Kyoto greenhouse gases are provided in **Table 1.1.**

Table 1.1 Global Warming Potential of Greenhouse Gases

Greenhouse Gas	GWP [1]
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
Hydrofluorocarbons (HFC's)	92 – 14,800
Perfluorocarbons (PFC's)	7,390 – 12,200
Sulphur hexafluoride (SF_6)	22,800

Notes: 1. Source is DEA (2016).

Because of the variation in GWP between different gases, the emission factors used to calculate greenhouse gas emissions from the project are stated in terms of carbon dioxide equivalents (CO2-e) and consider the various GWP's of the different greenhouse gases.

2. Construction and DMPA Fuel Combustion

2.1 Emission Factors

Greenhouse emission factors for liquid fuel consumption are shown in **Table 2.1**. Note that the emission factors are per kilolitre of diesel.

Table 2.1 Stationary Engine Liquid Fuel Greenhouse Gas Emission Factors

Fuel Type	Energy Content (GJ/kL) [1]	Scope 1 Emission Factor (kg CO2-e/GJ) [1, 2]	GHG Emission Factor (tonnes eCO2/ kL) [3]
Diesel	38.6	70.5	2.72
Fuel oil	39.7	74.3	2.95
Petrol	34.2	67.6	2.31

Notes: 1. Energy content of diesel is sourced from Table 3 of DEA (2016).
2. Emission factors include contributions from CO_2, CH_4 and N_2O from Table 4 of DEA (2016).
3. GHG Emission Factor is the Energy Content multiplied by Scope 1 Emission Factor.

The greenhouse gas emission from fuel usage is calculated by multiplying the fuel consumption by the emission factor from the last column in **Table 2.1**.

2.2 Wharf Construction Fuel Combustion

The wharf upgrade will take approximately seven to eight months. Construction hours are likely to be 6:30am to 6:30pm Monday to Saturday.

According to the Draft EIS, construction of the fuel storage and transfer infrastructure will require:

- 35 – 80 tonne mobile crane
- ~20 tonne Franna crane
- 20 tonne excavator
- rigid dump trucks
- power generators
- welding equipment.

New water, firefighting and sewerage services are required for wharves 1 to 5. These will include replacement / extension of existing water mains and installation of a sewage pump station, underground storage tank and odour control system. Equipment required for the construction of these services will include:

- ~20 tonne Franna crane
- 20 tonne excavator
- rigid dump trucks.
- concrete pump truck
- concrete delivery trucks

Work for the wharf upgrade includes installation of new berthing structures including driving of piles and drilling of sockets into the seabed. The undertaking of this construction will require:

- 35 – 80 tonne mobile crane
- ~20 tonne Franna crane

- concrete pump truck
- power generators
- 7 dump/concrete deliveries per day.

Calculation data for the fuel consumption are provided in **Table 2.2**.

Table 2.2 Wharf Construction Fuel Consumption

Equipment	Number	Hours / day	Operating Duration (days)	Operating Time (hours)	Fuel consumption (L/h)	Total Fuel Consumed (kL)	Fuel Type
35-80 t crane	2	12	193	2314	40	185	diesel
20 t franna crane	3	12	193	2314	20	139	diesel
20 t excavator	2	12	193	2314	20	93	diesel
Concrete trucks	11	12	193	2314	11.1	283	diesel
Dump trucks	2	12	193	2314	30	139	diesel

Equipment	Number	Distance (km/day)	Operating Duration (days)	Operating Distance (km)	Fuel consumption (L/100kms)	Total Fuel Consumed (kL)	Fuel Type
Site vehicles	23	25	193	4821	12.5	14	petrol

2.3 Booster Pump Fuel Combustion

It is expected that 3 land booster pumps and possibly one floating booster pump will be required for the Northern Sands pipeline. A booster pump is a very large, portable pump which is connected into the dredge pipeline to boost pumping pressure. Multiple booster stations can be connected in series when required, and they can be either land based or located offshore on barges.

Floating booster stations are barge-mounted and are towed to position before they are anchored to the seafloor. They are typically located close to the dredge and out of the surf zone. The booster pump station is connected either side to small lengths of floating line which are linked to the submerged line by risers.

Land based booster stations are delivered by road transport and sufficient access needs to be maintained at all times to allow inspections, maintenance and refuelling.

It is expected that the Northern Sands DMPA will operate 24 hours per day. Calculation data for the fuel consumption are provided in **Table 2.3**.

Table 2.3 Annual Booster Fuel Consumption

Equipment	Number	Hours / day	Operating Duration (days)	Operating Time (hours)	Fuel consumption (L/h)	Total Fuel Consumed (kL)	Fuel Type
On-shore boosters	3	24	72	1730	440	2284	diesel
Off-shore boosters	1	24	72	1730	985	1704	diesel

*Notes: 1. Emission factors from **Table 2.1**.*

2.4 Dredging, Tubs and Support Vessels Fuel Combustion

Dredging and hence placement of slurry at the Northern Sands DMPA is anticipated to require the following timeframes:

- The current time estimate for the operational phase is 10.3 weeks, day and night shifts plus pipeline mobilisation and demobilisation.
- DMPA and pipeline construction (concurrent) for Northern Sands will occur during daylight hours only for a duration of 6 weeks, with demobilisation also taking 6 weeks.

