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12 Air quality and greenhouse gas assessment

12.1 Chapter content

The Project impact assessment for air quality and greenhouse gas assessment was provided in Chapter 12 of the Project EIS.

This chapter provides additional information to address the submissions received during the statutory public display period of the Project EIS. The key issues raised from the Project EIS submission process relevant to the air quality and greenhouse gas assessment chapter are summarised in Table 12.1.

Table 12.1 Summary of submission issues received in relation to the Project EIS air quality and greenhouse gas assessment chapter

Submitter ID number (refer Appendix A)	Summary of submission issue raised	Project EIS section (public notification version)	AEIS section containing information to address submission comments	Complete replacement section for Project EIS	Supplements the Project EIS information
12.99	Clarify whether Level 2 or Level 1 watering is proposed to be applied to achieve a 75% reduction in emissions from the wheel generated dust and a 50% control on all other extraction and processing activities	Section 12.5	Section 12.2		✓
12.100	Provide and describe emissions of air pollutants from the diesel generators in terms of mg/Nm^3 at oxygen reference level and compare against the NSW *Protection of the Environment Operations (Clean Air) Regulation 2010*	Section 12.5	Section 12.2		✓
12.101	Provide at least the cumulated maximum PM_{10} 24-hr average GLC at the sensitive receptors in Targinnie. Should the maximum concentration exceed the EPP (Air) objective, provide the number of days of exceedances per year.	Section 12.5.2	Section 12.3		✓
12.96	Describe all GHG emission sources, there potential impacts and proposed mitigation measures in the draft EIS. Where GHG emissions are omitted from the draft EIS clearly explain why.	Section 12.6.2	Section 12.4	✓	

Submitter ID number (refer Appendix A)	Summary of submission issue raised	Project EIS section (public notification version)	AEIS section containing information to address submission comments	Complete replacement section for Project EIS	Supplements the Project EIS information
12.97	Correct or justify this inconsistency in maximum GHG annual emissions estimated for the Project	Section 12.6.2.2 Section 12.7	Section 12.5		✓
12.98	Discuss why the lower USEPA emissions factor was applied rather than the higher than the Australian NPI value. Discuss the implications of using the lower emissions factor on the modelled dust emissions. Discuss how worst case emissions compare to those modelled using the USEPA emissions factor. Discuss dust emissions from wind erosion of exposed areas under strong wind conditions and the effect these worst case emissions will have on the estimated maximum ground level concentrations (GLC) at sensitive receptors. Explain how the dust emissions from wind erosion were estimated in Table 12.21, Table 12.22 and Table 12.24.	Section 12.5	Section 12.6		✓
		Appendix J	Section 12.6	✓	
12.103	Describe the likely source of water to be applied as a dust suppression. Include an analysis of the potential impact of this water on the ability of the proposed project to meet water quality objectives and release limits	Section 12.6.1	Section 12.7		✓
12.102	Include a commitment to conduct dust deposition monitoring near the sensitive receptors in the Project EMPs. Include triggers for actions to protect against impacts of dust deposition at these sites and describe potential actions to avoid dust deposition impacts.	Section 12.5.2	Section 12.8		✓
		Appendix Q4	Appendices F, G and I	✓	
12.104	Include a commitment to prepare an Air Quality Management Plan, which includes all mitigation measures for GHG emissions	Section 12.6.2	Section 12.8		✓
		Appendix Q4	Appendix I	✓	

Submitter ID number (refer Appendix A)	Summary of submission issue raised	Project EIS section (public notification version)	AEIS section containing information to address submission comments	Complete replacement section for Project EIS	Supplements the Project EIS information
E9.12	Exceedance of PM_{10} levels for some Targinnie residents is unacceptable, due to the implications for human health. Watering of haul roads greater than the suggested level of 75% will be required. It may be necessary to progressively seal all haul roads as the Project progresses to prevent these unacceptable impacts on Targinnie residents, especially considering the three year duration of the Project.	Section 12.5.2	Sections 12.2 and 12.3		✓

Table notes:

1 Submitter ID number commencing with 'E' are submissions received under the EPBC Act public notification process (refer AEIS Appendix B for details)

2 Other ID numbers are submissions received under the SDPWO Act public notification process (refer AEIS Appendix A for details)

12.2 Potential construction impacts – dust emissions during construction of bund walls

This section replaces the Project EIS Section 12.5.1.2 (construction – dust emissions during construction of bund walls).

Dust is the primary air pollutant associated with the construction of the BUF and the WBE reclamation area bund walls. The construction of the BUF and bund walls requires external sourcing of materials (armour, core and fill material), transport to the site and bulldozing. Dust emissions are dependent on operation details, volume of materials to be used during construction, vehicle fleet, and locations of sources relative to sensitive receptors. Dozing and the handling of construction materials will occur during daylight hours. Night time emissions will only come from wind erosion of exposed areas.

Data used in estimating emissions are detailed in Section 12.6.

Dust emissions from Project activities will be reduced by the implementation of control measures (refer Table 12.2).

Dust emissions due to the extraction of the bund wall material from the Targinnie/Yarwun quarry area, and transport from the quarry to the BUF and WBE reclamation area have also been quantified as part of the assessment of the Project. It has been assumed that watering (at a rate of >2 litres/m^2/h) is used at the Targinnie/Yarwun quarry area to achieve a 75% reduction in emissions due to wheel generated dust from haul truck movements onsite, and a 50% control on all other extraction and processing activities due to the use of water sprays from vehicles and material being damp. Note that these dust emissions are based on the volume of bund wall material, not the total quarry extraction rate.

Dust emissions due to material haulage have been based on the average number of trips expected per day.

Minor levels of trace emissions of oxides of nitrogen (NO_X), carbon monoxide (CO), volatile organic hydrocarbons (VOCs) and other pollutants will also occur due to vehicle emissions. These emissions are transient and are expected to be negligible compared to dust emissions and have not been considered further.

The WBE reclamation area bund walls for the southern area and the northern area will be constructed over two 18 month periods (i.e. 18 months for each reclamation area). The WBE reclamation area (southern area) is shown in Figure 12.1, while the WBE reclamation area (northern area) is shown in Figure 12.2. The construction of the BUF will commence 12 months prior to dredging commencing. The estimated total emissions and dust emission rates for both reclamation areas are summarised in Table 12.3 and Table 12.4, respectively. Dust emissions due to the construction of the BUF have been considered in addition to construction activities in the northern area, as these will occur simultaneously for the 12 months prior to dredging commencing. Estimated emissions due to wind erosion of the bund walls have been calculated assuming that the entire bund wall is exposed, and has a total width of 23m. A 50% control has been applied to account for watering of the bund wall and compaction which will reduce wind erosion emissions.

