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Ports North

CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX S: Baseline Air Quality Assessment Report (2016)

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Cairns Shipping Development

Baseline Air Quality Constraints Assessment

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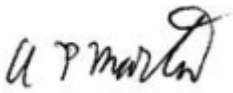
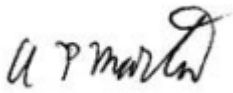
Author Signature		Approver Signature	
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1. Introduction

ASK Consulting Engineers Pty Ltd (ASK) was commissioned by Flanagan Consulting Group to provide air quality consultancy services to describe the existing situation for the Revised Draft Environmental Impact Statement (EIS) for the revised Cairns Shipping Development Project (CSD Project). The recalibration relates to a reduction in the quantity of material to be dredged from 4,400,000 m3 to 860,000 m3 in-situ material, and relocation of the dredge material placement area (DMPA) to land instead of sea.

Revision of the EIS is also to address feedback received from the OCG, including future assessment of the impact of ship exhausts and construction activities.

This report assesses the existing environment at each potential DMPA, and provides a constraints assessment for the project. Locations addressed include the wharf area and:

- dredging pipeline routes for each DMPA
- dredging pipeline booster stations for each DMPA
- the DMPAs.

Assessment of the existing air environment is typically based on review of available monitoring data. There is little benefit in additional short-term monitoring of air pollutants and meteorology due to the high degree of variability and dependence on seasonal changes. Therefore the scope of this assessment is based on searching for and compiling monitoring data from previous studies undertaken at locations representative of the study area.

The following scope of work has been undertaken for this report:

(1) A visual survey of surrounding land uses, sensitive uses and potential air pollution sources.

(2) Ascertain sensitive land uses near the channel route, the wharf area, the booster stations, the pipeline routes, and the DMPAs.

(3) Describe existing air quality using baseline data from DSITI, including any updates to the information provided in the draft EIS, and discussion of the context of the local and regional air shed.

(4) Summarise current air related criteria including dust, combustion gases and odour from EPP (Air) and EHP Guidelines.

(5) Undertake meteorological modelling in the region and vicinity using the meteorological models TAPM and Calmet.

(6) Establish the state of the local climate including seasonal rainfall temperatures, humidity, wind roses, and inversion heights.

(7) Research local meteorological conditions and climate patterns that could affect dust generation and dispersion and summarise in the report, including any updates to information provided in the draft EIS. This includes compilation of local data including temperature, and continuous wind speed and direction.

(8) Consider in a qualitative manner (for the purposes of describing the existing situation), the impacts of construction and operation of the distribution and containment infrastructure at the dredge placement sites and wharf area construction site.

(9) Develop a report summarising baseline data and recommendations of appropriateness of each site and opportunities to mitigate impacts.

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

2. Proposed Development

2.1 Project Description

The CSD Project involves upgrading of existing infrastructure for the Port of Cairns to accommodate larger cruise ships, including expansion of the existing shipping channel and swing basin, and upgrades to the existing wharves and associated services. Associated with this is the construction of infrastructure for placing the dredge material on land.

The following timeframes are anticipated:

- Dredging and hence placement of slurry at the DMPA is anticipated to require approximately 10 weeks, with the duration to be confirmed in the concept refinement / impact assessment phase. For the Northern Sands placement option, the current time estimate is 10.3 weeks plus pipeline mobilisation and demobilisation.
- Construction of the pipeline and boosters (if required) will take 3 months and removal a further 2 months.
- The wharf upgrade will take approximately eight to 10 months.
- The other land infrastructure will be concurrent with the wharf upgrade.

Section **7** includes discussion of anticipated emissions from these activities.

2.2 Wharf

The anticipated demand for ship berthings is 140 ships by 2026, including 104 megaclass ships.

An additional intermediate fuel oil storage tank, with capacity of approximately 10,000 m^3 will be required within the existing fuel farm to store monthly deliveries from fuel ships via the existing fuel wharf 10. Fuel will be delivered from the storage tank to cruise ships via pump station and pipeline to wharves 1 to 5. 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
- concrete delivery trucks.

The extent of the wharf and associated land works are shown in **Figure 2.1**. The extent of the upgrades for the fuel storage works is shown in **Figure 2.2**.

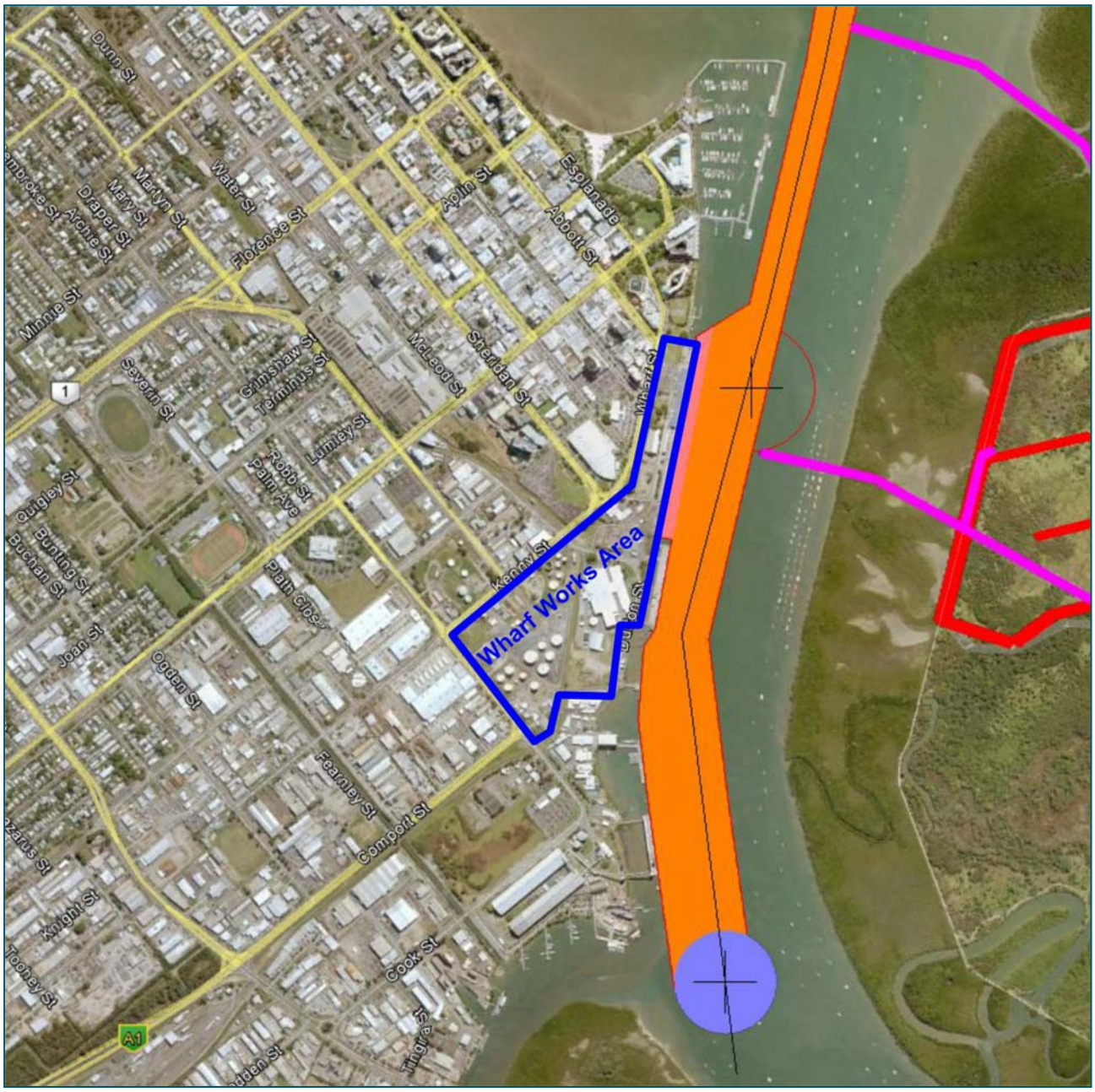


Figure 2.1 Extent of Wharf and Associated Land Works

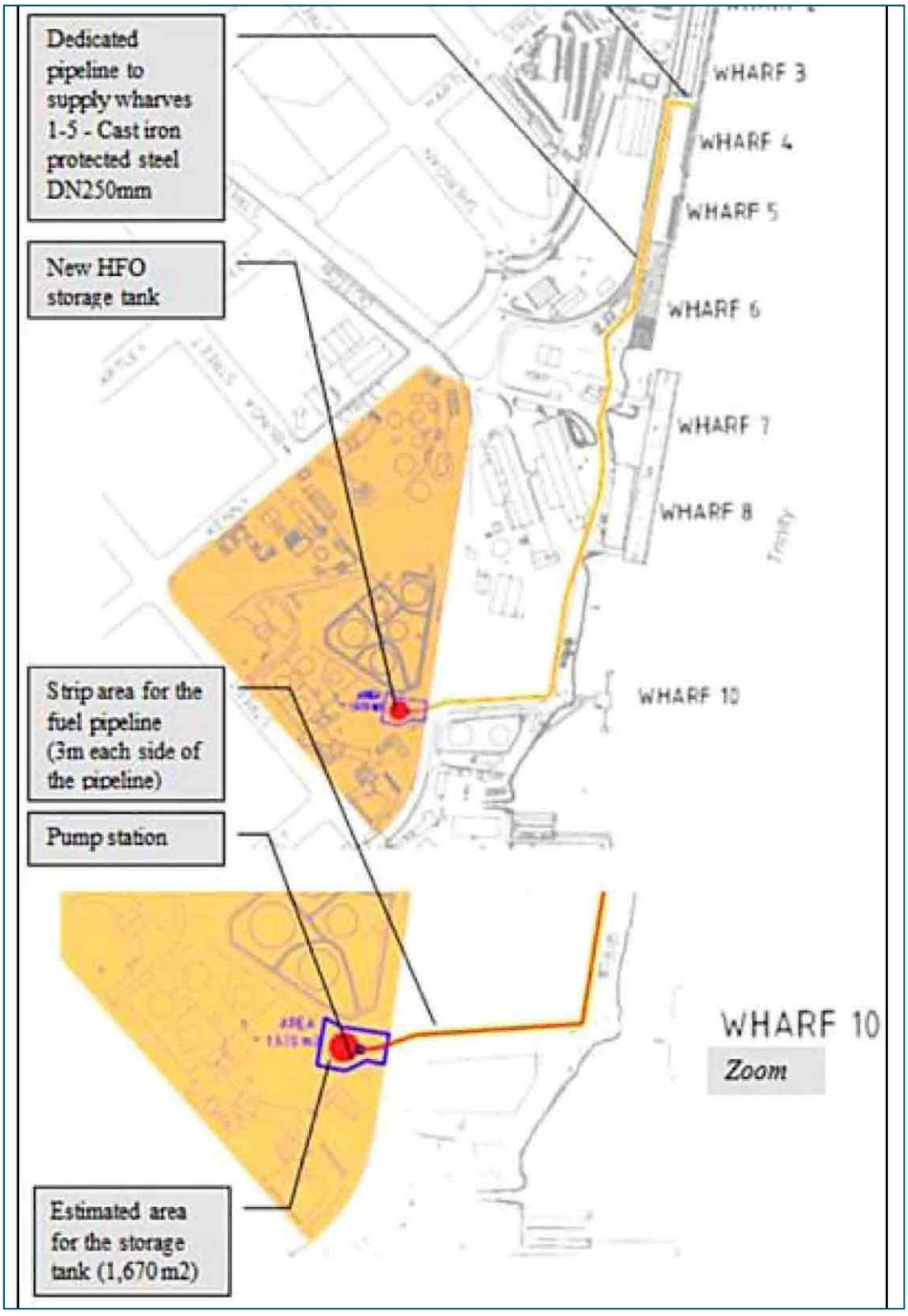


Figure 2.2 Fuel Storage Works

2.3 Temporary Pipeline Options

The recalibrated project anticipates a reduced total insitu dredge volume of less than 1 million m^3 to be dredged by a trailer suction hopper dredge (TSHD). Two onshore precincts for placement of the dredged material have been identified following a detailed options study. These two areas are; three potential sites at East Trinity (terrestrial above ground placement into constructed bunds), and the Barron Delta (placement into an existing void, possibly below groundwater level).