It is expected that the equipment required at sea during the 10.3 weeks will be as follows:

- One small to medium sized TSHD such as the 5,600 m^3 TSHD Marieke (Akuna 2017) to dredge soft clays and transport to shore, will operate 135 hrs /wk. This will moor to a temporary mooring facility at the pump out location without need for power. The TSHD power ratings are:
  - 6776 kW total power
  - 4050kW pump shore power
  - 4050kW propulsion sailing
  - 3450kW propulsion dredging
  - 450kW bow thruster.
- One 460kW survey/crew change launch will work day shift and standby at night.
- One 45T Bollard Pull Shoalbuster multicat workboat (~1200HP) for anchoring and coupling the TSHD and bunkering the booster, will operate day and night.
- One 25T Bollard Pull type tugboat (e.g. with two Cummins KTA19M engines 900 HP) will operate the sweep bar/plough, day time only.
- One off-shore booster pump station (nominally DI 509, 4475 kW) may be required to operate 40 hours per week (Akuna 2017) approximately 800 metres offshore. The total installed power is 4935 kW and pump power is 4475kW.
- A barge mounted crane may be required to install the off-shore pipeline.

Calculation data for the greenhouse gas emissions are provided in **Table 2.4**.

Table 2.4 Soft Clay Construction Dredging Emissions

Equipment	Number	Hours / day	Operating Duration (days)	Operating Time (hours)	Fuel consumption (L/h)	Total Fuel Consumed (kL)	Fuel Type	Emission factor (tonnes CO_2-e/kL) [1]	Total Emissions (kt CO_2-e)
TSHD	1	24	72	1730	979.8	1695	Fuel oil	2.95	5.00
Backhoe dredge	1	24	30	720	352.6	254	Fuel oil	2.95	0.75
Hopper barges and tugs	3	24	30	720	164.7	356	Fuel oil	2.95	1.05
Survey and crew boats	2	24	72	1728	119.9	414	diesel	2.72	1.13

*Notes: 1. Emission factors from **Table 2.1**.*

2.5 Soft Clay DMPA and Pipeline Construction Fuel Combustion

2.5.1 DMPA Land Equipment

It is expected that the equipment required on land at the Northern Sands soft clay DMPA will be:

- front end loaders
- excavators
- rigid dump trucks
- mobile cranes / telescopic handlers
- DMPA tailwater pumps with capacity 100,000 m3/day
- three booster pump stations (discussed in **Section 2.3**).
- two D8 dozers
- two 40 tonne excavators.

2.5.2 Pipeline Construction

The submerged pipeline required for the Northern Sands DMPA site will be fabricated by welding pipe components together onshore into ‘strings’ between 300m to 1,000m long. Pipe strings will be capped with blank flanges to allow them to float and to be transported (towed) over water by multicat / tug.

A pipe fabrication yard will be needed to allow the pipes strings to be welded together. This could either be located close to the dredge pipeline shore crossing, or at an existing yard within the port. If the fabrication yard is located near the shore crossing, a temporary cutting may be required at the beach through adjacent sand bars to allow the strings to be towed offshore. If an existing yard within the port is used to fabricate strings, a multi-cat workboat and / or tugs will be used to pull the strings to the offshore submerged pipeline location.

The floating pipeline is mild steel pipeline encapsulated in floatation material which keeps it buoyant even when filled with seawater and / or dredged material. It is fabricated onshore to the desired length and towed into position and provides the link between the riser and the TSHD at the pump out station.

The onshore pipeline is joined by bolted, flanged connections and the pipe is seated on discrete earthen mounds of sufficient height to stabilise the pipe and to just elevate the flanges above ground. It will require a construction corridor and road access along the length of its route. The corridor needs to be of sufficient width (7 to 10 metres) to allow for delivery of the pipe by truck, the unloading and installation of pipe components by excavator such as a CAT330 or CAT380, and vehicle access for inspection and maintenance throughout the dredging program.

The onshore pipeline will be delivered to Cairns by road transport in components typically up to 12 metres in length. The pipe components will need to be transported by road to a laydown area(s) that is located near to both the DMPA and dredge material pipeline shore crossing location. The preliminary numbers of truck movements required to transport this length of pipe are 225 B-Double movements each way (i.e. 450 total for mobilisation and demobilisation).

Laydown areas of sufficient size up to 1 hectare will be required for pipe storage, handling and fabrication. In addition, up to 0.5 hectares will be required for a submerged pipeline fabrication yard and the dredging contractor will need a further 1 hectare for his general works area (e.g. storage of plant and equipment, temporary workshop etc.).