The estimated dust emissions due to construction of the WBE reclamation area (northern area) and BUF are significantly higher than during the WBE reclamation area (southern area) due to a longer travel distance from the quarry area to the northern bund wall, and due to a higher maximum number of trips per day from the quarry area, and associated BUF construction activities. Dust emissions due to the WBE reclamation area (northern area) and BUF construction have been modelled as this is expected to provide a worst-case assessment of dust impacts during the construction phase.

Table 12.2 Control measures to mitigate dust emissions during construction of bund walls and the barge unloading facility

Activity/emission source	Control measure	Reduction
Extraction of materials from Targinnie/Yarwun quarry area	Watering	50%
Onsite haulage at Targinnie/Yarwun quarry area	Level 2 watering (>2 litres/m^2/h)*	75%
Unsealed haul roads	Level 1 watering (2 litres/m^2/h)*	50%
Exposed areas	Water truck for dust control/conditioning earth fill for compaction	50%
Movement of dredged material from the WB reclamation area to the BUF	Watering	50%
Dozing	No control	0%

Table note:

* Dependent on weather conditions

Table 12.3 Estimated total dust emissions (tonnes) for construction of bund walls at Western Basin Expansion reclamation area (18 months) and the barge unloading facility (12 months)

Activity	Location	Southern area			Northern area		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Extraction of material from Targinnie/Yarwun quarry area	Targinnie/Yarwun quarry area	89.3	34.1	4.6	123.5	45.7	6.0
Transport of materials from Targinnie/Yarwun quarry area to site	Public road network	98.3	18.9	4.6	149.7	28.7	7.0
Onsite haulage and dumping of materials	Bund wall	175.0	51.2	4.9	651.4	187.9	17.8
Dozing	Bund wall	573.8	406.2	48.3	573.8	406.2	48.3
Wind erosion	Bund wall	10.1	5.1	0.8	23.6	11.8	1.8

Activity	Location	Southern area			Northern area		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
BUF construction - Movement of dredged material from the WB reclamation area and the BUF	BUF	-	-	-	137.7 *	40.1 *	3.8 *
Total		**946.5**	**515.4**	**63.2**	**1,659.8**	**720.5**	**84.7**

Table note:

* BUF will be constructed over a 12 month period. All other construction activities in the northern area occur over 18 months.

Table 12.4 Estimated dust emission rates (g/s) for construction of bund walls at Western Basin Expansion reclamation area and barge unloading facility

Activity	Location	Southern area			Northern area		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Extraction of material from Targinnie/Yarwun quarry area	Targinnie/Yarwun quarry area	1.9	0.7	0.1	2.6	1.0	0.1
Transport of materials from Targinnie/Yarwun quarry area to site	Public road network	2.1	0.4	0.1	3.2	0.6	0.1
Onsite haulage and dumping of materials	Northern bund wall	3.7	1.1	0.1	13.8	4.0	0.4
Dozing	Northern bund wall	12.1	8.6	1.0	12.1	8.6	1.0
Wind erosion	North and south bund walls	0.2	0.1	0.02	0.4	0.2	0.03
BUF construction - Movement of dredged material from the WB reclamation area and the BUF	WB reclamation area and the BUF	-	-	-	4.4	1.3	0.1
Total (day time)		**20.0**	**10.9**	**1.3**	**36.5**	**15.6**	**1.8**
Total (night time)		**0.2**	**0.1**	**0.02**	**0.4**	**0.2**	**0.03**

Table note:

g/s = grams per second

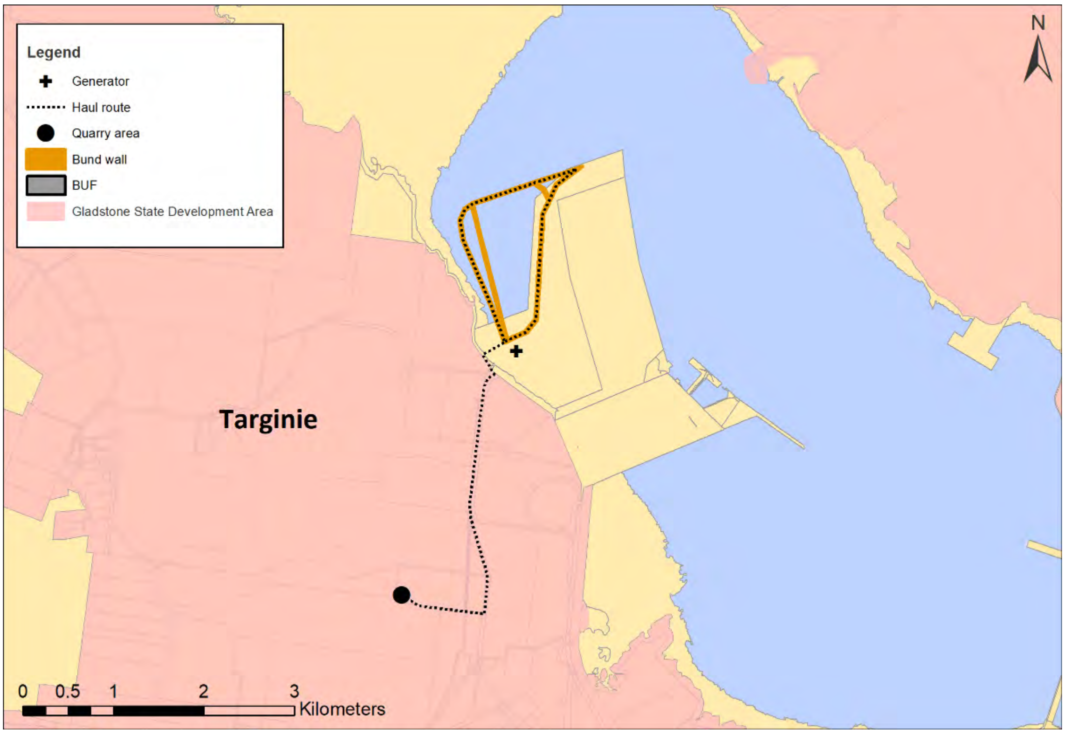

Figure 12.1 Western Basin Expansion reclamation area (southern area)