Conceptual arrangements showing pipeline routes, pipe storage and pipe fabrication areas, indicative booster locations and Dredge Material Placement Area (DMPA) footprints are provided in **Figure 2.3** to **Figure 2.8** for various options within each placement precinct.

Figure 2.3 East Trinity Site A Revised Conceptual Layout

Figure 2.4 East Trinity Site B Revised Conceptual Layout

Figure 2.5 East Trinity Site C Revised Conceptual Layout

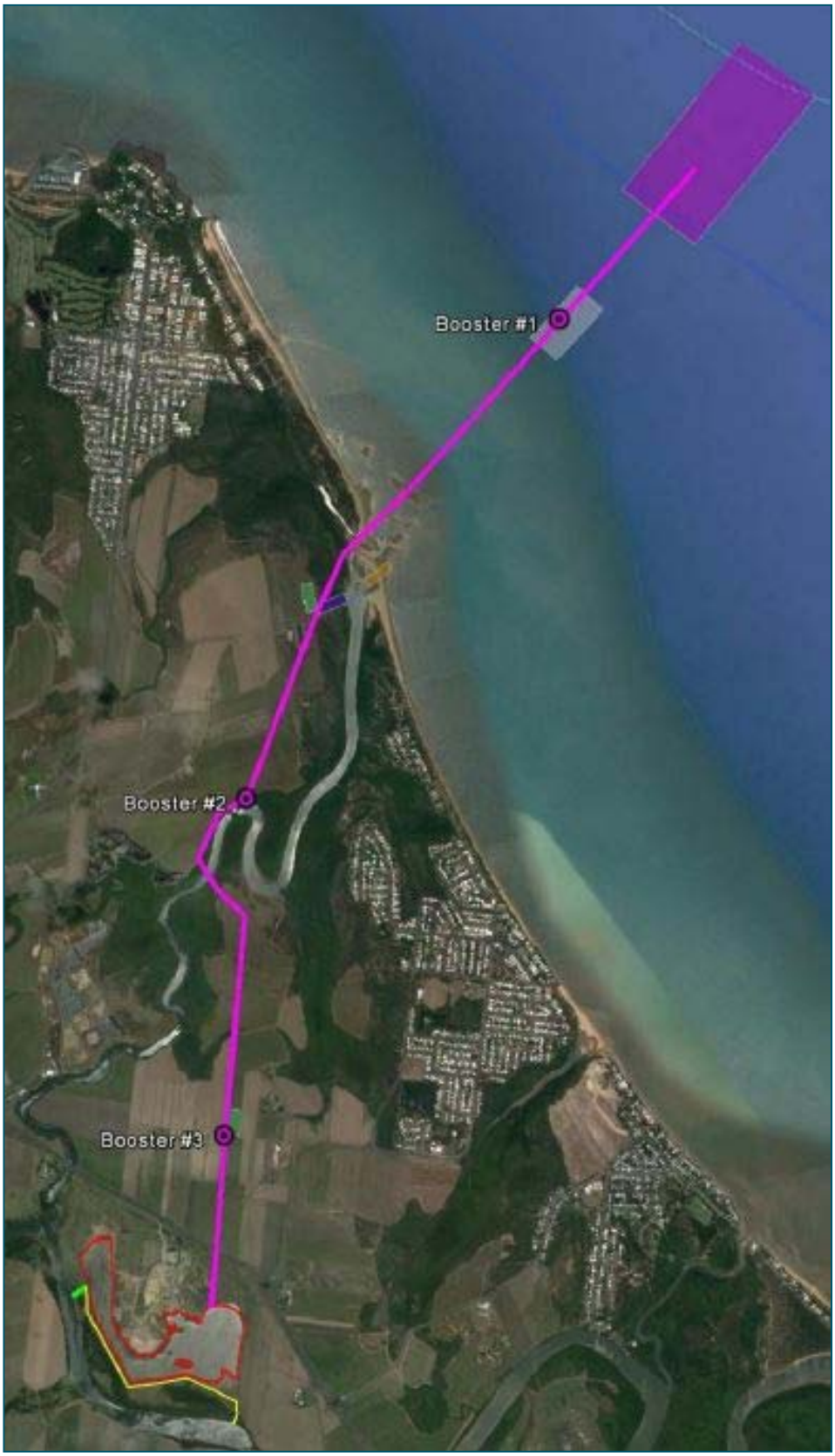


Figure 2.6 Barron Delta – Aquis Pipeline Option with Marine Booster Revised Conceptual Layout

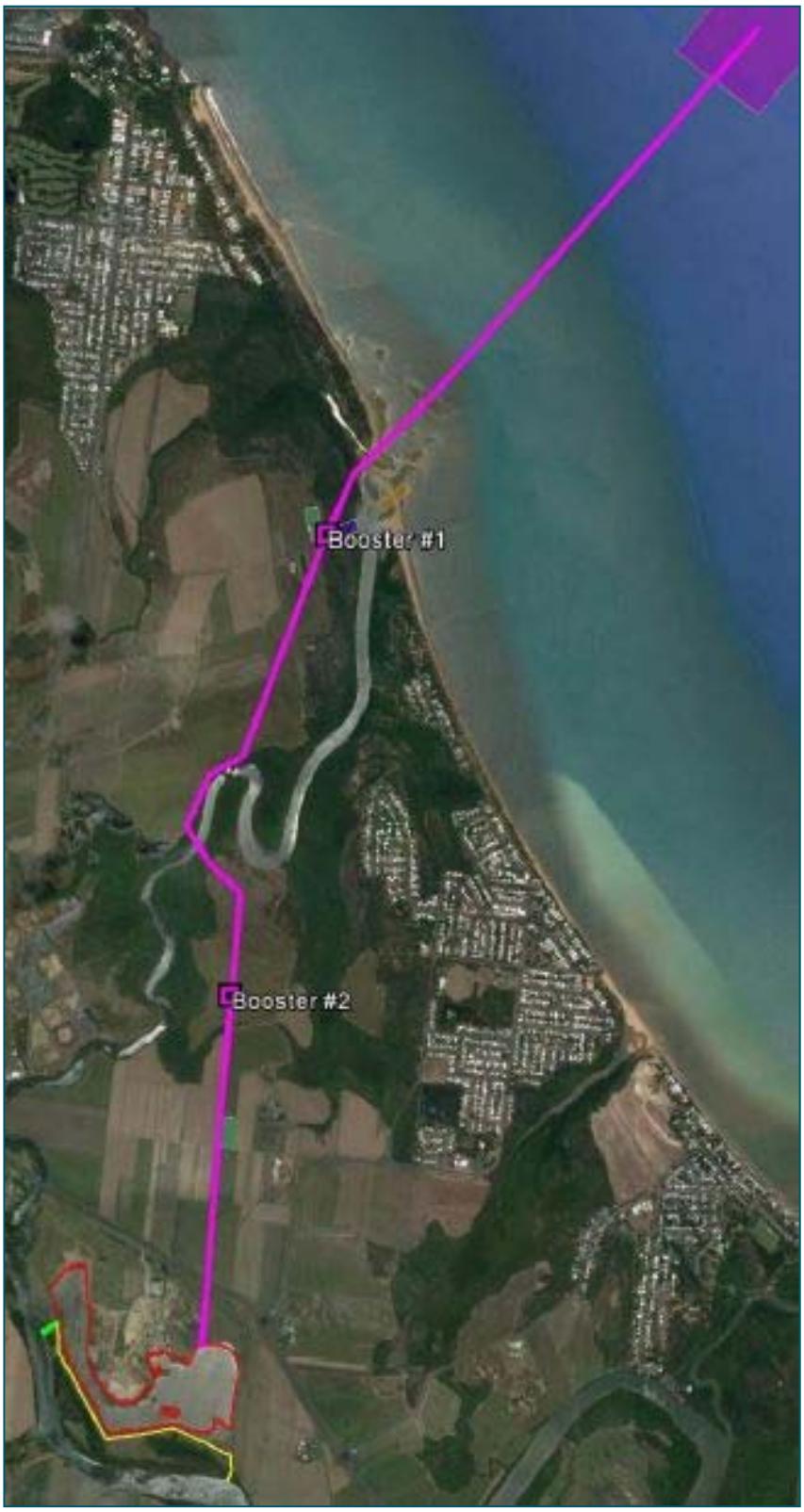


Figure 2.7 Barron Delta – Aquis Pipeline Option with no Marine Booster Revised Conceptual Layout

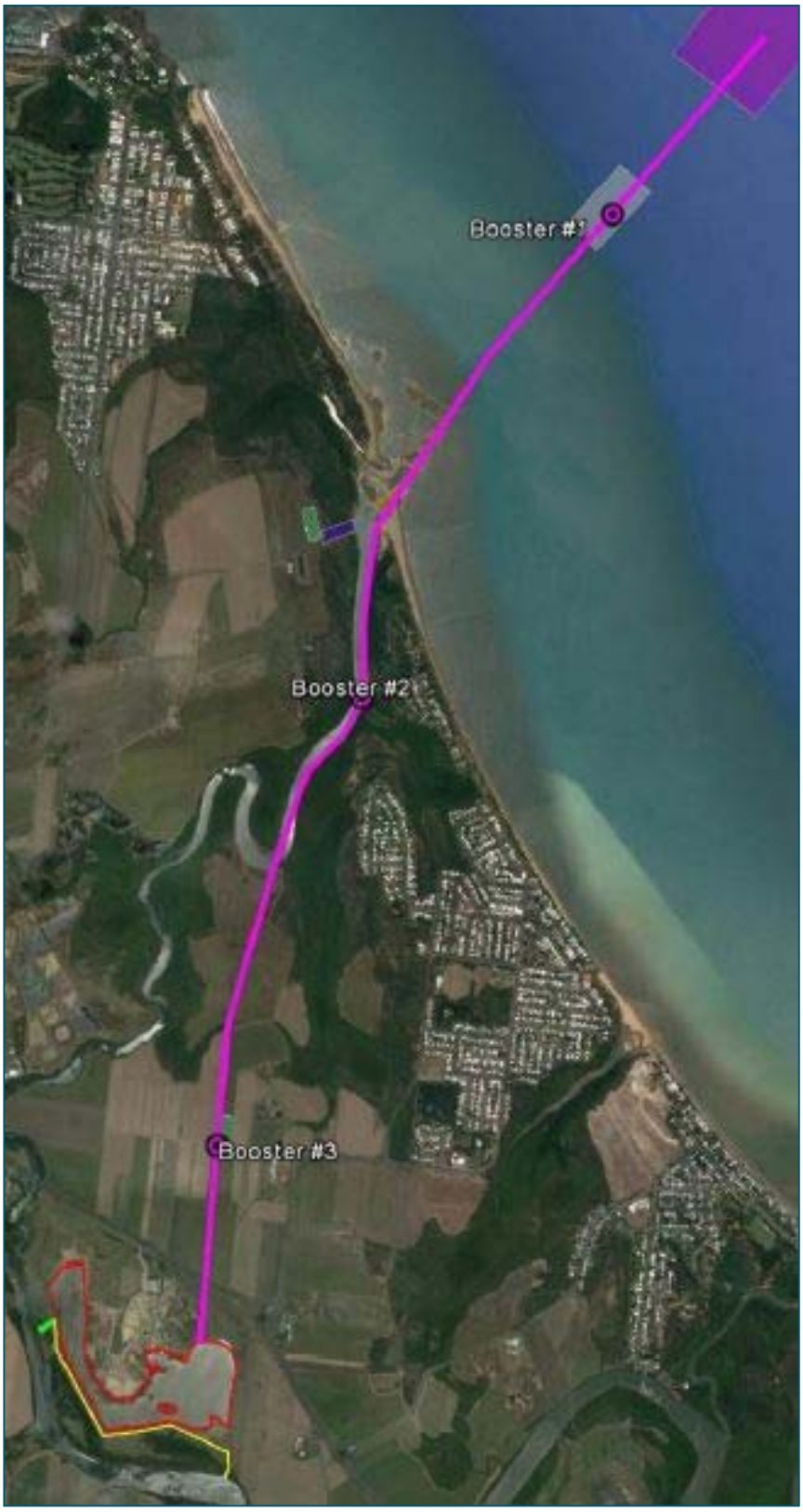


Figure 2.8 Barron Delta – Yorkeys Pipeline Option Revised Conceptual Layout

2.4 Dredging Site Establishment

2.4.1 Marine Equipment

It is expected that the equipment required at sea will be:

- small to medium sized TSHD to dredge soft clays and transport to shore
- backhoe/grab dredge and two hopper barges to dredge stiff clays and transport to shore.
- survey/crew change vessel
- work boat
- tug
- sweep bar/plough
- temporary mooring facility at the TSHD pump out location
- booster pump station (Barron Delta DMPA only)
- barge mounted crane to install pipeline.