Calculation data for the fuel consumption are provided in **Table 2.5**.

Table 2.5 Annual Soft Clay Fuel Consumption

Equipment	Number	Hours / day	Operating Duration (days)	Operating Time (hours)	Fuel consumption (L/h)	Total Fuel Consumed (kL)	Fuel Type
Front end loader	2	24	72	1730	20	69	diesel
40t excavator	2	24	72	1730	20	69	diesel
Dump trucks eg Cat 745C	2	24	72	1730	30	104	diesel
Dozer eg Cat D8	2	24	72	1730	38	132	diesel
De-watering pumps	-	24	72	1730	101	175	diesel

Equipment	Number	Distance (km/day)	Operating Duration (days)	Operating Distance (km)	Fuel consumption (L/100kms)	Total Fuel Consumed (kL)	Fuel Type
Site vehicles (operation	23	25	72	1803	12.5	5	petrol
Site vehicles (construction, decommission)	23	25	84	2100	12.5	6	petrol
Pipe delivery trucks	450 trips	1 h/trip	-	-	11.1 L/h	5	diesel

2.6 Stiff Clay Dredging

The Tingira Street DMPA will consist of two areas of port land previously reclaimed by Ports North at the southern end of Tingira Street, Portsmith as shown in **Figure 2.1**. The site is located on the southern boundary of an industrial area within Strategic Port Land, abutting Smiths Creek to the east and a mangrove system to the west.

The Tingira Street DMPA will consist of the following elements:

- Two land parcels with a total area of approximately 4 hectares serviced by an existing northern barge loading ramp.
- Temporary barge mooring piles may be necessary at the barge landing ramp
- Placed material to a depth of approximately 1.5 metres under RPEQ supervision incorporating a self-draining surface with geotechnically stable batters and appropriate erosion and sediment control, as identified in the Site Preparation and Chapter C1 (Post Placement Management Plan).

The stiff clay dredge material will be placed as engineered fill over previously consolidated dredged material. Material will be barged to the smaller northern area of the Tingira Street DMPA where it will be transferred by crane or excavators to heavy vehicles for short hauling to each placement area. No bunding is proposed. There will be no tailwater discharge needed from the Tingira Street DMPA. General hours of work are to be 14 x twelve hour shifts per week.

Preparation of the Tingira St placement areas is expected to include activities relevant to greenhosue emissions such as clearing, stripping topsoil and stockpiling.