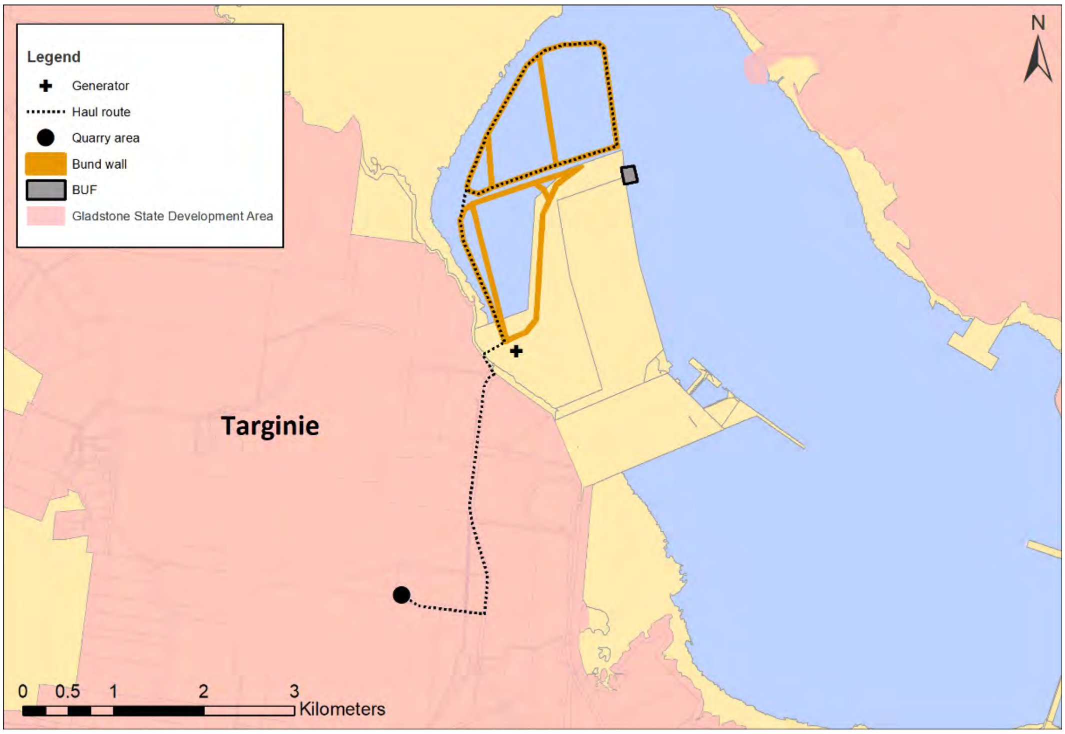

Figure 12.2 Western Basin Expansion reclamation area (northern area) and barge unloading facility

Construction – electricity generation

During construction, it is anticipated that diesel generators will operate at the construction compound, which is to be located south of the southern area bund wall. As detailed information about the generators is not available, it has been assumed that 4 x 550 kilowatt (kW) generators will operate 12 hours/day. Emission rates have been estimated using emission factors in the NPI Emission Estimation Technique Manual for Combustion Engines (NPI 2008) and stack characteristics have been based on manufacturer's specifications for a 550kW diesel generator. Emission rates and stack characteristics used in the assessment are presented in Table 12.5.

It has been assumed that the generator stacks are not wake affected.

Table 12.5 Estimated emission rates and stack characteristics used in the dispersion modelling of the generators

Parameter	Units	Value	Information source
Number	number	4	Assumed
Operating hours	hours/day	12	As for construction operations
Power output	kW	550	Assumed
Stack height	m	6.45	Assumed
Stack diameter	m	0.2	Assumed
Temperature	°C	515	Manufacturer's specifications – Cummings C550 D5e
Exit velocity	m/s	43.6	Calculated
NO_x emission rate	g/s	1.207	Calculated using emission factor for NO_x (controlled) from NPI for combustion engines
CO emission rate	g/s	0.504	Calculated using emission factors from NPI for combustion engines
$PM_{2.5}$ emission rate	g/s	0.064	
PM_{10} emission rate	g/s	0.066	
SO_2 emission rate	g/s	7.49×10^7	
NO_x emission concentration	mg/Nm^3	2,542	Calculated from emission rates, stack velocity and stack diameter
CO emission concentration	mg/Nm^3	1,062	
$PM_{2.5}$ emission concentration	mg/Nm^3	135	
PM_{10} emission concentration	mg/Nm^3	138	
SO_2 emission concentration	mg/Nm^3	0.0016	

Table note:

1 0°C. Oxygen content, moisture content and pressure not known

The relevant emission concentration standards from the NSW *Protection of the Environment Operations (Clean Air) Regulation 2010* are provided in Table 12.6.

Table 12.6 Emission concentration standards (*NSW EPA Protection of the Environment Operations (Clean Air) Regulation 2010*)

Parameter	Units	Value[1]	Information source
NOx emission concentration	mg/Nm3	450	Schedule 4, group 6, stationary reciprocating internal combustion engines
Solid particles (total)	mg/Nm3	50	Schedule 3, Group 5, Electricity generation, any activity or plant using a liquid or solid standard fuel or a non-standard fuel
VOCs, as n-propane	mg/Nm3	1,140 (VOCs)	Schedule 4, Group 6 – Any stationary reciprocating internal combustion engine using a liquid fuel
	mg/Nm^3	5,880 (CO)	

Table note:

1 Reference conditions: dry, 273 K, 101.3 kPa, 4% O_2.

There is no emission concentration standard in the NSW *Protection of the Environment Operations (Clean Air) Regulation 2010* for SO_2. The emission concentration of CO is significantly lower than the emission concentration standard for CO provided as a measure of total VOCs. The estimated emission concentration of NOx is higher than the emission standard of 450mg/Nm^3. The estimated emission concentrations of PM_{10} and $PM_{2.5}$ are also both higher than the emission standard for total solid particles of 100mg/Nm^3.

However, predicted ground-level concentrations of all pollutants emitted from the generators are predicted to be well below the Environmental Protection (Air) Policy 2008 objectives at sensitive receptors.

12.3 Dredged material placement – dust emissions

This section supplements the Project EIS Section 12.5.2.3 (dredged material placement and dredging operations, dredged material placement – dust emissions).

The maximum 24-hour average ground-level concentrations of PM_{10} in the Targinnie residential area is predicted to be 56.6µg/m^3. Ground-level concentrations of PM_{10} in this location are predicted to exceed the objective of 50µg/m^3 on one day during the year only.

12.4 Greenhouse gas emissions sources and inventory

This section replaces the Project EIS Section 12.5.3 (greenhouse gas emissions sources and inventory).

12.4.1 Emissions sources

The type of equipment and their number were estimated based on engineering practice and past experience in similar types of projects (refer Table 12.7 to Table 12.12). The actual Project equipment and their specifications may differ from those indicated and will be largely dependent on availability and choice of contractors during the construction phase of the Project.