2.4.2 Land Equipment

It is expected that the equipment required on land will be:

- swamp dozers (East Trinity only)
- front end loaders
- excavators
- rigid dump trucks
- mobile cranes / telescopic handlers
- water pumps
- booster pump stations (Barron Delta only).

2.4.3 Pipelines

Pipelines will be required to bring the dredged material as a slurry to the DMPA and from the DMPA to a water discharge point. They will be made from mild steel and nominally 1 metre in diameter. Booster pumps will be required along the slurry pipeline for the Barron Delta DMPA.

Preliminary estimates of B-double truck movements to transport pipes are 225 each way at Barron Delta and 100 each way at East Trinity. Laydown area, fabrication yards and storage areas are expected to total up to 2.5 hectare at Baron Delta and 1.5 hectares at East Trinity.

2.4.4 Reclamation / Placement Areas

Preparation of the East Trinity placement areas is expected to include activities relevant to air quality such as:

- clearing, stripping topsoil and stockpiling
- bund construction including fill importation.
- Site activities at the Barron Delta site will be minimal as the pipeline will deliver slurry to an existing water-filled void (possibly expanded slightly to the north-west).

2.5 Dredging and Placement

The Dredge Placement Scope Study (FCG May 2016) identifies that:

- the dredge material consists of approximately 10% sand and 90% silt

- the material has acid sulphate properties that will require lime treatment.

The dredge material is expected to contain greater than 90% fine material (<75 microns) with little or no sand. It will be further characterised prior to the completion of the revised draft EIS. Dredgers will operate 24 hours per day, seven days per week.

The TSHD would typically dredge at 1 to 3 knots then steam to and from the pumpout location at 6 to 9 knots. It would then unload at the pumpout location to the discharge pipeline, with seawater pumped into the pipeline to dilute solid material to 10 to 15% by volume.

The backhoe dredge would be between 700 to 1000 kW nominal power. Hopper barges would take the stiffer clays to shore where they would be loaded into trucks for transport to the placement site.

At the East Trinity DMPA, material delivered by pipeline will be distributed by excavators, trucks and dozers. The water levels will be controlled by a weir and bunds to allow solids to settle before the water is discharged. At the Barron Delta site the pipeline will deliver slurry to an existing water-filled void (possibly expanded).

3. Air Quality Criteria

3.1 Relevant Pollutants

This section identifies the air pollutants anticipated from the sources to be assessed. Construction of bunded areas and placement of dredged material has the potential to generate particulates and odour. Construction activities at the wharf also have potential to generate particulates. Ship engine exhausts will emit combustion products including sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulates, carbon monoxide (CO) and volatile organic compounds (VOCs). VOCs may include benzene, benzo(a)pyrene, formaldehyde, toluene and xylene.

3.2 State Legislative Instruments

The Terms of Reference for the impact assessment issued by the Queensland Coordinator-General, identifies the environmental values defined in the Environmental Protection (Air) Policy (EPP Air) (2008) under the Environmental Protection Act (1994).

The EPP (Air) provides objectives for air quality indicators (pollutants). Those objectives that are relevant to this project and human health and wellbeing have been summarised in **Table 3.1**.

Table 3.1 Air Quality Criteria (EPP Air) for Health and Wellbeing

Air Quality Indicator	Period	Criteria (µg/m^3)
benzene	1 year	10
benzo(a)pyrene	1 year	0.3 ng/m^3
CO	8 hours	11,000 [2]
formaldehyde	1 day	54
NO_2	1 hour	250 [2]
	1 year	62
$PM_{2.5}$	1 day	25
	1 year	8
PM_{10}	1 day	50 [1]
sulfur dioxide	1 hour	570
	1 day	230
	1 year	57
toluene	30 minutes	1100
	1 day	4100
	1 year	410
Total Suspended Particulates (TSP)	1 year	90
xylenes	1 day	1,200
	1 year	950

Notes:

1. *Five allowable exceedances are currently allowed although the intent of this was to cater for regional events.*
2. *Allowance is made to exclude one day.*

Note that the EPP Air also contains a criterion for visibility reducing particles, but this is a measure of regional air quality and is not relevant to point sources. The impact of visible particles from point sources is addressed by the $PM_{2.5}$ criteria.

3.3 National Environmental Protection (Ambient Air Quality) Measure

The EPP(Air) incorporates the goals nominated within the previous 2003 version of the National Environmental Protection (Ambient Air Quality) Measure. The current NEPM (Ambient Air Quality) dated February 2016 has multiple changes including the new standards and goals listed in **Table 3.2**. Exceedances of particulate standards are no longer allowed apart from the exceptional events defined below.

Table 3.2 New Standard and Goals in 2016 NEPM (Ambient Air Quality)

Air Quality Indicator	Period	Criteria (µg/m^3)
$PM_{2.5}$ goals for 2025	1 day	20
	1 year	7
PM_{10}	1 year	25

Notes: For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ 1 day average standards, jurisdictions shall exclude monitoring data that has been determined as being directly associated with an exceptional event (bushfire, jurisdiction authorised hazard reduction burning or continental scale windblown dust that causes exceedance of 1 day average standards).

These goals have not yet been adopted into the EPP(Air) so it is thus not clear how much reduction of existing background concentrations is expected to assist with achievement of the 2025 goals, and how much is to be achieved by restrictions on development. Thus these goals have not been adopted for this assessment.

3.4 National Environmental Protection (Air Toxics) Measure

The EPP(Air) also incorporates as standards, the investigation levels contained in the National Environmental Protection (Air Toxics) Measure.

3.5 Dust Deposition

Whilst there are no quantitative limits for dust deposition specified in legislation, there are guidelines designed to avoid nuisance caused by dust deposition fallout onto near horizontal surfaces.

The Department of Environment and Heritage Protection (EHP 2013a) suggests the guideline that deposited matter averaged over one month should not exceed 120 mg/m^2/day (3.6 g/m^2/month). For extractive industries, it is the insoluble component of analysed dust that is used.

The NSW Department of Environment and Conservation (2005) specifies an annual average limit of 4 g/m^2/month (130 mg/m^2/day), and states that it is the insoluble component of analysed dust that is to be used.

It should be noted that these values are a guideline for the level that may cause nuisance at a sensitive receptor such as a residence or sensitive commercial land use. It is not normally necessary to achieve this level at the boundary, but boundary measurement can assist in the assessment of whether there is risk of nuisance occurring or not.

3.6 Odour

EHP (2013b) specifies an annoyance threshold for odour of 0.5 ou (odour units) for wake-free stacks and 2.5 ou for other sources, to be compared to the 99.5 percentile one hour model predictions.

3.7 Summary of Relevant Pollutant Concentration Criteria

Criteria adopted for the assessment are summarised in **Table 3.3**.

Table 3.3 Adopted Criteria for this Assessment

Air Quality Indicator	Period	Criteria (µg/m^3)
benzene	1 year	10
benzo(a)pyrene	1 year	0.3 ng/m^3
CO	8 hours	11,000 [2]
formaldehyde	1 day	54
NO_2	1 hour	250 [2]
	1 year	62
$PM_{2.5}$	1 day	25
	1 year	8
PM_{10}	1 day	50 [1]
sulfur dioxide	1 hour	570
	1 day	230
	1 year	57
toluene	30 minutes	1100
	1 day	4100
	1 year	410
TSP	1 year	90
xylenes	1 day	1,200
	1 year	950
odour from fugitives	99.5% 1 hour	2.5 ou
dust deposition	1 month	120 mg/m^2/day

4. Existing Air Quality

4.1 Study Area Description

4.1.1 DMPAs

The potential DMPAs are all in rural areas surrounded mainly by sugar cane farming. It is understood cane firing is no longer widely practised in the area, so air pollution issues generated by existing activities would include dust from vehicle traffic, cane field preparation andharvesting, and wind erosion, with occasional smoke from canefiring during havesting season.

At the proposed Barron Delta DMPA, there is currently an existing sand extraction and waste disposal operation (Northern Sands) with associated traffic. It is anticipated that these activities would generate particulates mostly of larger particle size. This would elevate dust deposition levels in the vicinity of the site.

At the East Trinity area, the only other activities observed were related to boating (maintenance and repair) and cane harvesting. Potential air emissions from this activity include particulates and VOCs from surface preparations associated with maintenance. These are not likely to be significant due to the apparent small size of the facilities.

4.1.2 Wharf Area

The wharf area is adjacent to industry to the south-west, commercial uses to the north-east and Trinity Inlet to the west. ASK visited the industrial area and identified the following existing uses which are anticipated to emit pollutants to the air:

1. Shell Service Station with diesel bowsers
2. fuel storage tank farm
3. Caltex service station
4. Liquid Speciality Beverages
5. Cairns Laundry and Linen
6. Cement Australia bulk terminal and load out facility
7. Australian Fisheries
8. Pupstars Daycare and Grooming
9. Volks Centre car repairs (No spray booth was observed.)
10. Pete's Welding Services
11. Centrepoint Windscreens and Tinting
12. S and B Automotive Spray Painting and Panel Beating
13. Australian Professional Galvanising
14. Department of Defence FSU-NE including surface finishing
15. Boral Concrete Batching Plant
16. Cleanaway Bins
17. Hume Timber and Doors (No spray booth was observed.)
18. Cairns City Paint and Panel

19. Stanley's Panel Works
20. Cairns Raw Materials with stockpiled soil and gravel
21. Hanson concrete batching plant
22. Sims Metal Management
23. Origin Energy
24. QSL
25. Tonkins Steel
26. Hastings Deering CAT
27. Cranleys Smash Repairs
28. Viridian Glass
29. Existing cruise ship vessels
30. Existing tourist / cargo / fishing vessels utilising the port/wharf area
31. Fuel bunkering and tank venting
32. Fertilizer unloading (emission ofinorganics and particulates)
33. Other wharf users including freight and tourist vessels.

Thus the area has a mixture of light and medium industries with a few medium to high impact activities including galvanising, concrete batching, surface coating, and potentially powder coating and abrasive blasting.

4.2 Overview of Available Air Quality Data

Monitoring data from similar locations have been used to review the existing background. In the absence of continuous monitoring data, it is recommended (Victoria (2001) to use the 70th percentile as a background concentration for dispersion modelling.

The nearest ambient air monitoring station operated by Department of Science, Information Technology and Innovation (DSITI) was Earlville in western Cairns in the 1990s, and more recently DSITI has monitored at three stations in Townsville, as discussed in the sections below.

Additional monitoring has also been undertaken for two specific projects in the area: the Portsmith Waste Treatment Facility and the Cityport Development.

4.3 Portsmith Waste Treatment Facility

Short-term monitoring of gaseous and particulate pollutants was undertaken from 27 to 29 March 2000 in and around Woree approximately 3 to 5 kilometres to the west of the wharf (Kamst & Simpson, 2000). Due to the short duration of sampling and the distance to the wharf, these results are not considered representative of air quality at the wharf.

4.4 Cityport Development

Short-term monitoring (3 to 6 minute samples) of gaseous pollutants (Kamst & Simpson 1998) was undertaken within the Cityport area on 12 and 13 May 1998. No exceedences of criteria were detected. However this short duration sampling is not representative of ambient (environmental) air quality due to the high degree of variability of wind conditions and potentially source emissions.

Short-term monitoring of TSP was undertaken on three days using a high volume sampler. The concentrations measured were 34 and 35 µg/m^3 on the walkway to the ships at Trinity Wharf and 23 µg/m^3 at the Cairns Port Authority depot near the corner of Wharf and Sheridan Streets. These indicate that particulate levels close to the wharf may be higher although concentrations will vary greatly between days. Although this monitoring was at the location of the wharf, the small number of days samples are not representative in time.