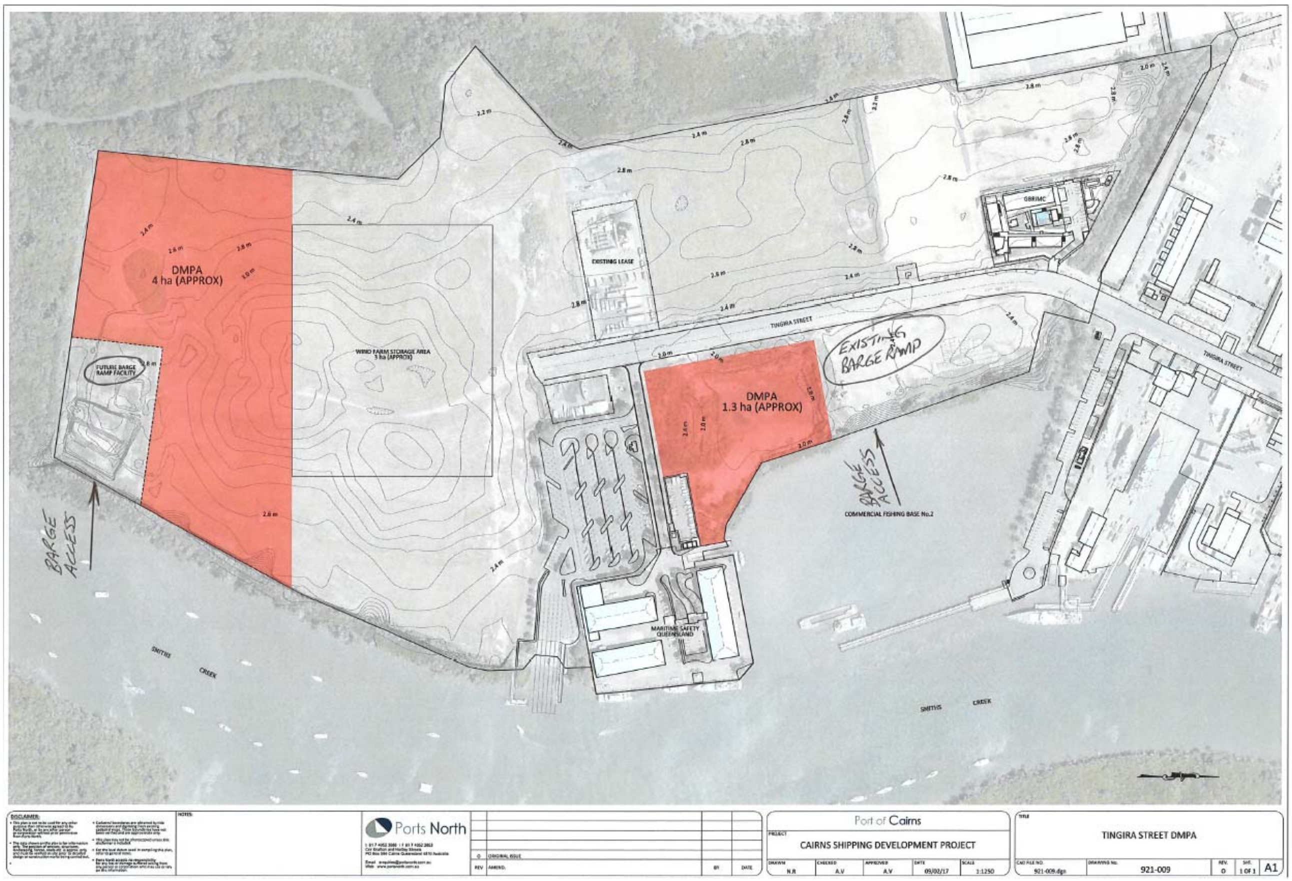

Figure 2.1 Tingira Street DMPA locality

2.6.1 DMPA Equipment

The equipment envisaged on-shore at the DMPA is:

- 180’ spudded flat top barge with ramp
- unloading excavator such as a Hitachi ZX870 (Bucket Capacity = 5.0m^3) 10 hours per shift
- three dump trucks such as Cat 745C (Capacity 45 tonnes) 10 hours per shift
- one dozer such as Cat D6T LGP 10 hours per shift
- one grader such as Cat 12M 3 -4 hours per shift
- one water truck 6 - 8 hours per shift.

2.6.2 Off-shore Equipment

The equipment envisaged off-shore is:

- one backhoe dredge such as a Machiavelli De Donge ‘D’Type with Bucket capacity = 4.5m^3 and engine between 700 to 1000 kW
- two non-propelled 1200m^3 split hopper barges (with 425 hp Cummins QSM11 engine for manoeuvring)
- two tug boats such as the PT May and PT Mary twin screw 17 tonne bollard pull, 2 x Cummins KTA-19-M3 engines (447kW each) with fuel consumption of 4 m^3/day.

- One 25T Bollard Pull type tugboat (e.g. with two Cummins KTA19M engines 900 HP) will operate the sweep bar/plough, day time only.

The dredge and associated equipment will operate in 14 x 12-hour shifts per week. A typical program will be:

- barge loading time: 3.8 hours (continuous operation)
- average transit time (dredge to unloading facility): 1 hour
- barge unloading time: 4.8 hours (continuous operation)
- average transit time (unloading facility to dredge): 1 hour.

The estimated volume of material per 12-hour shift (dredged, transported to unloading facility, unloaded, trucked and placed) is 1,500 m^3. 92,312 m^3 of stiff clay is to be removed (83,796 by backhoe and 8,516 by drag bar). The drag bar is to work 170 hours (17 days 10 hours per day) and the backhoe 313 hours (16 days 20 hours per day). The total working days are to be 22.5 days but this may extend to 30 days. A typical program with two barges is 4 hours of loading, one hour of towing and five hours of unloading.

Calculation data for the fuel consumption are provided in **Table 2.6**.

Table 2.6 Annual Stiff Clay Fuel Consumption

Equipment	Number	Hours / day	Operating Duration (days)	Operating Time (hours)	Fuel consumption (L/h)	Total Fuel Consumed (kL)	Fuel Type
Excavator	1	20	30	600	20	12	diesel
Dozer eg Cat D6	1	10	30	300	25	8	diesel
Grader eg Cat 12M	1	8	30	240	16	4	diesel
Dump trucks eg Cat 745C	3	20	30	600	30	54	diesel

Equipment	Number	Distance (km/day)	Operating Duration (days)	Operating Distance (km)	Fuel consumption (L/100kms)	Total Fuel Consumed (kL)	Fuel Type
Site vehicles	23	25	30	750	12.5	2	petrol

3. Emissions from Vegetation Clearing

Emissions from vegetation clearing were calculated using the Plot module of the FullCAM software v4.1.6.19417 (Department of the Environment 2015).

Spatial data (rainfall, evaporation, temperature and local tree species) were downloaded for latitude -16.829° longitude 145.728°, a location near the proposed booster stations at Yorkeys Knob.

A clearing schedule was not available at the time of this assessment. Therefore for the purpose of this assessment it was assumed that all vegetation clearing was undertaken in one year. Each of the areas and vegetation types listed in **Table 3.1** were entered into FullCAM as a plot. The default biomass values were used. No product recovery was assumed, which is an over-estimate and is considered a worst case scenario for greenhouse gas emissions.