Table 12.7 Equipment summary for bund wall construction

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
CAT 12 G grader (blade width 2.5m)	1	Diesel	5.3L/km	To evenly spread the material, trimming to required line and level
Dozer (D6) – medium	1	Diesel	29.1L/km	Spread/push earth fill or rock fill
Dozer (D9) – large	1	Diesel	56.4L/km	Spread/push earth fill or rock fill
Excavator – medium	1	Diesel	32.1L/km	Placing of core, armour and revetments and geotextile
Haul truck - dump trucks/trailer (B-Doubles)	20	Diesel	27.9L/km	Quarry material – including public roads
Water cart (minimum - 10,000L)	1	Diesel	28.7L/km	Dust control/conditioning earth fill for compaction
Small skid-steer (Bobcat)	1	Diesel	33.8L/km	To spread material on very soft soils and placement of geotextile
Vibratory roller (smooth/sheep foot) CB534D	1	Diesel	15.1L/km	Finishing earth fill surface
Diesel Generator	1	Diesel	12.7L/km	Diesel generator for site compound
Excavator – large	2	Diesel	114.0L/km	Quarry area – excavate rock fill
Loader – medium	2	Diesel	33.8L/km	Quarry area – load rock fill into trucks

Table 12.8 Equipment summary for barge unloading facility

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
Sheet pile driver	1	Diesel	114.0L/km	Installation of sheet piling or similar earth retaining structure
Loader – medium	1	Diesel	33.8L/km	Load excavated material into trucks
Haul truck – dump trucks/trailer (B-Doubles)	2	Diesel	27.9L/km	Transport of excavated material
Excavator – large	1	Diesel	32.1L/km	Placing of core, armour and revetments and geotextile
Loader – medium	2	Diesel	33.8L/km	Quarry area – load rock fill into trucks

Table 12.9 Equipment summary for placement of navigational aids

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
Barge (15m x15m) with crane (> 50t)	1	Diesel	200L/hr	Transport of equipment and navigation aids
Diesel generator with hydraulic pumps	1	Diesel	12.7L/hr	Piling will be less than 4 hours per navigational aid
Junttan hydraulic impact hammer - HHK 10S	1			

Table note:

L/hr = litres per hour

Table 12.10 Equipment summary for dredging operations

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
TSHD – 20,000m³ (25,540kW)	1	Heavy fuel oil	110g/kWh	Capital dredging of channels
CSD – 20,000m³ (27,240kW)	1	Heavy fuel oil	194g/kWh	Initial dredging works
Tug boat	1	Heavy fuel oil	185g/kWh	Transfer of dredged material to BUF
Barge (pushbuster)	4			
Work boat	1	Diesel	50L/hr	Transporting crew

Table notes:

g/kWh = grams per kilowatt hour
L/hr = litres per hour

Table 12.11 Equipment summary for dredged material placement and earthworks

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
Excavators – large	6	Diesel	32.1L/km	Loading of dredged material onto trucks at BUF
Trucks	32	Diesel	27.9L/km	Transport of dredged material from BUF to placement areas
CAT 12 G grader (blade width 2.5m)	1	Diesel	5.3L/km	To evenly spread the material, trimming to required line and level. Grading only required at end of dredged material earthwork activities to level final land form.
Dozer (D6) – medium	1	Diesel	29.1L/hr	Spread/push dredged spoil

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
Dozer (D9) – large	1	Diesel	56.4L/hr	Spread/push dredged spoil
Loader – medium	1	Diesel	33.8L/hr	Earthworks - general
Water cart (minimum - 10,000L)	1	Diesel	28.7L/hr	Dust control/conditioning earth fill for compaction
Small skid-steer (Bobcat)	1	Diesel	33.8L/hr	To spread material on very soft soils
Compactor - vibratory roller (smooth) CB534D	1	Diesel	15.1L/hr	Finishing surface/compaction dredged spoil
Diesel generator	1	Diesel	12.7L/hr	Diesel generator for site compound

Table 12.12 Equipment summary for post-dredging operations

Equipment type	Number	Fuel type	Fuel rate	Purpose/activity
Loader – medium	1	Diesel	33.8L/hr	Maintenance and compaction of landforms
Worksite vehicle	1	Diesel	15L/100km	Surveillance and monitoring
TSHD – 20,000m^3 (25,540kW)	1	Heavy fuel oil	110g/kWh	Capital dredging of channels

Table notes:

L/hr = litres per hour / L/100km = litres per 100 kilometres
g/kWh = grams per kilowatt hour

Construction works for each component of the Project were assumed for the purpose of the GHG assessment to generally occur for an average of 20 days in a month for 12 hours a day. This is to account for anticipated downtime related to weekends, holidays and inclement weather. However, due to the limited availability of dredging vessels, the TSHD is assumed to operate for 24 hours per day for approximately 12 to 13 days per fortnight, allowing for crew change each fortnight. The cutter suction dredger (CSD) is assumed to operate for 24 hours per day for 5 days per week while in use. The CSD is unlikely to have onboard accommodation.

Fuel usage was estimated for both the staged approach and the singular campaign scenarios, presented in Table 12.13 and Table 12.14, respectively. The estimates are based on equipment characteristics and utilisation rates against the approximated schedules presented in Table 12.2 and Table 12.3.

Post-dredging operations including operational management of the final Project reclamation landform and maintenance dredging activities will occur on an ongoing annual basis:

- Operational management of the reclamation landform is estimated to occur for approximately 2 weeks per quarter
- Maintenance dredging of the channel is anticipated to be completed in an annual 6 week dredging campaign.

Table 12.13 and Table 12.15 are organised by the controlling entity associated with the emission source (GPC or the dredging contractor), providing an indication of the envisaged reporting responsibility under the NGER program.

Table 12.13 Staged approach – emissions source summary

Component	Fuel type	Total fuel consumption (L)						
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
GPC controlled activities								
Bund wall construction - earthworks								
Earthmoving equipment	Diesel	745,579	745,579	745,579				
Quarry area	Diesel	2,460,623	2,460,623	2,460,623				
Generators	Diesel	36,607	36,607	36,607				
BUF construction								
Earthmoving equipment	Diesel			914,958				
Generators	Diesel			36,607				
Navigational aids								
Barge	Diesel							144,000
Generator	Diesel							9,152
Dredging contractor controlled activities								
Initial dredging								
TSHD	Heavy fuel oil				142,528			
CSD	Heavy fuel oil				2,673,924			
Dredging operations								
TSHD	Heavy fuel oil				16,605,511			12,579,933
Barge/Tugboat	Heavy fuel oil				15,611,618			11,826,984
Workboat	Diesel				8,962			6,789
Dredged material earthworks								
BUF dredged material transfer	Diesel				12,835,831			7,487,568
Dredged material placement and earthmoving equipment	Diesel				750,676			425,547
Generators	Diesel				36,607			21,354
Total diesel		**3,242,809**	**3,242,809**	**4,194,374**	**13,632,075**	**-**	**-**	**8,094,410**
Total fuel oil		**-**	**-**	**-**	**35,033,582**	**-**	**-**	**24,406,916**