4.5 Earlville

Monitoring of TSP was undertaken in Mulgrave Road, Earlville, until 1999. The monitoring site is approximately 4 kilometres to the west of the wharf adjacent to a busy road and near light industry uses. The average concentration from 1995 to 1999 was 24 µg/m^3:

- 26 µg/m^3 in 1995
- 31 µg/m^3 in 1996
- 21 µg/m^3 in 1997
- 20 µg/m^3 in 1998
- 21 µg/m^3 in 1999.

This is considered to be the most representative long-term monitoring site and hence the TSP measurements from this location have been adopted as background.

4.6 Townsville Coast Guard

Monitoring at the Townsville Coast Guard site began in 2007 as part of the Townsville Dust Monitoring Program, implemented in response to community concerns about dust impacts from the Port of Townsville operations. In May 2014 the Townsville Coast Guard station and the Townsville Port monitoring station were amalgamated into one joint monitoring station at the Townsville Coast Guard. Due to the high activity levels from freight shipping including bulk handling, this location is likely to have higher pollutant concentrations than in the Cairns Port. The station measures:

- meteorological data
- PM_{10}
- TSP
- metals.

4.7 Townsville Port

Established by the Port of Townsville Limited in 1994, the Townsville Port monitoring station was located on the western boundary of the Townsville Harbour. It monitored the impact of port activities on nearby residential areas. In May 2014 this station was amalgamated with the Townsville Coast Guard station to form one joint monitoring station at the Townsville Coast Guard. It was classified as a peak (port operations) station and due to the high activity levels from freight shipping including bulk handling, is likely to have higher pollutant concentrations than in the Cairns Port. The station measured:

- meteorological data
- PM_{10}
- TSP.

4.8 Pimlico

The Pimlico monitoring station was established in June 2004 to measure air pollutants in the Townsville area. It is classified as a neighbourhood station and was located at Latitude: -19.2871; Longitude: 146.7813 within the TAFE North Pimlico Campus grounds until the site was redeveloped in February 2016. The station measured:

- meteorological data
- ozone
- sulfur dioxide
- oxides of nitrogen
- PM_{10}.

This is considered to be the most representative site for PM_{10} and acid gases, and the measured concentrations are presented in **Table 4.1**.

Table 4.1 Concentrations Recorded by Queensland DSITI Air Quality Monitoring Station at Pimlico in Townsville from 2007 until 2015

Year	75th percentile 1-hour NO_2 concentration ($\mu g/m^3$)	Annual NO_2 concentration ($\mu g/m^3$)	75th percentile 1-hour SO_2 concentration ($\mu g/m^3$)	75th percentile 24-hour SO_2 concentration ($\mu g/m^3$)	Annual SO_2 concentration ($\mu g/m^3$)	75th percentile 24-hour PM_{10} concentration ($\mu g/m^3$)
2007	30	8	5	3	3	15
2008	32	11	3	0	0	19
2009	36	9	3	3	0	18
2010	30	9	5	3	0	16
2011	not available	11	10	5	3	18
2012	32	9	5	3	3	16
2013	24	8	3	3	0	18
2014	26	8	5	3	3	17
2015	28	8	5	3	3	21
Average	30	9	5	3	1	18

4.9 Gladstone Memorial Park

Established in 2009, the Memorial Park station uses differential optical absorption spectroscopy (DOAS) equipment to monitor pollutants over a light path from the Entertainment Centre to Memorial Park. It is classified as a neighbourhood station and is located at Latitude: -23.8426; Longitude: 151.2534. The station measures:

- ozone
- nitrogen oxides
- sulfur dioxide
- air toxics (organic pollutants).

This is considered to be the most representative site for organic pollutants, and the measured concentrations are presented in **Table 4.2**.

Table 4.2 Concentrations Recorded by Monitoring Station at Gladstone Memorial Park

Year	Annual average benzene ($\mu g/m^3$)	Maximum 24h toluene ($\mu g/m^3$)	Annual average toluene ($\mu g/m^3$)	Maximum 24h xylene ($\mu g/m^3$)	Annual average xylene ($\mu g/m^3$)	Maximum 24h formadehyde ($\mu g/m^3$)
2009	i.d.	5	i.d.	34	i.d.	6
2010	i.d.	8	i.d.	33	i.d.	5
2011	i.d.	7	4	39	29	5
2012	i.d.	27	i.d.	149	i.d.	5
2013	i.d.	11	i.d.	79	i.d.	6
2014	4	18	8	127	51	5
2015	5	11	7	90	52	5
Average	**5**	**12**	**6**	**79**	**44**	**5**

Note: i.d. = insufficient data

4.10 South Gladstone

Established in 1992, the monitoring station is located in the grounds of the South Gladstone State School in a residential district. Since the Townsville and Mackay monitoring stations do not include $PM_{2.5}$, the South Gladstone station is considered the most representative for Cairns and the measured concentrations at this station are presented in **Table 4.3.**

Table 4.3 Concentrations of Fine Particulates ($PM_{2.5}$) Recorded by Queensland DSITI Air Quality Monitoring Station at South Gladstone for 2009-2015

Year	75th percentile 24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Annual $PM_{2.5}$ concentration ($\mu g/m^3$)
2009	10.5 [1]	9.2 [1]
2010	7.6	6.2
2011	7.6	7.5
2012	5.9	5.2
2013	6.3	5.6
2014	7.5	6.0
2015	5.2	4.3
Average	**6.7**	**5.8**

Note: 1 This data was not included in the average since the DSITI NEPM report for 2009 stated that there was a much higher than normal incidence and severity of wind blow dust events throughout Queensland.

4.11 Toowoomba

The Toowoomba DSITI monitoring station located at Willowburn Oval was the only CO monitoring station in Queensland outside of the Brisbane CBD, but closed down recently due to flooding. It was surrounded by residential and light industry areas. It is considered the most representative station and will be used for estimating background levels of CO for the purposes of this assessment. **Table 4.4** shows that the averaged maximum 8-hour background CO is 2.2 ppm (2750 $\mu g/m^3$).

Table 4.4 Concentrations of Carbon Monoxide Recorded by Queensland DSITI Air Quality Monitoring Station at Toowoomba for 2003-2010

Year	Maximum 8-hour average CO (ppm)
2003	2.6
2004	3.4
2005	2.3
2006	1.9
2007	2.2
2008	1.9
2009	1.8
2010	1.7
Average	**2.2**

4.12 Dust Deposition

Dust deposition varies substantially depending on local sources and season. Any dust deposition data for the local area is not publicly available. In industrial areas, insoluble dust deposition levels are typically in the order of 50 mg/m^2/day.

4.13 Summary of Estimated Background Levels

Based on the discussions in the preceding sections, the expected background air quality for key pollutants has been summarised with the estimated concentrations listed in **Table 4.5**. These are well within the criteria contained in **Table 3.3**. It is anticipated that the criteria would only be exceeded during regional events such as bushfires, dust storms or the afternoon cane fire haze events during harvesting season.

Table 4.5 Existing and Projected Background Air Quality

Pollutant	Averaging period	Assumed Background (µg/m3)
TSP	1 year	24
PM_{10}	24 hours	18
$PM_{2.5}$	24 hours	6.7
	1 year	5.8
NO_2	1 hour	30
	1 year	9
SO_2	1 hour	5
	24 hours	3
	1 year	1
CO	8 hours	2.2
Benzene	1 year	5
Toluene	24 hours	12
	Annual average	6

Pollutant	Averaging period	Assumed Background (µg/m3)
Xylene	24 hours	79
	Annual average	44
Formaldehyde	24 hours	5
Dust deposition	Annual average	50 mg/m^2/day

5. Meteorology and Climate

5.1 Weather Stations

The nearest available meteorological monitoring data is collected by the Bureau of Meteorology (BoM) at the Cairns Airport which is located approximately seven kilometres north-west of the wharf and East Trinity. It is approximately 2.4 kilometres south-east of the Barron Delta DMPA. Climatic information has been recorded at Cairns Airport since 1941 for a range of meteorological data including temperature, humidity, wind and rainfall.

The long-term averages have been based on up to 71 years of data, as noted in **Table 5.1**.

5.2 Temperature, Rain and Humidity

In summer, the average maximum temperature ranges from 31.2°C to 31.4°C and the minimum temperature ranges from 23.4°C to 23.8°C. In winter, the average maximum temperature ranges from 25.7°C to 26.6°C and the minimum temperature ranges from 17.1°C to 17.8°C.

The annual average humidity reading for Cairns at 9am is 72% and at 3pm is 62%. The months with the highest humidity on average are February, March and April with 9am averages of 78%, and the lowest is September with a 3pm average of 55%.

Rainfall data shows that the wettest month is February with an average rainfall of 451 mm. The lowest rainfall month on average is August with 27 mm. The average annual rainfall is 2015 mm over an average of 120 rain days.

Table 5.1 Long-term Average Climate Information from Cairns Airport

Month	Mean Daily Maximum Temperature (°C)	Mean Daily Minimum Temperature (°C)	Mean Monthly Rainfall (mm)	Mean 9am Relative Humidity (%)	Mean 3pm Relative Humidity (%)
Jan	31.4	23.7	395	75	66
Feb	31.2	23.8	451	78	69
Mar	30.6	23.1	424	78	67
Apr	29.2	21.6	195	78	65
May	27.6	19.9	91	76	64
Jun	26.0	17.8	45	74	61
Jul	25.7	17.1	29	72	58
Aug	26.6	17.4	27	70	56
Sep	28.1	18.7	34	66	55
Oct	29.5	20.6	47	65	57
Nov	30.6	22.3	94	68	60
Dec	31.4	23.4	179	70	62
Mean	29	20.8	168	72	62

5.3 Wind Records

Wind data from the BoM monitoring station at Cairns airport is presented in **Figure 5.1** and **Figure 5.2**.

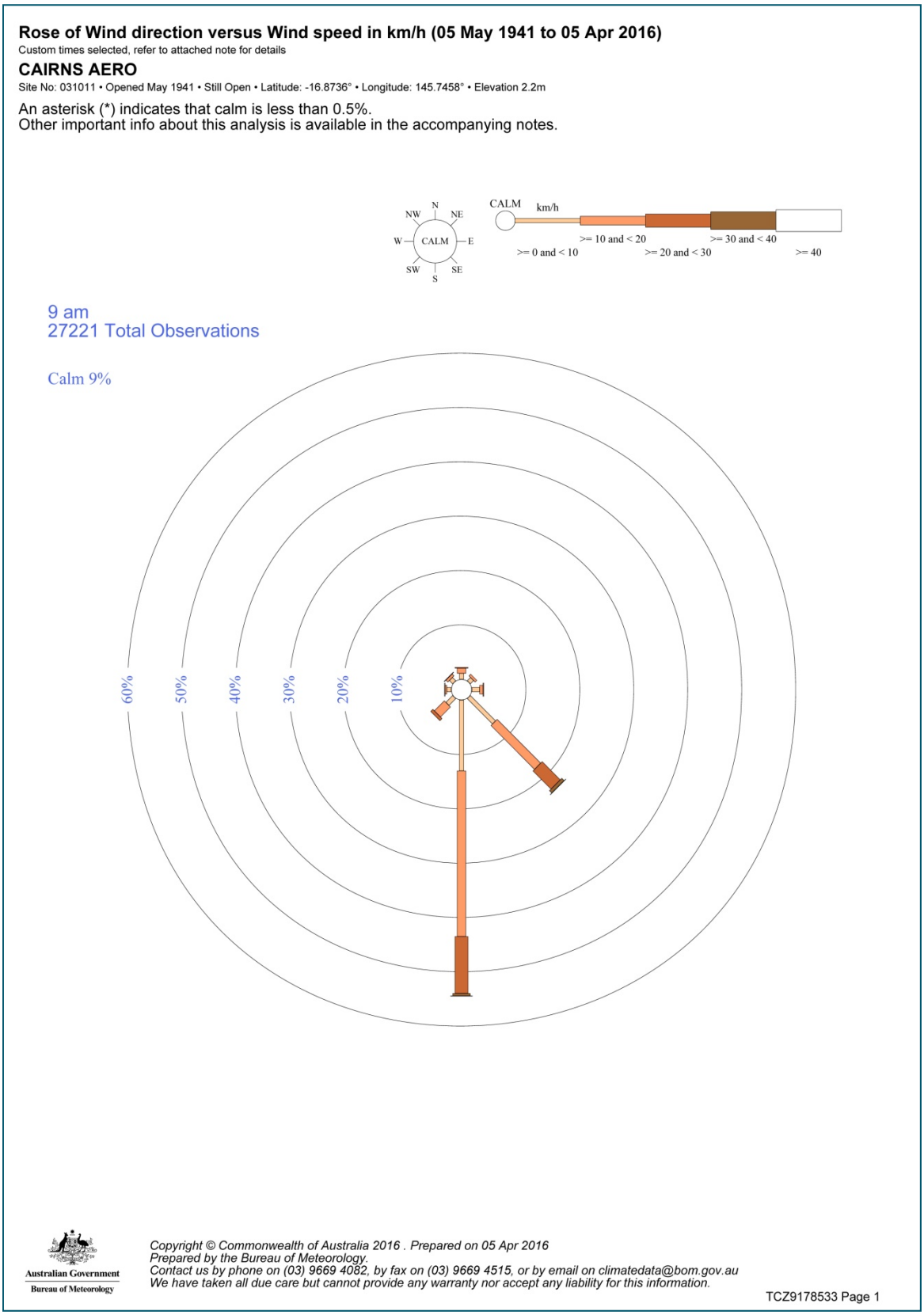


Figure 5.1 Morning (9am) Wind Rose from Cairns Airport

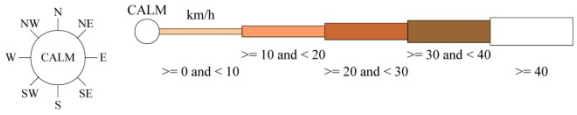
Rose of Wind direction versus Wind speed in km/h (05 May 1941 to 05 Apr 2016)