Table 3.1 Vegetation Proposed to be Cleared in the Study Area

Location	Vegetation type	Area to be cleared (ha)
Pipeline	RE1.1.1 (LC) Mangrove	0.16
Discharge Option 1	-	N/A
Discharge Option 2	RE1.1.1 (LC) Mangrove	0.11
Pipeline	RE 7.2.9a / 7.3.25a (OC) Melaleuca wetland	0.14
Northern Sands DMPA	Grassland	12.05
Tingira St DMPA	Grassland	4.17
Tingira St DMPA	Tidally influenced land	0.76

The decay or combustion of vegetation will emit both CO_2 and, in anaerobic conditions, CH_4. Literature provided by Department of Climate Change and Energy Efficiency and its predecessors, provide some factors for the proportion of non-CO_2 gases released by combustion, but not by decay. Therefore this assessment assumes that the carbon is released as CO_2.

The results of the model simulation are shown in **Table 3.2**. The molecular weight of carbon is 12 and that of CO_2 is 44. Therefore, applying a conversion factor of 44 / 12 / 1000 converts these predicted values to kilotonnes $CO_{2\text{-}e}$.

Table 3.2 Carbon Emissions from Vegetation Clearing

Location	Vegetation	Net carbon mass (tonnes)	Emission (kilotonnes $CO_{2\text{-}e}$)
Pipeline	RE1.1.1 (LC) Mangrove	14	0.05
Pipeline and Discharge Option 2	RE1.1.1 (LC) Mangrove	24	0.09
Pipeline	RE 7.2.9a / 7.3.25a (OC) Melaleuca wetland	13	0.05
Northern Sands DMPA	Grassland	53	0.19
-	**Total Option 1**	**80**	**0.29**
-	**Total Option 2**	**90**	**0.33**
Tingira St DMPA	Grassland	18	0.07
Tingira St DMPA	Tidally influenced land (treated as Mangrove)	67	0.24
-	**Total Tingira St**	**85**	**0.31**

The data in **Table 3.2** is included into the project 2018 inventory with the following notes:

(1) The inbound pipeline area will be rehabilitated following decommissioning of the pipeline. Hence this is included in the 2018 project inventory but not the 2028 inventory. A greenhouse sink (offset) similar to the 2018 pipeline emission would be provided in the years following decommissioning of the pipeline.

(2) The Tingira Street DMPA clearing would take place anyway under the approved industrial land project. Hence it is included in the projected 2018 baseline inventory as well as the project 2018 inventory.

4. Scope 1 Operational Emissions

4.1 Scope

This section assesses greenhouse gas emissions from cruise ships, maintenance dredging and associated vessels. It does not account for other shipping, which is not directly affected by the project.

The numbers of cruise ships berthing at the Port of Cairns is currently approximately 30. In 2026 with the upgrade the number of cruise ships is projected to be up to a maximum of 177 cruise ships including 164 megaships per year. It is anticipated that only one cruise ship will be docked at any one time.

Other vehicles will include buses, taxis, private vehicles, delivery trucks, sewerage trucks and fuel tankers. Traffic volumes on the neighbouring streets are not anticipated to change significantly.

4.2 Maintenance Dredging Fuel Combustion

The annual maintenance dredging volume of the outer channel will increase by approximately 30% up to a total of approximately 450,000 m^3 per year. This will be removed by a dredge similar to the currently used Port of Brisbane's TSHD. With the project, the dredge is assumed to operate 12 hour days on 30 days per year. For the baseline scenario the duration has been scaled back to 23 days per year. Calculation data for the greenhouse gas emissions are provided in **Table 4.1**.

Table 4.1 Annual Maintenance Dredge Emissions

Equipment	Hours / day	Operating Duration (days)	Operating Time (hours)	Fuel consumption (L/h)	Total Fuel Consumed (kL)	Fuel Type	Emission factor (tonnes CO_2-e/kL) [1]	Total Emissions (kt CO_2-e)
TSHD baseline	12	23	277	809	224	Fuel oil	2.95	0.66
TSHD project	12	30	360	809	291	Fuel oil	2.95	0.86

*Notes: 1. Emission factors from **Table 2.1**.*

4.3 Cruise Ship Fuel Combustion

Emissions were modelled for four scenarios: the first year of operation (2018) and the ten year planning horizon (2028); both with the project and without the project.

4.3.1 Projected Cruise Shipping Movements

The information in this sub-section has been summarised from AEC (2016). **Table 4.2** provides the relevant details of each classification of cruise ship.