Table 12.14 Singular campaign approach – emissions source summary

Component	Fuel type	Total fuel consumption (L)				
		Year 1	Year 2	Year 3	Year 4	Year 5
GPC controlled activities						
Bund wall construction - earthworks						
Earthmoving equipment	Diesel	745,579	745,579	745,579		
Quarry area	Diesel	2,460,623	2,460,623	2,460,623		
Generators	Diesel	36,607	36,607	36,607		
BUF construction						
Earthmoving equipment	Diesel			914,958		
Generators	Diesel			36,607		
Navigational aids						
Barge	Diesel					144,000
Generator	Diesel					9,152
Dredging contractor controlled activities						
Initial dredging						
TSHD	Heavy fuel oil				142,528	
CSD	Heavy fuel oil				2,673,924	
Dredging operations						
TSHD	Heavy fuel oil				22,895,477	6,289,966
Barge/Tugboat					21,525,110	5,913,492
Workboat	Diesel				12,357	3,395
Dredged material earthworks						
BUF dredged material transfer	Diesel				12,835,831	7,487,568
Dredged material placement and earthmoving equipment	Diesel				750,676	425,547
Generators	Diesel				36,607	21,354
Total diesel		**3,242,809**	**3,242,809**	**4,194,374**	**13,635,470**	**8,091,015**
Total fuel oil		**-**	**-**	**-**	**47,237,040**	**12,203,458**

Table 12.15 Post-dredging operations - emissions source summary

Component	Fuel type	Annual fuel consumption (L)
GPC controlled activities		
Operational maintenance of reclamation landform		
Earthmoving equipment	Diesel	22,777
Dredging contractor controlled activities		
Maintenance dredging operations		
TSHD	Heavy fuel oil	300,000
Workboat	Diesel	1,500
Total diesel		**24,277**
Total fuel oil		**300,000**

12.4.2 Greenhouse gas emissions inventory

Estimated annual energy use and associated GHG emissions for the Project are summarised in Table 12.16 and Table 12.17, respectively. Annual energy use and GHG summaries are organised by Project scenario and then by Project component. GPC controlled emissions should be included in GPC's annual reporting under the NGER program. A more accurate estimate of annual GHG will be made during the detailed design phase of the Project.

The total energy use and GHG emissions associated with the Project are equal for both scenarios. However, the annual energy use and GHG emissions vary in line with the scheduling of Project components associated with each scenario.

The range of annual GHG emissions according to each scenario is:

- Staged approach – 8,787 to 139,638 tonnes at carbon dioxide equivalent (tCO_2-e) over a period of approximately 7 years
- Singular campaign – 8,787 to 175,421 tCO_2-e over a period of approximately 5 years.

Annual GHG emissions associated with the operational management of the landform and maintenance dredging activities have been estimated to be 945 tCO_2-e.

The maximum annual emissions estimated for the Project of 175,421 tCO2-e represent 0.03% and 0.12% of national and State emissions, respectively.

In terms of the main components of the Project, the majority of GHG emissions are associated with dredging operations (67%) followed by bund wall construction (11%) and dredged material earthworks (22%) as illustrated in Figure 12.3.

Table 12.16 Annual energy use (TJ) summarised by scenario and component

Year	Staged dredging approach					Singular campaign				
	Bund wall construction[1, 2]	Dredging operations[3]	Dredged material earthworks[3,4]	Navigational aids[1]	Total	Bund wall construction[1,2]	Dredging operations[3]	Dredged material earthworks[3,4]	Navigational aids[1]	Total
1	125	-	-	-	**125**	125	-	-	-	**125**
2	125	-	-	-	**125**	125	-	-	-	**125**
3	162	-	-	-	**162**	162	-	-	-	**162**
4	-	1,391	526	-	**1,917**	-	1,876	526	-	**2,402**
5	-	-	-	-	**-**	-	485	306	6	**797**
6	-	-	-	-	**-**	-	-	-	-	**-**
7	-	969	306	6	**1,281**	-	-	-	-	**-**
Total	**-**	**2,360**	**832**	**6**	**3,611**	**412**	**2,360**	**832**	**6**	**3,611**

Table notes:

1 GPC controlled activities 2 Includes BUF construction 3 Dredging contractor controlled activities 4 Includes transfer of dredged material from BUF

Table 12.17 Annual greenhouse gas emissions (tCO_2-e) summarised by scenario and component

Year	Staged dredging approach					Singular campaign				
	Bund wall construction[1,2]	Dredging operations[3]	Dredged material earthworks[3,4]	Navigational aids[1]	Total	Bund wall construction[1,2]	Dredging operations[3]	Dredged material earthworks[3,4]	Navigational aids[1]	Total
1	8,787	-	-	-	**8,787**	8,787	-	-	-	**8,787**
2	8,787	-	-	-	**8,787**	8,787	-	-	-	**8,787**
3	11,366	-	-	-	**11,366**	11,366	-	-	-	**11,366**
4	-	102,723	36,915	-	**139,638**	-	138,506	36,915	-	**175,421**
5	-	-	-	-	**-**	-	35,783	21,500	415	**57,698**
6	-	-	-	-	**-**	-	-	-	-	**-**
7	-	71,566	21,500	415	**93,481**	-	-	-	-	**-**
Total	**28,940**	**174,289**	**58,415**	**415**	**262,059**	**28,940**	**174,289**	**58,415**	**415**	**262,059**

Table notes:

1 GPC controlled activities 2 Includes BUF construction 3 Dredging contractor controlled activities 4 Includes transfer of dredged material from BUF

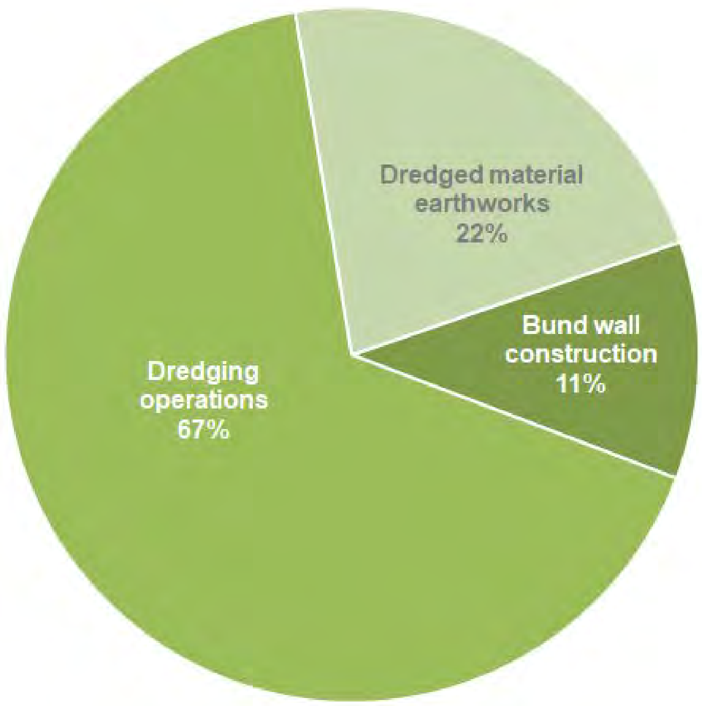

Figure 12.3 Estimated greenhouse gas emissions by Project component

Table 12.18 Post-dredging operations - emissions source summary

Component	Energy use (TJ)	Greenhouse gas emissions (tCO_2-e)
GPC controlled activities		
Operational maintenance of reclamation landform		
Earthmoving equipment	0.9	62
Dredging contractor controlled activities		
Maintenance dredging operations		
TSHD	11.9	879
Workboat	0.1	4
TOTAL	**12.9**	**945**

12.5 Maximum greenhouse gas annual emissions for the Project

This section supplements the Project EIS Section 12.5.4 (greenhouse gas) and Section 12.7 (summary).