Custom times selected, refer to attached note for details

CAIRNS AERO

Site No: 031011 • Opened May 1941 • Still Open • Latitude: -16.8736° • Longitude: 145.7458° • Elevation 2.2m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm
27169 Total Observations

Calm 2%

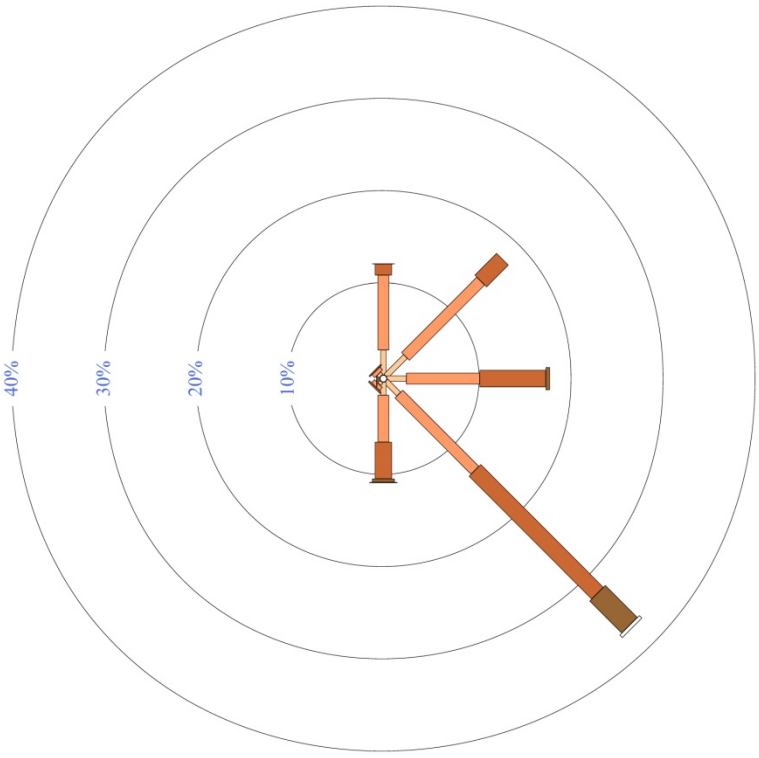


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Figure 5.2 Afternoon (3pm) Wind Rose from Cairns Airport

5.3.1 Relevance to the Wharf

The predominately south to south-easterly winds could potentially move emissions generated from the operations in the wharf area north to north-west of the Port of Cairns. The Cairns Central Business District (CBD), which is situated north-west of the wharf may be slightly affected by some south-easterly winds (predominately in the afternoon), which could carry potential pollution generated in the vicinity of the wharf toward the CBD. However moderate wind speeds and the morning southerly wind direction indicates that potential pollutants would be unlikely to settle over the CBD and would more likely continue away from the coast.

5.3.2 Relevance to East Trinity DMPAs

Emissions from East Trinity DMPAs will tend to be blown by the prevailing winds away from the permanent residences located to the south-east as shown on **Figure 6.3**, but the prevailing winds are toward the boat moorings to the north-west.

5.3.3 Relevance to Barron Delta DMPA

Emissions from the Barron Delta DMPA are more likely to impact on receptors to the north-west shown on **Figure 6.2** due to the prevailing winds.

5.4 Topographic Influence on Wind

The topography of the area immediately surrounding the Cairns area is relatively flat with an increase in elevation 4 kilometres to the east and 6 kilometres to the west. These landforms are considered likely to cause containment or recirculation of pollutants in the area due to the predominant south-easterly winds blowing the air mass along the coast. The substantial hills to the east are close to the East Trinity DMPAs and are likely to influence wind direction in that area.

5.5 TAPM Meteorological Modelling

5.5.1 TAPM Fundamentals

The meteorological component of The Air Pollution Model (TAPM) was used to provide wind fields over the region. Wind speed and direction has been monitored at the Cairns airport and this data was assimilated into the modelling. No other site specific meteorological data is publicly available for the vicinity.

The databases required to run TAPM are provided by CSIRO and include global and Australian terrain height data, vegetation and soil type datasets, sea surface temperature datasets and synoptic scale meteorological datasets.

The Australian terrain data is in the form of 9-second grid spacing (approximately 0.3 kilometres) and is based on data available from Geosciences Australia. Australian vegetation and soil type data is on a longitude/latitude grid at 3-minute grid spacing (approximately 5 kilometres) and is public domain data provided by CSIRO Wildlife and Ecology.

The synoptic scale meteorology dataset used is a six-hourly synoptic scale analysis on a longitude/latitude grid at 0.75 or 1.0-degree grid spacing (approximately 75 kilometres or 100 kilometres). The database is derived from US NCEP reanalysis synoptic product.

TAPM dynamically fits the gridded data for the selected region to finer grids taking into account terrain, surface type and surface moisture conditions. It produces detailed fields of hourly estimated temperature, winds, pressure, turbulence, cloud cover and humidity at various levels in the atmosphere as well as surface solar radiation and rainfall.

5.5.2 TAPM Configuration

A detailed analysis (Adhkiari, 2013) of eight years of Townsville monitoring and modelling data sponsored by ASK found that 2006 was the most representative year. A comparison of the long-term wind roses at Cairns airport,shown in **Figure 5.1** and **Figure 5.2,** shows similar pattern to the 2006 Cairns airport data shown in **Figure 5.3.** Thus 2006 is considered representative and has been used for the meteorological simulation.

TAPM was setup using four nested 30 x 30 grids centred on latitude 16°52.0' south, longitude 145°17.0' east. The four nested grids were as follows:

- 750 km x 750 km with 30 km resolution
- 250 km x 250 km with 10 km resolution
- 75 km x 75 km with 3 km resolution
- 22.5 km x 22.5 km with 900 m resolution

Thirty (30) vertical levels were used with lower level steps at 10, 25, 50, 75 and 100 metres up to 8 kilometres in altitude. This is greater than normal number of vertical layers in order to provide better resolution of vertical layers. Boundary conditions on the outer grid were derived from the synoptic analysis. Non-hydrostatic pressures were included to better represent the terrain features in the inner grid.

TAPM land use data was updated using the latest aerial photography available being October 2015 from the Queensland Globe overlay for Google Earth from the Department of Natural Resources & Mines.

Meteorological data from Cairns airport was available for assimilation into the model run. A windrose of this data is shown in **Figure 5.3**. TAPM was run without assimilation of this data and the windrose for the same period is shown in **Figure 5.4**. The two wind roses show a very similar pattern except TAPM predicted a lower proportion of calm conditions, and a higher proportion of light wind conditions, which is typical and leads to conservative results. Therefore the observational data was included into the TAPM model for generating data for the project.