Table 4.2 Cruise Ship Classification by Length

Classification	Length (m)	Example	Gross registered mass (tonnes)	Overall Length (m)
Sub-regal	< 240	Pacific Aria	55,451	219
Regal	240 – 260	Pacific Dawn	70,285	245
Sun	260 – 290	Sun Princess	77,441	261
Vista	290 – 300	Queen Victoria	90,049	294
Grand	300 – 310	Emerald Princess	113,561	290
Voyager	> 310	Voyager of the Seas	137,276	312

Projections of ship visits are provided in **Table 4.3** for the lowest baseline (AEC scenario 1 without Brisbane Cruise Terminal and without home porting) and in **Table 4.4** the highest with project (scenario 16 with Brisbane Cruise Terminal and home porting and bunkering). Voyager class will not be able to negotiate the inlet even with the proposed channel widening, and have been excluded from all calculations. **Table 4.5** shows the baseline ship visits to Yorkeys Knob. The project scenario ship visits to Yorkeys Knob will be zero (apart from the Voyager class).

AEC provided low, medium and high projections for the years 2016, 2021, 2026 and 2031. For this assessment, the medium baseline and high project projections have been used. ASK has interpolated these linearly to obtain 2018 and 2028.

Table 4.3 Projected Baseline (AEC Scenario 1) Ship Visits to Trinity Wharves

Classification	2016	2018	2021	2026	2028	2031
Sub-regal	29	27	25	33	37	42
Regal	-	-	-	-	-	-
Sun	15	15	16	14	12	10
Vista	-	-	-	-	-	-
Grand	-	-	-	-	-	-
TOTAL	**44**	**42**	**41**	**47**	**49**	**52**

Table 4.4 Projected Project (AEC Scenario 16) Ship Visits to Trinity Wharves

Classification	2016	2018	2021	2026	2028	2031
Sub-regal	29	31	33	43	48	55
Regal	-	3	7	4	5	6
Sun	15	25	40	31	27	20
Vista	-	27	67	77	69	57
Grand	-	3	7	22	31	45
TOTAL	**44**	**89**	**154**	**177**	**180**	**183**

Table 4.5 Projected Baseline (AEC Scenario 1) Ship Visits to Yorkeys Knob

Classification	2016	2018	2021	2026	2028	2031
Sub-regal	-	-	-	-	-	-
Regal	11	8	3	2	2	2
Sun	-	-	-	-	-	-
Vista	5	10	18	23	20	16
Grand	-	1	3	9	13	20
TOTAL	**16**	**19**	**24**	**34**	**35**	**38**

4.3.2 Cruise Ship Movement Scenario

Information in this sub-section was provided by Ports North. Port of Cairns speed restrictions are:

- 10 knots seaward of beacon 15
- 8 knots inward of beacon 15.

The engine configuration is different for each ship however a typical scenario for the Jewel Vista class vessel for arrival is as follows:

- Transit from Pilot Boarding Ground Alpha (Lat 16 degrees:47 Min; Long 145 deg:53 mins which is approximately 4 nautical miles NNE of channel entrance fairway beacons) to First lines on wharf is with running of 3 x engines. Typically each DG is 20,000 HP. Time taken is 1 hour and 30 mins on average coming in, including swinging in swing basin. Transit speed in channel is 10 to 12 knots up to Beacon 15 / 16 (WGS84 UTM coordinates of 371952, 8132238) then slow to 8 to 10 knots beacon 15/16 to beacon 20 (WGS84 UTM coordinates of 370553, 8129245). Then 6 to 8 knots from Beacon 20 down to 4 knots at swing basin (WGS84 UTM coordinates of 370335, 8128172).
- Swing basin manoeuvre takes approx. 15 to 20 mins including coming in parallel to berth with stern and bow thrusters (at very low speed).
- From First Lines on wharf to all lines fast 2 x engines are run. Time taken approximately 15 to 20mins.
- Whilst alongside continue to power ship services with 1 x engine.

A typical scenario for departure is as follows:

- Continue with 1 generator from first rope off to last rope off.
- From Last Line off for full departure to Pilot Boarding Ground 3 x engines. Time approx. 1 hour (no swinging) .

A typical scenario for the Radiance Vista class vessel from Pilot on board to alongside.

- Transit POB – Alongside Gas Turbine .
- Alongside 1 x engine.
- Departure is Gas Turbine.

Where a range of potential speeds has been provided, ASK has calculated fuel consumption based on the higher number, a conservative assumption.

4.3.3 Cruise Ships off Yorkeys Knob

The impact of the project will increase cruise ship numbers berthing at Trinity Wharves but will decrease cruise ships parking off Yorkeys Knob. Thus the greenhouse inventory should include fuel combustion emissions from Yorkeys Knob. The following information has been provided by the Ports North.

Cruise Vessels parked off Yorkeys Knob have to run propulsion engines (stern and bow thrusters) to hold and adjust position during disembarking and embarking of passengers. Passengers are ferried into Yorkeys Knob by Reef Catamarans at typically 150 passengers per trip. In some cases due to non-availability from the Cairns Fleet, the Reef Cats are engaged from and travel up and back from Townsville.

Power generation on the ship at the wharf is likely slightly less than off Yorkeys Knob as more passengers disembark for a longer period so baseline emissions would be slightly more. This minor effect is difficult to quantify and has not been included in calculations.