Maximum annual emissions of 175,521 tCO2-e for the Project occur in Year 4 of the singular campaign scenario.

The total GHG emissions associated with the Project are:

- Construction phase: 262,059 tCO_2-e
- Operational phase: 945 tCO2-e

The vast majority of Project emissions are associated with the construction phase of the Project. Dredging activities accounted for the majority of these emissions (67%).

12.6 Air quality emissions data

This section replaces the Project EIS Appendix J (air quality emissions data).

12.6.1 Project activity information

The Project activity information below has been used as inputs into the Project air quality modelling.

Table 12.19 Construction of bund walls and barge unloading facility

Parameter		WBE reclamation area		BUF	Information source
		Southern	Northern		
Operations					
Operating hours	days/week	6			EIS assumption
	hours/day	12			EIS assumption
Generator operating hours	days/week	7			EIS assumption
	hours/day	24			EIS assumption
Timeframe	months	18	18	12	EIS assumption
Materials					
Density	tonnes/m³	2.6 (rock density)		1.8 (reclaimed material - after settling in reclamation area)	EIS assumption
Fines content (core material)	%	10		-	EIS assumption
Moisture content (bund wall material)	%	2.1		-	AP42, Chapter 13.2.4 Mean value for various limestone products (stone quarry and processing)
Moisture content (reclaimed material)	%	-		3.4	AP42, Chapter 13.2.4 Mean value for exposed ground (Western surface coal mining)
Silt loading (Paved road)	g/m^2	1		-	Conservative estimate based on review of public road silt loading values from AP42, Chapter 13.2.1
Silt content					
▪ Dusty bund wall material	%	10		-	EIS assumption
▪ Unpaved road	%	8.5			AP42, Chapter 13.2 Mean value for construction sites, scraper routes
Materials required for construction of outer bund walls and BUF					
▪ Armour	m³	60,000	113,000	-	EIS assumption
▪ Core	m³	387,568	567,730	-	EIS assumption
▪ Reclaimed material	m³	-	-	200,000	EIS assumption

Parameter		WBE reclamation area		BUF	Information source
		Southern	Northern		
Equipment					
B-doubles (to haul materials from Yarwun/Targinnie quarry area)					
■ Empty weight	tonnes	23		23	EIS assumption
■ Payload	tonnes	40		40	EIS assumption
■ Maximum number of trips	trips/day	130	198	21	EIS assumption
Dozers	#	2		-	EIS assumption
Graders	#	1		-	EIS assumption
Average speed	km/hour	11.4		-	AP42, Chapter 11.9. Geometric mean of grader speeds
Generator	#	4		-	EIS assumption
Power output	kW	550		-	EIS assumption
Dimensions					
Width of bund wall	m	23		-	Estimated from EIS cross-sections
Exposed area	ha	16	32	2.2	Calculated from width and layout diagrams
Distance (one way)					
Quarry area to site (sealed road)	km	4.2		-	EIS assumption
Unsealed road, up to bund wall	km	0	1.9	-	EIS assumption
Average distance travelled along bund wall	km	1.27	1.32	-	EIS assumption
Average distance travelled from WBRE to BUF	km	-	-	2.3	EIS assumption
Distance travelled					
Quarry area to site (sealed road)	VKT/day	549.3	836.6	-	Calculated based on amount of material moved
Distance travelled around bund wall	VKT/day	164.9	627.4	-	
WBRE to BUF	VKT/day	-	-	98	Calculated based on volume of material used
On-site haulage at quarry area	VKT/day	32.5	49.5	-	Calculated based on amount of material moved and assumed haul length of 500m per trip

Table note:

VKT = vehicle-kilometres travelled

Dust emissions associated with the following sources at quarry area have been estimated:

- Material transfers (extraction, stockpile loading, truck loading)
- Processing (one crusher, one screen, and one conveyor transfer)
- Onsite haulage
- Wind erosion of 37ha of exposed ground, estimated from aerial imagery.

Table 12.20 Dredging operations

Parameter		Value	Information source
TSHD			
TSHD count	#	1	EIS assumption
Operating hours	days/week	7	EIS assumption
	hours/day	24	EIS assumption
Power			
▪ Pump power (trailing)	kW	3,400	Based on 8700 TSHD (www.jandenul.com) with hopper capacity of 18,000m^3
▪ Pump power (discharging)	kW	14,000	
▪ Propulsion power	kW	15,000	
▪ Total installed diesel power	kW	22,540	
▪ Auxiliary power	kW	4,140	Calculated from total installed diesel power less propulsion and trailing power
CSD			
CSD count	#	1	EIS assumption
Operating hours	days/week	7	EIS assumption
	hours/day	24	EIS assumption
Power			
▪ Submerged pump power	kW	3,800	Based on J.F.J. DE NUL CSD (www.jandenul.com) with total installed diesel power similar to the 8700 TSHD
▪ Inboard pump power	kW	12,000	
▪ Cutter power	kW	7,600	
▪ Propulsion power	kW	7,600	
▪ Total installed diesel power	kW	27,240	
▪ Auxiliary power	kW	3,840	Calculated from total installed diesel power less submerged pump, inboard pump and cutter powers
Barges (propelled by pushbusters)			
Barges count	#	4	EIS assumption
Operating hours	days/week	7	EIS assumption
	hours/day	24	EIS assumption
Power			
▪ Total installed engine capacity	kW	4,163	EIS assumption (based on https://www.vanoord.com/activities/hopper-barge-and-pushbuster)
▪ Propulsion capacity	kW	3,650	
▪ Auxiliary engine capacity	kW	513	

Parameter		Value	Information source
Tugs at BUF			
Tugs count	#	1	EIS assumption
Operating hours	days/week	7	EIS assumption
	hours/day	24	EIS assumption
Power			
▪ Total installed engine capacity	kW	3,271	Table 3-10 US EPA , mean values for tugs.
▪ Propulsion capacity	kW	3,080	
▪ Auxiliary engine capacity	kW	100.2	

Table 12.21 Dredged management placement

Parameter		Value	Information source
Operations			
Operating hours	days/week	7	EIS assumption
	hours/day	24	EIS assumption
Dozers	number	2	EIS assumption
Graders	number	1	EIS assumption
Average grader speed	km/h	11.4	Geometric mean in Table 11.9-3, AP42 documents
Compactors	number	1	EIS assumption
Dredged material moisture content	%	3.4	Average for exposed ground from AP42 13.2, Western surface coal mining
Dredged material silt content – Stage 2	%	2.0	EIS assumption
Dredge material – initial dredging works	Mm^3	0.31	EIS assumption
Dredged material – Stage 1	Mm^3	9.06	EIS assumption
Dredged material – Stage 2	Mm^3	6.69	EIS assumption
Dimensions			
Footprint of exposed area	ha	86	Obtained from EIS concept design site layouts
Haulage			
Silt content of haul route	%	8.5	AP42, Chapter 13.2.2 Mean value for construction sites, scraper routes
Haul truck payload	tonnes	32.5	EIS assumption
Haul truck empty weight	tonnes	28.2	EIS assumption
Distance (one way)	km	1.4	EIS assumption
Average distance travelled per day	VKT/day	4282	Calculated from distance and amount of material moved.