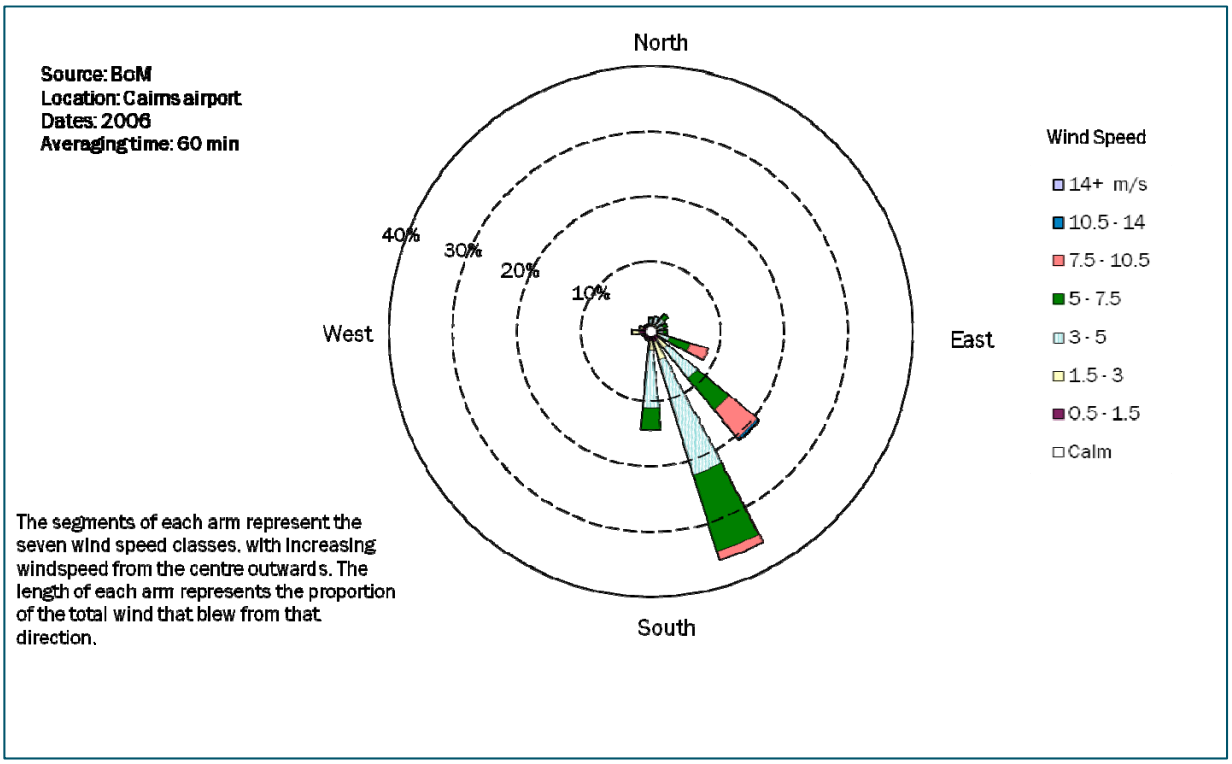

Figure 5.3 Continuous Data Cairns Airport Windrose

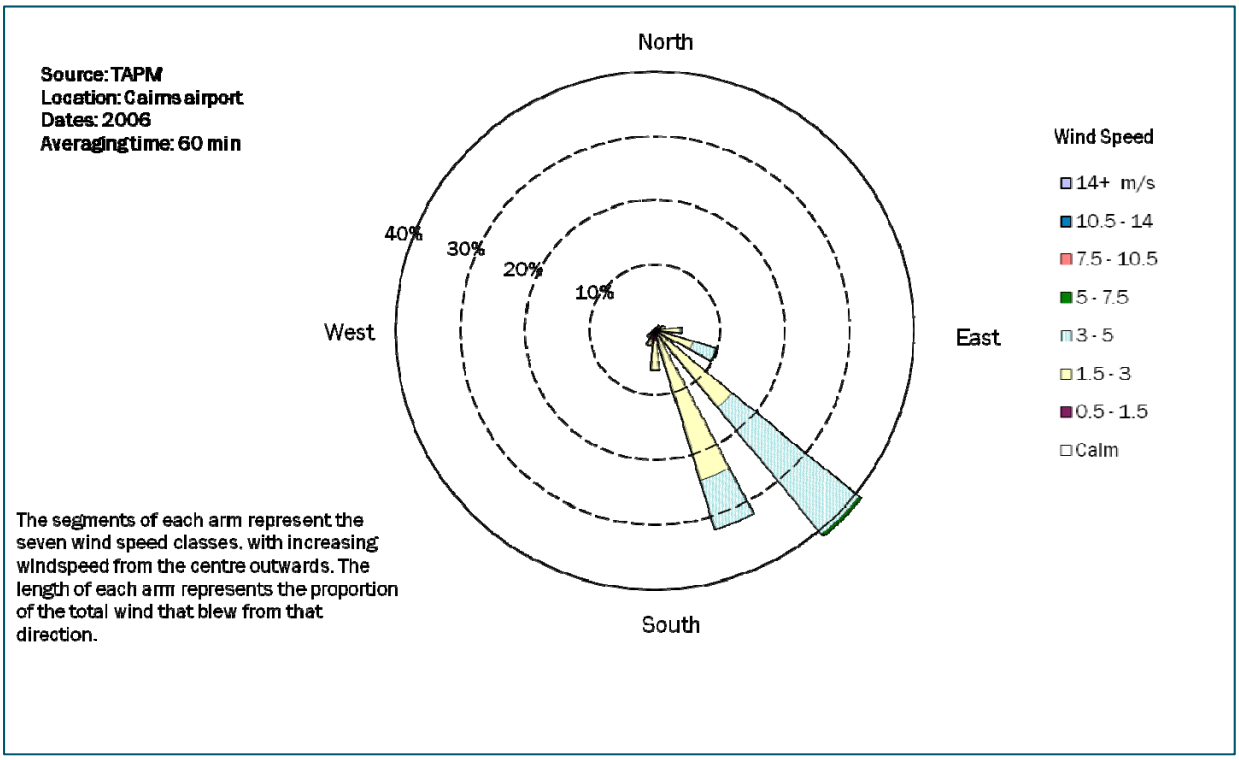

Figure 5.4 TAPM Windrose without Assimilation of Airport Data

5.5.3 TAPM Validation

The TAPM GIS visualisation tool was used to examine the final windfields generated by the model. The last few hours of the year were reviewed to ensure the model completed the run correctly. The windfields in the inner grid throughout the month of June were examined in detail to understand the local wind patterns, influence of topography, and to ensure that the data assimilation had progressed smoothly. The following patterns were observed:

- Assimilated data tracks well with the winds over the remainder of the domain, although it has greater variability, which is normal. The model shows increased velocities over the water even within the zone of influence of the assimilated data.
- Topography to the west has a substantial effect on winds with strong south-easterlies across Trinity Inlet prevalent, originating from the north-west slopes, with moderate easterlies prevalent off the western slopes.
- Morning winds were south to south-easterlies.
- Afternoon winds were moderate to strong south-easterlies.
- Night winds were light to moderate south to south-easterlies.
- Overall, winds were dominated by south-easterlies.

5.6 Topography and Land Use

For the purpose of providing topographic data for the detailed modelling, the coordinates of a rectangular grid representative of the area around the proposed site were derived using WGS84 coordinates from Google Earth Professional. The south-west corner coordinates were (367000, 8125000), north-east corner coordinates were (374000, 8132000), and the grid interval was 100 metres with zero height receptors.

The WGS84 and GDA94 grids are identical to an accuracy of less than one metre. All coordinates in this report are rounded off to the nearest metre and are valid for both coordinate grids.

Gridded topographic data for Calmet was created using Shuttle Radar Topography Mission (SRTM) elevations on a 1-second grid (approximately 30 metre spacing).

5.7 Calmet Wind Field Modelling Configuration

The Calmet configuration used is consistent with NSW OEH guidance (TRC 2011). The model was run over the full year of 2006 based on a 3-dimensional grid produced using the Caltapm utility program to convert TAPM data to MM5 format suitable for Calmet to read. The Calmet grid was set to grid spacing of 100 metres and 70 by 70 grid points. Twelve vertical layers were modelled with cell face heights of 0, 20, 40, 80, 160, 300, 450, 650, 900, 1200, 1700, 2300, and 3200 metres. This is greater than the normal number of vertical layers in order to provide better resolution of vertical layers.

Mixing height calculation parameters were set to default values. The maximum mixing height was set to 3000 metres. Temperature prediction parameters were set to default.

Divergence minimisation was used. The critical Froude number was set to 1. Slope flow effects were included. The radius of influence of terrain features was set to 4 kilometres.

The output from Calmet was a three dimensional grid of wind-field data for incorporation into Calpuff.

5.8 Calmet Results

The frequency distributions of occurrences of winds for each direction sector and for each wind class (wind rose) as generated by Calmet for Cairns are illustrated in **Figure 5.5**.

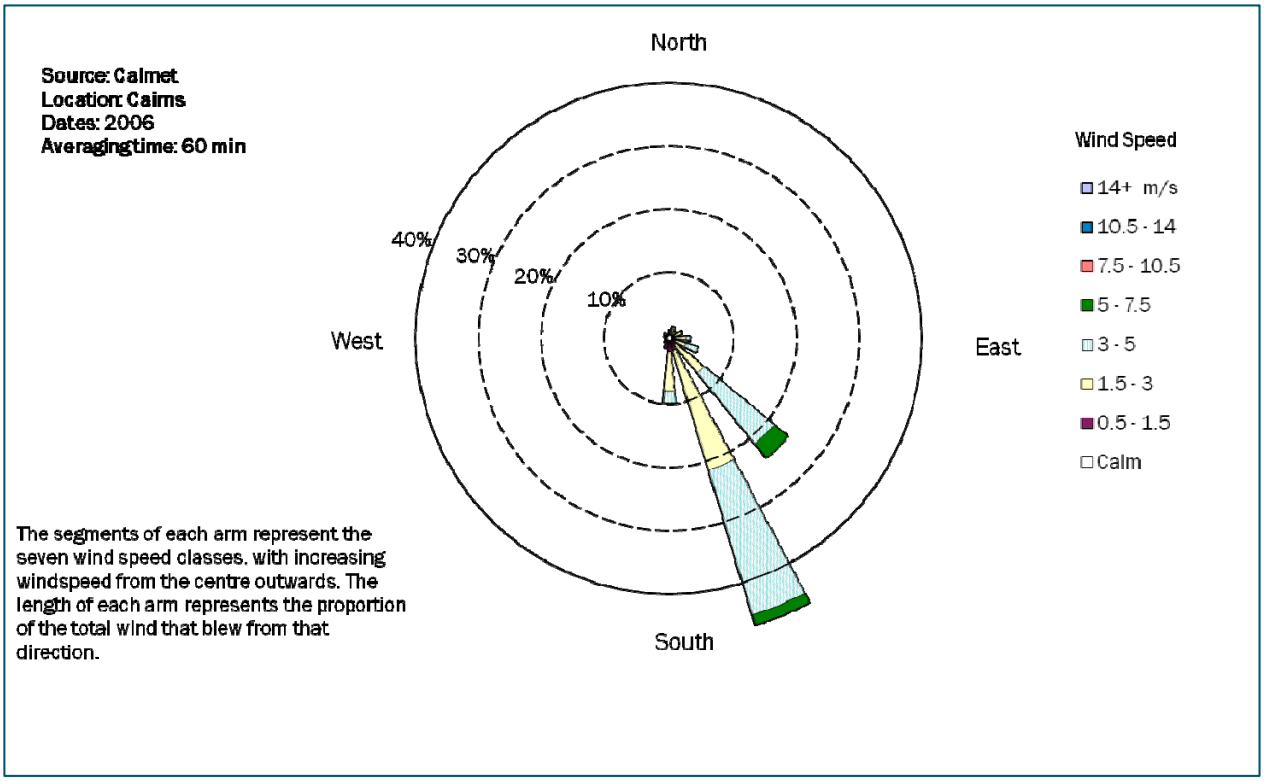

Figure 5.5 Wind Rose from Calmet

Figure 5.6 and **Figure 5.7** show, respectively, the frequency of stable conditions throughout the day, and the variation of mixing height throughout the day.

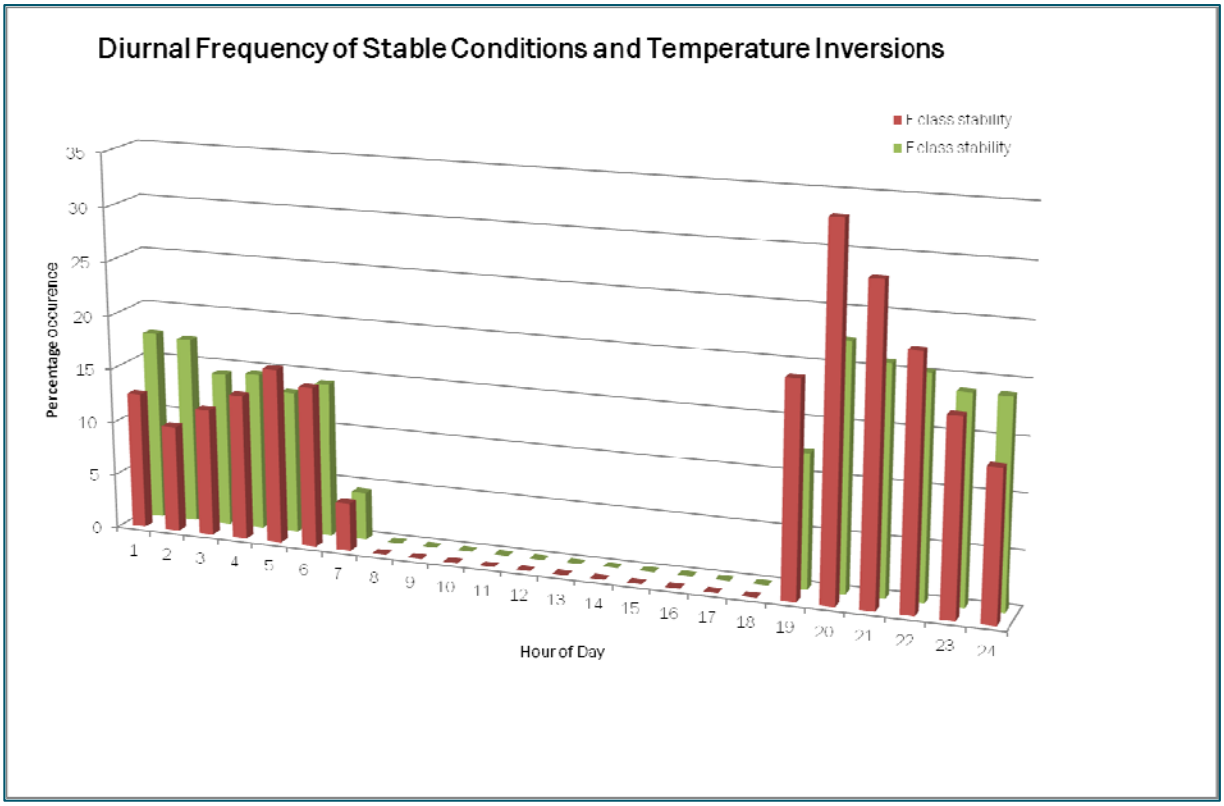

Figure 5.6 Diurnal Frequency of Stable Conditions

Day time conditions are either neutral or unstable. There is an unusually high frequency of E class stability especially in the evening. Modelling of emissions will therefore consider this high proportion of stable conditions, which may lead to poor dispersion of ground level or downwashed emissions, whilst maintaining height on elevated emissions not subject to downwash. Structural downwash will therefore be important in the dispersion modelling.