Ships will typically be running two diesel generators (20,000 HP typically) whilst parked. This feeds the normal on board electrical requirements and runs thrusters to hold/change position. Fuel consumption is typically 60 tonnes per day of which 40 tonnes per day is to run thrusters. That is approximately 20 tonnes per day to power on board accommodation, entertainment, air conditioning, cooking etc. This is provided by one engine at about 75% power.

By comparison when alongside wharf this consumption is more typically 10 – 15 tonnes per day or one engine at about 40%-50% power.

The Reef Catamarans typically burn approximately 450 l/h at full power. Typically 2 Cats are used and they do about 12 - 15 round trips (about 15 minutes each way) from ship to shore and back, per visit (per day effectively). Remaining time is spent idling at ship and at berth in between. It is 30 mins each way from their Marina base if in Cairns. They each typically burn 1000 - 1200 litres of fuel per day. Thus Cat fuel consumption is assumed to be 2200 l/day for each ship visit.

4.3.4 Greenhouse Gas Emission Calculations

Table 4.6 below present the total fuel consumption and the resultant emissions, with a total greenhouse gas emission increase relative to the baseline of 2 megatonnes CO_2-e from fuel combustion for the 2028 project scenario.

Table 4.6 Cruise Ship Fuel Combustion Annual Emission Summary

Activity	Total Fuel Consumed (kL)	Emission factor (tonnes CO_2-e/kL) [1]	Total Emissions (kt CO_2-e)
Current 2016	1,964	295	5.8
Baseline 2018 Cairns Wharf and Channel	919		
Baseline 2018 Yorkeys Knob (non-Voyager ships + cats)	1,189		
Baseline 2018 Total	2,108	2.95	6.2
Baseline 2028 Cairns Wharf and Channel	1,072		
Baseline 2028 Yorkeys Knob (non-Voyager ships + cats)	2,190		
Baseline 2028 Total	3,262	2.95	9.6
Project 2018 Cairns Wharf and Channel	1,949	2.95	5.8
Project 2028 Cairns Wharf and Channel	3,944	2.95	11.6

*Notes: 1. Emission factors from **Table 2.1**.*

5. Scope 2 Port Facility Electricity Emissions

The most inefficient use of power if ships all visit on separate days and wharves 1 to 4 used. If multiple ships are berthed at the same time, wharves 1 to 6 are used, but the number of days would be reduced, so the net result would be less power consumption. For the purpose of these calculations, it is assumed that ships arrive on separate days.

Power consumption rates of lights and motors at the wharf are provided in **Table 5.1**. Transit ship average stay duration is 20 hours with 11 of these daylight (26 kW used) and 9 hours with lights on (33 kW) during ship stay. Adding on no ship for 4 hours, this equates to power use of 27 + 290 + 295 = 612 KWh / day.

Home porting vessels would be turned around faster (approximately 10 hours of daylight) but would use a little more power for screening and temporary facilities (a few pedestal fans and extra lights). This scenario has not been included in the calculations.

Table 5.1 Wharf Power Consumption Rates (provided by Ports North)

Item	Use	Number of items	Power Consumption (kW)	Daily duration (hrs)	Daily total consumption (kWhr)
250W internal lighting	Ships	57	14.25	24	-
70W internal lighting	Ships	10	0.7	24	-
160W customs lighting	Always	30	4.8	24	-
60W LED lighting	Ships	10	0.6	24	-
350W fan motors	Ships	10	3.5	24	-
500W fan motors	Ships	1	0.5	24	-
150W external night[1] lighting	Night ships	5	0.75	13	-
110W external night lighting	Night ships	4	0.44	13	-
250W external night lighting	Night ships	5	1.25	13	-
500W Breeze way lighting	Always	4	2	24	-
1000W Wharf 4 night lighting	Night ships	4	4	13	-
1000W Wharf 5 night lighting	Night ships	9	9	13	-
Total	No ships berthed	-	6.8	4 24	27 163
Total	Day ships	-	26	11	290
Total wharves 1 to 4	Night ships	-	33	9 13	295 426
Total wharves 1 to 6	Night ships	-	42	9 13	376 543

Notes: 1 Night time is assumed to be 1730 – 0630

Emission factors associated with consumption of purchased electricity are shown in **Table 5.2.**

Table 5.2 Purchased Electricity (Scope 2) Emission Summary

Scenario and Year	Number of Ships	Total Electricity Consumed (kWh)	Emission factor [1] (kg CO_2-e / kWh)	Total Emissions (kt CO_2-e)
Baseline 2018	42	612 x 42 + 163 x (365-42) = 78353	0.78	0.061
Baseline 2028	49	612 x 49 + 163 x (365-49) = 81496	0.78	0.064
Project 2018	89	612 x 89 + 163 x (365-89) = 99456	0.78	0.078
Project 2028	180	612 x 180 + 163 x (365-180) = 140315	0.78	0.109

Note: 1. Source is Table 5 of DEA (2016).