12.6.2 Emission factors

12.6.2.1 Wheel-generated dust on haul roads

The emission factors for unpaved roads were calculated from the AP42 documents in Section 13.2.2 titled 'unpaved roads' dated December 2003.

The equation included in the assessment is as follows:

$$E = 281.9 * k \ (s/12)^a (W/3)^b$$

where

E = emission factor (g/VKT)

s = surface material silt content (%)

W =mean vehicle weight (tons) and the following constants were assumed.

The multiplier of 281.9 converts the units from lb/VMT to g/VKT.

The particle size multiplier in the equation k and exponents varies with aerodynamic particle size range, as defined in Table 12.22.

Table 12.22 Constants used in calculating emissions from wheel-generated dust

Constant	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

12.6.2.2 Materials handling

Emissions for materials handling are dependent on the amount of materials being transferred. Materials handling and transfers include truck loading and dumping using front end loaders and excavators, transfer points at conveyor transfer stations. These were calculated from the AP42 documents, using the following equation:

$$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:

EF = emission factor (kg/Mg)

k = particle size multiplier (dimensionless)

U = mean wind speed (m/s)

M = material moisture content (%)

The particle size multiplier in the equation *k*, varies with aerodynamic particle size range, as follows:

k = 0.74 Particle size < 30 µm

k = 0.35 Particle size < 10 µm

k = 0.053 Particle size < 2.5 µm

12.6.2.3 Dozing

The TSP emission factor for dozing is based on the AP42 Ch. 11.9 emission factor. PM_{10} emissions were assumed to be 75% TSP emissions, while $PM_{2.5}$ emissions were assumed to be 10.5% of TSP emissions. These are based on the PM_{10}:TSP and $PM_{2.5}$:PM_{10} ratios of AP42 emission factors.

In equation form, the emission factor is:

$$EF_{TSP} = 2.6 \times \left(\frac{s^{1.2}}{M^{1.3}}\right)$$

where:

EF_{TSP} = emission factor for TSP (kg/hr)

s = silt content (%)

M = material moisture content (%)

12.6.2.4 Wind erosion from exposed areas

Emissions from erosion of exposed areas were based on the AP42 Ch. 11.9 emission factor of 0.85 Mg/ha/year. Of TSP emissions, 50% are estimated to be PM_{10} and 7.5% of TSP emissions are estimated to be $PM_{2.5}$. The particulate matter size distribution is based on the USEPA AP42 document, Chapter 13.2.5.

The National Pollution Inventory Emission Estimation Technique (NPI EET) manual for mining (NPI 2012) provides an emission factor of 0.4 kg/ha/h for emissions of TSP due to wind erosion for both active coal stockpiles and exposed areas. For comparison, this equates to 3.5 Mg/ha/year. The exposed area emission factor from the AP42 Ch. 11.9 is considered more representative of exposed areas. Exposed areas are likely to have lower dust emissions due to wind erosion compared with active stockpiles as they are not regularly disturbed or replenished with new material.

Dust emissions from wind erosion are dependent on wind speed, with higher emissions occurring during periods of strong winds. However, these conditions are also good for dispersion. Conversely, periods of light winds provide for poor dispersion conditions, however dust emissions from wind erosion are small during these times.

Dust emissions due to wind erosion have not been modelled as occurring at a constant rate, however, given the magnitude of these emissions compared to other sources, this is not expected to alter the outcome of the assessment.

12.6.3 Exhaust emissions

12.6.3.1 Auxiliary engines

Emission factors for auxiliary engines are estimated based on the NPI EET manual (NPI 2012) for maritime operations for auxiliary engines using marine diesel oil. These are summarised in Table 12.23.

Table 12.23 Emission factors (kg/kWh) for auxiliary engines (marine diesel oil)

Pollutant	Emission Factor (kg/kWh)
NO_X (uncontrolled)	1.39×10^{-2}
CO	1.10×10^{-2}
$PM_{2.5}$	2.8×10^{-4}
PM_{10}	7.5×10^{-4}
SO_2	6.16×10^{-3}

12.6.3.2 Engine room engines

Emission factors for all engines in the engine room are based on the maximum of emission factors for stationary large diesel engines (NPI 2008), and medium speed diesel engines running on marine diesel oil (USEPA 2009), with the exception of NOx and sulphur dioxide (SO_2) which have been selected as detailed in Section 12.2.1.4.

The emission factors used are summarised in Table 12.24.

Table 12.24 Emission factors (kg/kWh) for auxiliary engines (marine diesel oil)

Pollutant	Emission Factor (kg/kWh)	Source
NO_X	3.40E-03	Tier III emission limit (AMSA 2015)
CO	3.30E-03	Maximum out of large diesel engine NPI emission factor and US EPA vessel emission factor
$PM_{2.5}$	4.30E-04	
PM_{10}	4.70E-04	
SO_2	1.99E-03	As for CO, with emission factor adjusted to reflect 0.5% sulfur content (ASMA 2015)

12.6.4 Dispersion modelling

12.6.4.1 Meteorological modelling

TAPM meteorological simulations

The prognostic meteorological model, TAPM (The Air Pollution Model) Version 3.0.7, was developed by the CSIRO and has been validated by the CSIRO, Katestone Environmental and others for many locations in Australia, in southeast Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone Environmental has used the TAPM model throughout Australia as well as in parts of Southeast Asia and North America. This model has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20km to 200km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy and soil, and radiative fluxes.

TAPM requires synoptic meteorological information for the Gladstone region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75km, and at elevations of 100m to 5km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM was configured as follows:

- Mother domain of 30km with three nested daughter grids of 10km, 3km and 1km
- 48 x 34 grid points for all modelling domains resulting in a 48 x 34km grid at 1km resolution
- 30 vertical levels, from the surface up to an altitude of 8,000m above ground level
- AUSLIG 9 second DEM terrain data
- The TAPM defaults for sea surface temperature and land use

- Default options selected for advanced meteorological inputs
- Year modelled: 1 April 2006 to 30 March 2007.