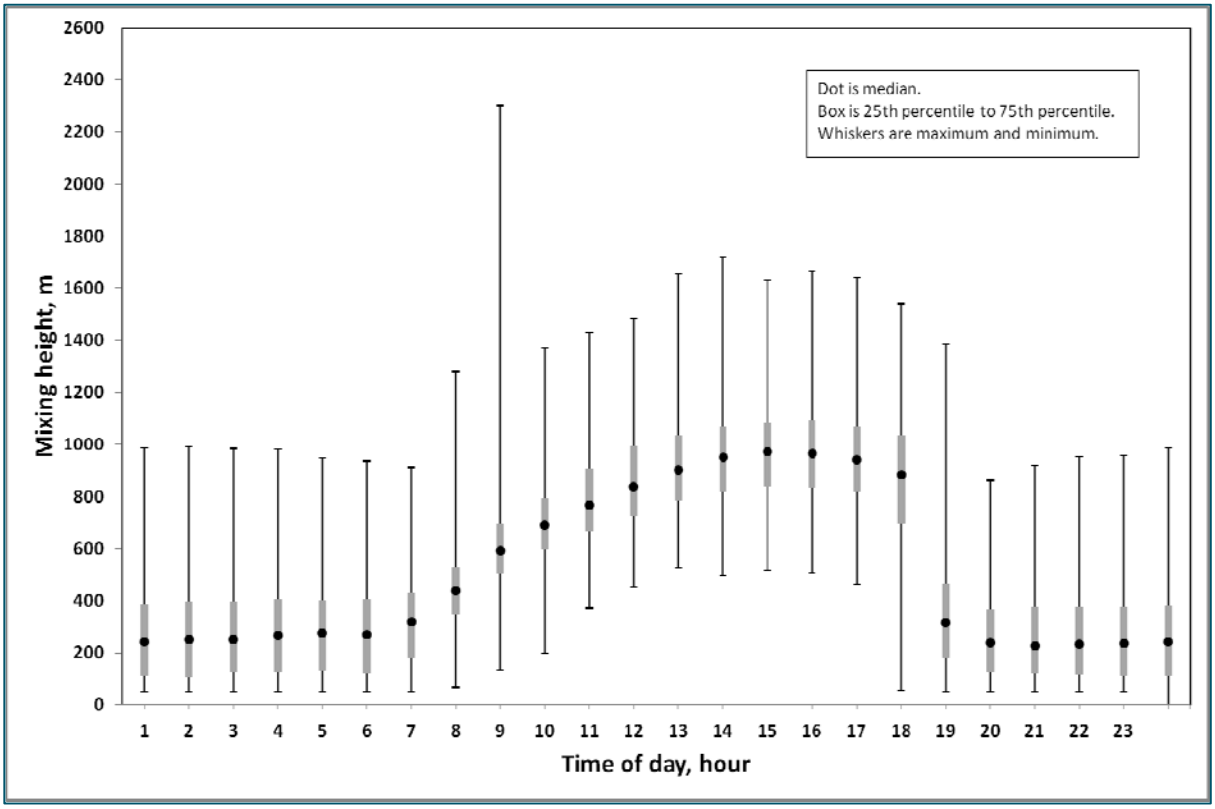

Figure 5.7 Prediction of Mixing Height from Calmet Model

In the morning the median mixing height rises up gradually reaching approximately 1 kilometre by the afternoon, then reforming at ground level again at nightfall.

The maximum has an unusual peak at 9am. The 99.5 percentile mixing height at 9am was 1288 metres, which is similar to the maxima at other times. The median at 9am follows the regular pattern. Hence this is unlikely to influence the modelling of anything other than tall stacks.

6. Sensitive Receptors

Sensitive land uses are defined in the State Planning Policy (2014) as caretakers accommodation, child care centre, community care centre, community residence, detention facility, dual occupancy, dwelling house, dwelling unit, educational establishment, health care services, hospital, hotel, multiple dwelling, non-resident workforce accommodation, relocatable home park, residential care facility, resort complex, retirement facility, rooming accommodation, rural workers accommodation, short-term accommodation or tourist park.

The nearest sensitive receptors are summarised in **Table 6.1** including their northing and easting locations and are shown in **Figure 6.1** to **Figure 6.3**. Boat berths where permanent pylons are provided for mooring are considered sensitive locations under the definition of relocatable home park. It is understood that Ports North control the lease of these mooring pylons.

The Mandingalbay Yidindji Aboriginal Corporation (MYAC) has interests in the area delineated by the yellow polygon in **Figure 6.3**. This overlaps East Trinity DMPA Site C and would be impacted by pipeline construction for other optional East Trinity sites. The air quality impacts onto cultural values may include temporary dust deposition and reduction of visibility. Consultation with MYAC may be necessary to manage impacts.

Table 6.1 List of Sensitive Receptors with UTM Coordinates (WGS84 Z55)

ID	Name / Address	Real Property Description	Approximate Distance and Direction from Site	Easting (m)	Northing (m)
Near wharf	**Cairns City**				
A	Park Regis City Quays Hotel, 6-8 Lake Street	N/A	Approximately 130 metres west of dockside.	369960	8128319
B	Park Regis Piermonde Apartments 2-4 Lake St	N/A	Approximately 130 metres west of dockside.	369999	8128255
C	Jack & Newel Apartments 27-29 Wharf St	N/A	Approximately 130 metres west of dockside.	370006	8128299
D	Madison on Abbott Apartments, 3 Abbott Street	N/A	Approximately 130 metres west of dockside.	370001	8128362
E	Pullman Reef Hotel & Casino 6-8 Abbott St	N/A	Approximately 100 metres west of dockside.	370054	8128412
F	Cairns Hilton Hotel, 34 Esplanade	N/A	Approximately 80 metres west of shipping channel.	370141	8128578
G	Cairns Harbour Lights Managed Apartments, 101 Marlin Parade	N/A	Approximately 100 metres west of shipping channel.	370151	8128632
H	Shangri-La Hotel, Pier Point Rd	N/A	Approximately 220 metres west of shipping channel.	370146	8128990
I	Boats used as residences, east side of Trinity Inlet	N/A	Variable		

ID	Name / Address	Real Property Description	Approximate Distance and Direction from Site	Easting (m)	Northing (m)
Near Barron Delta Placement area					
S	Dwelling under construction, Holloways Beach Access Road	22/SP211748	Approximately 850 metres north of Baron Delta area	364587	8136488
T	637 Captain Cook Highway Barron	4/RP800591	Approximately 200 metres north-west of Baron Delta area	363235	8136373
U	637 Captain Cook Highway Barron	4/RP800591	Approximately 200 metres north-west of Baron Delta area	363162	8136228
V	Holloways Beach Access Road	1/RP804218	Approximately 400 metres east of Baron Delta area	364663	8135785
W	Holloways Beach Access Road	1/RP804218	Approximately 300 metres east of Baron Delta area	364566	8135742
X	Holloways Beach Access Road	1/RP804218	Approximately 300 metres east of Baron Delta area	364561	8135676
Y	417-419 Captain Cook Highway	4/RP748713	Approximately 400 metres east of Baron Delta area	364658	8135085
Near East Trinity area	**Glen Boughton**				
Z	1673 Pine Creek Yarrabah Road	11/SP232030	Approximately 890 metres east of East Trinity Site B	373868	8126419
AA	1685 Pine Creek Yarrabah Road, Glen Boughton	3/SP186247	Approximately 930 metres east of East Trinity Site B	373925	8126506
AB	Pine Creek Yarrabah Road, Glen Boughton	1/SP178692	Approximately 50 metres east of East Trinity Site A	373811	8127765
AC	Pine Creek Yarrabah Road	1/SP178692	Approximately 50 metres east of East Trinity Site A	373765	8127900
AD	Pine Creek Yarrabah Road, Glen Boughton	785/AP19382	Approximately 490 metres north of East Trinity Site A	373652	8128778

Figure 6.1 Location of Sensitive Receptors in Wharf Street Area (Image from Google Earth Pro)