6. Summary

Summaries of the data are provided in **Table 6.1** to **Table 6.3**.

6.1 Construction Results

Table 6.1 Fuel Consumption Factors for Relevant Project Elements

Plant type	Reference	Fuel consumption		
		Fuel	Factor	Units
Trailer suction hopper dredger	Fuel consumption based on similar-sized ship: • 2008-built TSHD with shore pump-out, with total installed power of 3,135 kW, and total fuel consumption at 450 l/hr. Fuel usage pro-rated by total installed power for quoted TSHD make and model: • 5,580 m^3 type, *Marieke* (Dredging International), with total installed power of 6,828 kW.	HFO	980	l/hr
Backhoe dredger	Fuel consumption based on similar-sized ship: • 2014-built excavator dredger, with total installed power of 3,040 kW; fuel usage quoted at 540 l/hr. Fuel usage pro-rated by total installed power for quoted backhoe dredger make and model: • 1,600 kW *Hippopotes* (Van Ooord), with total installed power of 1,985 kW	HFO	353	l/hr
On-shore booster pumps	Scaled to 2000 kW booster from 550 l/h for 2500 kW booster quoted in Sunshine Coast Airport Expansion Project EIS Appendix A5 (2014).	Diesel	440	l/h
Off-shore booster pump	Scaled to 4475 kW booster from 550 l/h for 2500 kW booster quoted in Sunshine Coast Airport Expansion Project EIS Appendix A5 (2014).		985	l/h
Tugs (for construction dredging)	CA EPA (1999), *Source Inventory – Tugs and Towboats, Dredge Vessels and Others*, '1501-2000 HP-Tug'	HFO	164.7	l/hr
Support vessels	CA EPA (1999), *Source Inventory – Tugs and Towboats, Dredge Vessels and Others*, '1001-1500 HP Tug'	Diesel	119.9	l/hr
Concrete trucks (15 t)	National Ready Mixed Concrete Association (2012), *Fleet Benchmarking and Costs Survey, Table 5*	Diesel	11.1	l/hr
Site vehicles	Assume a Holden VF SIDI Utility Evoke, Urban fuel consumption, as per http://www.greenvhielceguide.gov.au/	Petrol	12.5	l/100 km

Table 6.2 Estimated Construction Phase GHG Emissions

Emission source	Est. fuel consumption (kl)	Fuel type	GHG emissions ($ktCO_2$-e)	% of construction emissions
Trucks	584	Diesel	1.59	7%
Site vehicles (utility, 4WD etc.)	27	Petrol	0.06	0.3%
Construction plant (e.g. excavators)	710	Diesel	1.93	8%
Dredging – TSHD	1695	HFO	5.00	21%
Dredging – backhoe dredge	254	HFO	0.75	3%

Emission source	Est. fuel consumption (kl)	Fuel type	GHG emissions ($ktCO_2$-e)	% of construction emissions
Dredging – hopper barges, including tugs	356	HFO	1.05	4%
Dredging – support, survey and crew boats	414	Diesel	1.13	5%
Dredging – booster pumps	4162	Diesel	11.33	47%
Construction (piling) – pile driving rig	29	Diesel	0.08	0.3%
Construction (piling) – pile delivery barge	229	HFO	0.67	3%
Vegetation clearing	n/a	n/a	0.64	3%
Total	**8461**		**23.9**	

6.2 Operational Results

Table 6.3 Estimated Operational Phase GHG Emissions

Emissions source	Baseline condition		Project scenario	
	2018	2028	2018	2028
	($ktCO_2$-e)	($ktCO_2$-e)	($ktCO_2$-e)	($ktCO_2$-e)
Scope 1 emissions				
Dredging maintenance	0.66	0.66	0.86	0.86
Emissions from increased shipping	0.4	3.8	0.0	5.8
Scope 2 emissions				
Port facility electricity	0.06	0.06	0.08	0.11
Total	**1.1**	**4.5**	**0.9**	**6.8**

6.3 Perspective

The total scope 1 greenhouse gas emissions in 2015 - 2016 from corporations that had to report to NGER was 90 Megatonnes CO_2-e in Queensland and 334 Megatonnes CO_2-e in Australia (Clean Energy Regulator 2017). The Australian total scope 2 greenhouse gas emissions in 2015 – 2016 were 90 Megatonnes CO_2-e.

References

Clean Energy Regulator (2017), *2015-16 National Greenhouse and Energy Reporting Published Data Highlights*, **http://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/Data-highlights**, published 16 May 2017.

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ACOUSTICS & AIR QUALITY

Appendix A Glossary

Parameter or Term	Description
ASK	ASK Consulting Engineers Pty Ltd
CO2	Carbon dioxide
CO2-e	Carbon dioxide-equivalent
GHG	Greenhouse gas
GJ	Giga joule
GWh	Gigawatt hours
GWP	Global Warming Potential
kg	Kilogram
kL	Kilolitre
NGER	National Greenhouse and Energy Reporting