The land use for the inner 1km grid required significant modification due to the coarseness of the TAPM dataset. Representative data was derived from vegetation maps obtained from DES and from aerial imaging by Google Earth. The coastline was also re-defined in the database to better represent the complex coastline and islands in Gladstone. Detailed 9-second arc DEM elevation data (resolution approximately 100m) was obtained from Auslig for this modelling domain. TAPM was modelled using data assimilation from three meteorological sites; Boyne Smelter (BOY), Gladstone Radar (GLR), and Targinnie Swann's Road (YAR) with the following configuration:

- BOY assimilation radius of influence 4km over the lowest 4 vertical levels
- GLR assimilation radius of influence 7km over the lowest 3 vertical levels
- YAR assimilation radius of influence 5km over the lowest 3 vertical levels.

CALMET meteorological simulations

CALMET is an advanced non-steady-state diagnostic 3-dimensional (3D) meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF dispersion model. CALMET is capable reading in hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded 3D prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET v6 was used to simulate meteorological conditions in the Gladstone airshed. The modelling domain was set to mirror the TAPM 1km grid described above. CALMET was initialised with the gridded TAPM three dimensional wind field data from the 1km grid. Standard modelling procedure would indicate that a 3 to 1 ratio of model resolutions from TAPM to CALMET should be maintained. However the terrain characteristics of the Gladstone region are not well represented by the coarse 3km TAPM grid and CALMET's reliance on detailed meteorological inputs from TAPM required the use of the 1km grid resolution to capture the terrain and mesoscale wind patterns pertinent to dispersion.

CALMET treats the prognostic model output as the initial guess field for the diagnostic model wind fields. CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation. The coupled approach unites the mesoscale prognostic capabilities of TAPM with the refined terrain and land use capabilities of CALMET.

The use of a three dimensional wind field is a significant improvement as the CALMET modelling domain has a complete set of meteorological variables at every grid point and vertical level for every hour of the simulated year. No data assimilation was used in CALMET as the modelling domain covered a region larger than the meteorological stations could reasonably cover adequately and eliminate any possibly of erroneous convergence due to the overlap of radii of influence.

The model was set up with 12 vertical levels with heights at 20m, 60m, 100m, 150m, 200m, 250m, 350m, 500m, 800m, 1600m, 2,600m and 4,600m at each grid point. The geophysical data (land use and terrain heights) were generated from TAPM, using the adjusted land use for the 1km grid. All default options and factors were selected except where noted below.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 48 by 34km with 1km grid spacing
- 1 year time scale (1 April 2006 to 1 March 2007), divided into individual months for analysis
- Prognostic wind fields input as MM5/3D.Dat 'initial guess' field only (as generated from TAPM)

- Mixing height parameters all set as default
- Step 1 wind field options include kinematic effects, divergence minimisation, Froude adjustment to a critical Froude number of 1 and slope flows
- Terrain radius of influence set at 2km
- Cloud cover calculated from prognostic relative humidity.

Froude number (Fn) adjustments the wind for terrain features, such that if the local Fn is less than the critical Fn and the wind at that grid point has an uphill component, the wind direction is adjusted to be tangent to the terrain.

12.6.4.2 CALPUFF dispersion modelling

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

The assessment was conducted using CALPUFF model version 7.2.1. Technical details of the configuration of the CALPUFF model are discussed in Appendix B.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 36 by 32 grids at 200m spacing, nested from the CALMET grid of 1km
- 365 days modelled (1 April 2006 to 31 March 2007)
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables
- PDF used for dispersion under convective conditions
- Dry deposition on
- Minimum turbulence velocities over land and water set to 0.2 m/s and
- All other options set to default.

Dust emissions associated with construction of bund walls and creation of final land form were modelled as area sources. Operational emissions were modelled during day hours (from 7:00am to 6:00pm). Wind erosion sources were modelled for 24 hours. With the exception of the quarry, all construction emissions were modelled as area sources with an effective height of 8m and initial vertical dispersion coefficient of 2.

The quarry was modelled as a volume source with an effective height of 15m, initial sigma-y of 100 and initial sigma-z of 10.

Dust emissions during dredge placement were modelled as area sources with an effective height of 1m for wind erosion (sigma-z of 0.3) and 5m for landscaping activities (sigma-z of 1.3).

Stack heights used for modelling emissions from the dredge vessels have been estimated from images in the manufacturer's specifications. An exit velocity of 15m/s has been assumed for both vessels.

Characteristics of the point sources used to model emissions from the dredging vessels are detailed in Table 12.25. Multiple point sources were used to represent the TSHD dredging in the channel, and travelling from the channel to the transfer location. All point sources were configured as shown in Table 12.25.

Table 12.25 Stack characteristics used to model emissions from the dredging vessels

Parameter	Units	CSD	TSHD	Tugs	Barges	Information source
Stack height	m	19.3	30.5	10	10	Estimated from images and vessel dimensions on manufacturer's specifications
Stack diameter	m	1.3	1.0	0.5	0.5	
Exit velocity	m/s	15	15	30	6,7	EIS assumption
Exit temperature	K	428	428	600	428	EIS assumption

12.7 Source of water for dust suppression

This section supplements the Project EIS Section 12.6.1 (air quality).

Water for dust suppression during Project earthworks and dredging activities within the existing Western Basin and WBE reclamation areas will be sourced from GPC's existing raw water truck fill point at Fisherman's Landing. Additionally, when available, fresh water may also be sourced from GPC's Ticor Quarry stormwater settlement ponds.

Water used for Project dust suppression will be applied to potential dust generating surfaces within the existing Western Basin and WBE reclamation areas at a rate that minimises the dust generation from these areas. As a result water used for Project dust suppression will not be used in quantities that result in runoff into the reclamation areas or marine environment. Therefore the water used for Project dust suppression will not impact on the Project's ability to achieve the nominated water quality tailwater release limits included in the AEIS Appendix H (Environmental Monitoring Procedure).

12.8 Mitigation measures

This section supplements the Project EIS Section 12.6.1 (air quality) and Section 12.6.2 (greenhouse gas).

The additional air quality and greenhouse gas mitigation measures below will be implemented as part of the Project.

- An Air Quality Management Plan will be prepared, which will include all mitigation measures for greenhouse gas emissions
- Dust deposition monitoring will be conducted at locations of sensitive receptors
- The Project EMP and Dredging EMP will include triggers for actions to protect against impacts of dust deposition at locations of sensitive receptors, and actions to avoid dust deposition impacts
- The Project EMP and Dredging EMP will include specific measures to reduce GHG emissions and their associated potential impacts.

These above mitigation measures have been included in the EIS commitments (refer AEIS Appendix I).