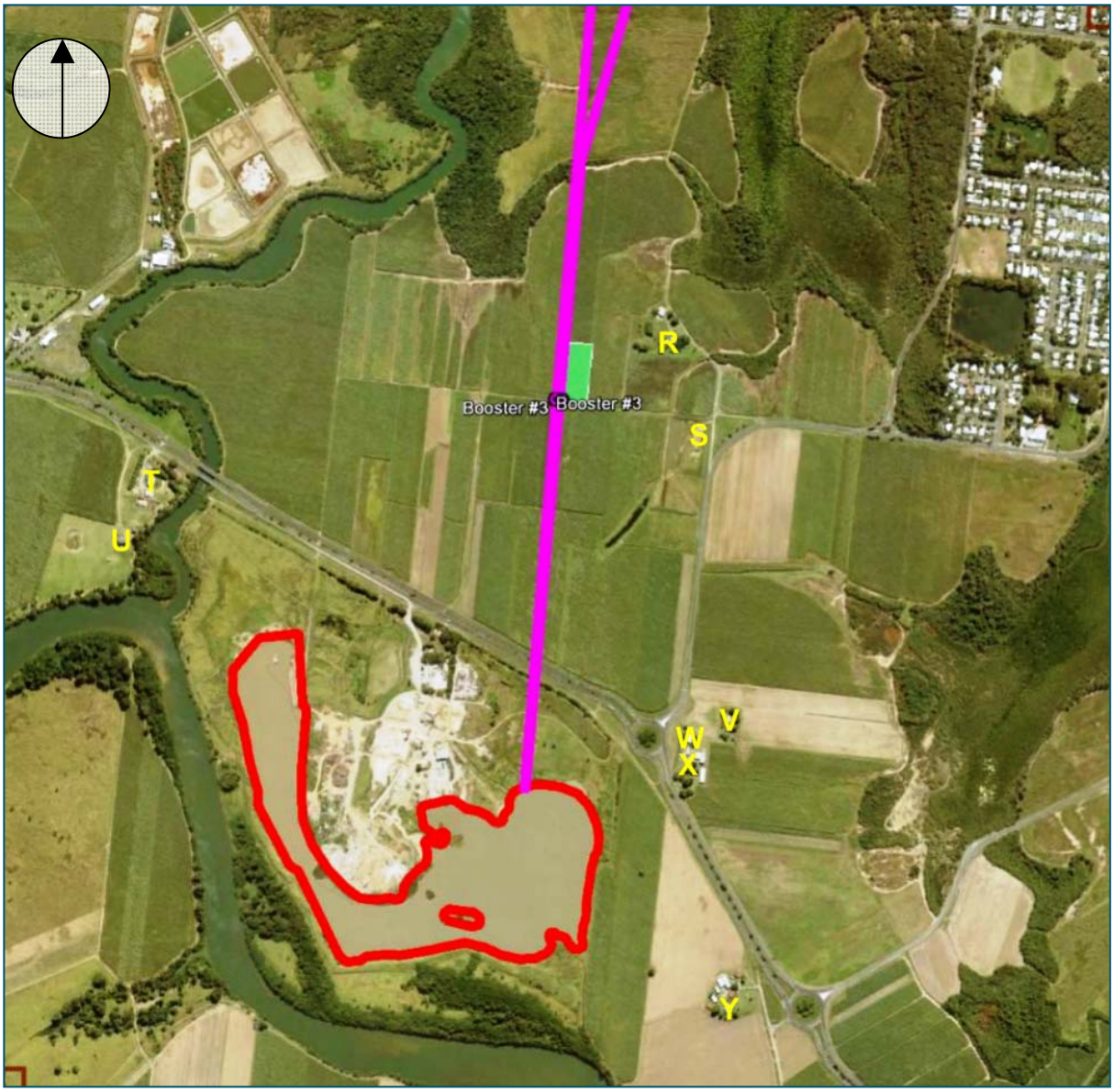

Figure 6.2 Location of Sensitive Receptors near Baron Delta Placement Area

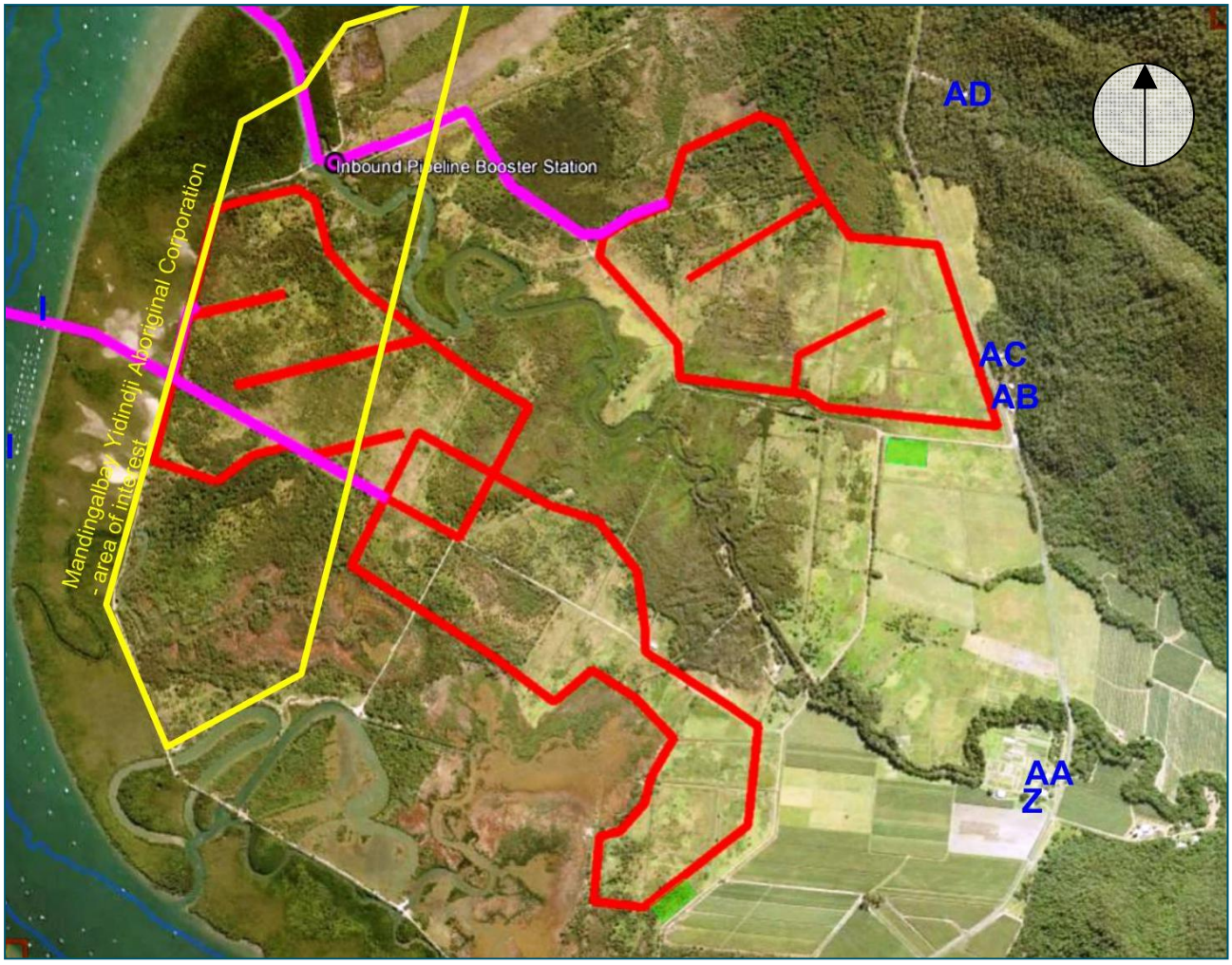

Figure 6.3 Location of Sensitive Receptors in East Trinity Area (Image from Google Earth Pro)

7. Constraints Assessment

7.1 Potential Impacts of Wharf Construction

Construction activities at the wharf have the potential to generate particulates from demolition and construction dust and, to a lesser degree of impact, combustion products from plant exhausts. Based on the description of the wharf upgrade, the scale of work is not likely to be greater than a typical inner-city construction project.

Sensitive receptors are approximately 40 metres (across Wharf Street) from the boundary of the works area, and it is anticipated that major works will be undertaken well inside the boundary. Good practice control measures are normally sufficient to avoid exceedance of criteria and complaints with this available buffer. Such measures, along with monitoring and reporting requirements are to be outlined in the Stage 1D impact assessment and specified in Demolition and Construction Management Plans.

7.2 Potential Impacts at East Trinity DMPA

Emissions from vessels including dredges and tugs will occur during travel, mooring, connection and pipline handling. These emissions are expected to be low risk and considering their temporary nature, should be adequately controlled by management plans. Placement of dredged material has the potential to generate particulates and odour. The project includes large quantities of material to be distributed over a wide area. Impacts from pipeline construction and operation (use of pumping stations and machinery to move material) will include diesel emissions but are considered minor.

7.2.1 Particulates

The placement area would be especially large in the case of the East Trinity placement site options. However, whilst the material is wet it will not be greatly prone to dust. After it drys out, it will form a crust and should also not be readily eroded. However, management plans should require visual monitoring and prompt rehabilitation of finished surfaces.

Use of lime dust to treat acid sulphate properties may also become airborne but can be managed through timing of lime placement for times when wind speed is low.

The greater likelihood of dust emissions will be during establishment of the placement areas rather than during placement of the dredged material.

7.2.2 Odour

The presence of materials with acid sulphate properties to be disposed of at the site may lead to emission of odorous sulphur compounds if the material is not properly treated with lime. In addition, exposure of seabed material (containing biological materials) to oxygen typically leads to release of odorous compounds during decomposition.

7.2.3 Buffers

The approximate distance to the nearest permanent sensitive receptor is 50 metres for East Trinity Site A, 890 metres for East Trinity Site B and further for East Trinity Site C. East Trinity Site C is more than 400 metres from boat moorings. Thus East Trinity Site B is preferred from an air quality perspective due to the larger buffer distances. The buffer to East Trinity Site A may not be sufficient to prevent dust and odour impacts at the nearest sensitive receptors at times when the topography redirects winds back toward the south or east.

7.3 Potential Impacts at Barron Delta DMPA

7.3.1 Particulates

Placement of material would be into a deep, wet pit, and so particulate emissions are of no concern from placement of the material itself. However there is some potential for dust during construction of the associated pipeline, and vehicle/plant movements along the pipeline route, laydown yards, and trucks using unsealed roadways. It is understood that a staging area may be constructed on Pappalardo's farm adjacent to the mouth of Thomatis Creek, but this is approximatle 800 metres form the nearest sensitive receptor so will not cause air quality impacts provided it is reasonably well managed.

7.3.2 Odour

For minimisation of odour emissions, the deeper placement pit at the Barron Delta Site is preferred to the shallow placement proposed at East Trinity.

7.3.3 Buffers

The nearest sensitive receptor is 200 metres downwind of the edge of the existing pit. Although emissions from this end of the DMPA are likely to be minor, there are residences within 400 metres of the south-eastern end near the pipeline.

7.4 Potential Impacts of Future Wharf Operation

Ship engine exhausts will emit combustion products including sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulates, carbon monoxide (CO) and volatile organic compounds (VOCs). VOCs may include benzene, benzo(a)pyrene, formaldehyde, toluene and xylene.

On-shore sensitive receptors have a buffer of at least 80 metres to the wharf and shipping channel and this is within typical expectations for an adequate buffer provided appropriate mitigation measures are adhered to. However the boat berths on the eastern side of Trinity Inlet are in close proximity to the shipping channel and swing basin, so despite the predominant south-easterlies, may have exposure to high concentrations of pollutants during ship manoeuvring in near-calm conditions.

Emissions whilst ships are berthed can be mitigatedby prohibition of the use of incinerators, and specification of fuel type when alongside. Exhaust emissions during ship manoeuvring are typically managed by specifying the grade and type of fuel and engine designs to be used by ships allowed into the port. The need for measures is to be established during stage 1D of the impact assessment study.

8. Recommendations

8.1 Wharf Construction and Operations

ASK provides the following recommendations relating to air quality.

Wharf Construction:

(1) Buffers to sensitive receptors are sufficient. However wharf construction activities should be managed by good practice control measures prescribed in Construction Management Plans.

Wharf Operations

(2) Buffers to on-shore sensitive receptors are considered reasonable. Impacts and necessary control measures should be specified following detailed impact assessment.

(3) Buffers to boat moorings on the eastern side of Trinity Inlet may be too small to address with control measures. Clarification is required as to whether boat moorings should be included in the definition of sensitive receptors or not. Impacts on these locations are to be ascertained during detailed assessment.

8.2 Dredged Material Placement

The opportunities and constraints associated with the different location options for the placement of dredged material are summarised in **Table 8.1**. The key recommendations for the placement locations are as follows:

(1) East Trinity Site A is not recommended due to the small, and potentially inadequate separation distance to sensitive receptors.

(2) East Trinity Sites B and C are the preferred options since the separation distances to sensitive receptors are large and there are a reduced number of permanent sensitive receptors. Dust and odour impacts are likely to be addressed by normal control measures and these sites are recommended from an air quality perspective. Odour from material containing acid sulphate properties and decomposing biological material can be managed by proper treatment with lime.

(3) The Barron Delta placement site is also favourable due to moderate separation and lower impact due to pre-existence of pit. Dust emissions will require good practice control measures during construction of the associated pipeline. Odour from material containing acid sulphate properties and decomposing biological material will be reduced by the depth of the placement pit at this site. The Site Establishment and Operation Management measures for this site will need to address dust. However emissions from the pipeline construction and operation are considered minor and should not influence the choice of pipeline route.

Table 8.1 Opportunities and Constraints of Location Options for Dredged Material Placement

Location Option	Opportunities and Strengths	Constraints and Weaknesses
East Trinity Overall	• Less sensitive receptors potentially impacted. • Generally larger separation distances to sensitive receptors, both DMPA's and other activity areas.	• Site establishment works required for placement areas, dust will be generated from this work. • Placement areas not currently used for industry (i.e. currently cane harvesting only), would introduce new dust source. • Consultation with MYAC may be necessary to manage impacts.
East Trinity A	• Nil	• Portion of site is located within 100 metres of sensitive receptors. • Closest East Trinity option to sensitive receptors. • Closest East Trinity pipe fabrication area to receptors • Adds new dust source, currently cane harvesting only.
East Trinity B & C	• Good separation to residential sensitive receptors. • Likely that minimal management of activities would be required to mitigate dust emissions.	• Adds new dust source, currently cane harvesting only . • Site C is the closest East Trinity option to boat moorings.
Barron Delta	• Minimal DMPA site establishment work required. • DMPA site located at existing quarry and waste disposal area, where existing environment influenced by dust. • Less site establishment work (bunding, land treatment) required. • The pipeline construction and operation is not likely to impact on receptors. • The choice of pipeline route options is not constrained by air quality.	• More sensitive receptors potentially impacted due to extent of land based project area. • Further expansion of north-western area of DMPA site would require activity within 300 metres of receptors U and T. • Greater potential for dust impacts/complaints due to larger potentially affected population. • Dust emissions will require good practice control measures during site establishment. • There is potential for odour from material containing acid sulphate properties, but this can be managed by proper treatment with lime, and odour from decomposing biological material will be reduced by the depth of the placement pit at this site.

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Appendix A Glossary

Parameter or Term	Description
ASK	ASK Consulting Engineers Pty Ltd
BoM	Bureau of Meteorology
CO	Carbon monoxide
CSD	Cairns Shipping Development
DMPA	Dredge material placement area
DSITI	Department of Science, Information Technology and Innovation
Dust fallout deposition	Dust that has fallen out of the air onto a horizontal surface
EHP	Queensland Department of Environment and Heritage Protection
EPP (Air)	Queensland Environmental Protection (Air) Policy 2008
FEL	Front end loader
$g/m^2/month$	Grams per square metre per month
m/s	Metres per second
$mg/m^2/day$	Milligrams per square metre per day
mg/m^3	Milligrams per cubic metre
NPI	National Pollutant Inventory
NEPM	National Environmental Protection (Ambient Air Quality) Measure
NO_x	Oxides of nitrogen including nitric oxide and nitrogen dioxide
NO_2	Nitrogen dioxide
NSW OEH	New South Wales Office of Environment and Heritage
$PM_{2.5}$	Particulates suspended in air with aerodynamic diameter less than 2.5 microns
PM_{10}	Particulates suspended in air with aerodynamic diameter less than 10 microns
ppb	Parts per billion by volume
ppm	Parts per million by volume
SO2	Sulphur dioxide
TAPM	The Air Pollution Model developed by CSIRO and used by ASK for meteorological modelling
TSHD	Trailer suction hopper dredge
TSP	Total particulates suspended in air
$\mu g/m^3$	Micrograms per cubic metre
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTM	Universal Transverse Mercator coordinate system
VOCs	Volatile organic compounds
WHO	World Health Organisation