Habitat	Area	Ecological Value	Predicted Impact	Relevant Section of EIS
Water quality	TMPP project area	High ecological value as good water quality intrinsically important for support of healthy marine ecosystems. Currently some levels of contaminants in areas adjacent to Precinct footprint.	Opportunity to co-locate commercial industries into a new, purpose built, facility. Potential for improving the water quality in the lower reach of Ross River.	3.9

3.11 Air quality

3.11.1 Description of environmental values

The DERM has a monitoring network of five sites in Townsville. Results from this monitoring, along with additional industry monitoring from the Townsville Port Authority and Sun Metals Corporation, are reported on monthly[6] and annually[7] by the DERM.

The gaseous pollutants of Ozone (O_3), Nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2) are measured by the DERM at Pimlico (inland and to the South-east of the Port) while industrial monitoring of SO_2 is done by Sun Metals at Stuart (well inland and south of the Port). Respirable particulate matter (PM10) is measured at Pimlico (DERM) and the Townsville Port (industry). The DERM have a more extensive network for Dustfall and Total Suspended Particulate matter (TSP) at the Coast Guard, South Townsville, North Ward and Yarrawonga to supplement dustfall measured at Pimlico. These dust measurements, from March 2008, speciate for various metals[8] (TSP) and Lead (TSP and dustfall).

The following information, from DERM annual reporting for 2007 against the National Environment Protection (Ambient Air Quality) Measure requirements[9], summarises the air quality environmental values for the Townsville airshed:

- Carbon monoxide (CO) is not required to be monitored because “pollutant levels are reasonably expected to be consistently below the relevant NEPM standard”;
- Monitoring at Pimlico “over the period 2004 to 2007 has shown nitrogen dioxide levels to be consistently below 40 percent of the NEPM standards”;
- Lead falls into the same category as CO (however monitoring has commenced in Townsville around industrial sources from May 2008);
- Of the five regions reporting against the 24-hour PM10 NEPM standard (South-east Queensland, Toowoomba, Gladstone and Mackay), Townsville was the lowest;

6 http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_quality_reports/monthly_bulletins/

7 http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_quality_reports/

8 TSP measured one day in six and analysed metals are Copper, Zinc, Nickel, Arsenic, and Cadmium as well as Lead

9 http://www.epa.qld.gov.au/publications/p02572aa.pdf/Queensland_2007_air_monitoring_report.pdf

- For all 1-hour sulfur dioxide statistics at and above the 90th percentile, both Pimlico and Stuart are lower than for all other regions; and
- Similar to all regions, the 1-hour and 4-hour NEPM standards for ozone were always met.

3.11.2 Potential adverse and beneficial impacts

During construction and ongoing maintenance of the Precinct, dust will be generated principally via the following mechanisms:

- Mechanical disturbance: dust emissions brought about by construction and maintenance vehicles/equipment; and
- Wind erosion: dust emissions from exposed, disturbed soil surfaces under high wind speeds.

On-going maintenance of the Precinct is expected to generate little and only sporadic dust events. These can be considered normal construction activity not associated with a significant project and exposed open space is no longer considered in this report. The extent to which construction dust emissions may impact on the surrounding sensitive land uses will depend upon a number of site-specific factors. Once construction is completed, exposed surfaces will either be built over or minimised through rehabilitation of the site. Normal traffic associated with precinct activity will be no worse than any other port/marina. Key factors have been identified and are discussed in more detail in Appendix L.

3.11.2.1 Adopted Dust Emission Rates

National Pollutant Inventory (NPI) emission factors give an estimate of likely dust generation for each type of construction activity. A default silt content of 10% and a moisture content of 2% were assumed. This is conservative because material so close to the Ocean has potential to be wetter than default (overburden at coal mines). The excavator was used in loading the haul trucks while the grader (taken as a CAT 247B Multi-terrain Loader) and a CAT 323C Vibratory Soil Compactor were modelled in continuous tandem operation. The wheel-generated dust of the grader was calculated using the default emission factor based on an operating speed of 10 km/h. The compactor emission rate was calculated assuming operation on wet material with moisture content of 10% and a working speed of 5.0 km/h. Twenty (20) tonne capacity haul trucks with gross vehicle mass of 30 tonne were assumed to complete 18 dumping/loading cycles per hour. The operating speed of the haul trucks generating wheel dust was limited to 15 km/h (on-site speed limit). Wind erosion from stockpiles and exposed areas assumed the NPI default emission factor, independent of wind speed, of 0.4 kg/ha/h with PM10 being half this value. It has been assumed that the greatest exposed area at any one time is 13.72 hectares.

The hourly emission rates modelled are given in Table 3-60.

Table 3-60 Emission rates

Construction activity	Emission rate (kg/h)	
	TSP	PM10
Loading and dumping	16.8	6
Grader	10.8	3.4
Bulldozer	50.2	12.2
Compactor	1.5	0.7
Excavator	16.9	8.0
Hauling	5.5	2.7
Exposed stockpile and surfaces	16.8	6

3.11.2.2 Modelling Results

Modelling of dust emissions and dispersion was used to identify worst-case conditions and to give an indication of the radius of influence from construction activities to potential sensitive receptors. The results of dispersion modelling are shown in Figure 3-73 for PM10 dust concentration. For the residential zoning areas with sensitive receptors, dust concentrations are always below 50 $\mu g/m^3$ at distances greater than 800m from the construction activity. The modelling shows that, for the assumed default and uncontrolled emissions, dust concentrations will likely exceed the criteria at nearby residential receivers and therefore mitigation will be required.

3.11.2.3 Mitigation measures

Worst-case modelling suggests that the hourly dust concentrations may exceed 50 $\mu g/m^3$ at nearby dust sensitive receivers. The following commonly used dust mitigation actions were considered to reduce the estimated dust impact from the development.

- Level 1 watering on all exposed surfaces (2 litres/m2/h). This control method achieves a 50% emission reduction (NPI Emission Estimation Technique Manual for Mining and Processing of Non-Metallic Minerals Version 2.0, 2000).
- Access road to be surfaced (an asphalt seal results in near zero dust emissions) from site entry until at least 50 m north, beyond the coordinate (482810 East, 7869676 North).

The results of dispersion modelling including mitigation measures are shown in Figure 3-74 for PM10 dust concentration and in Figure 3-75 for dust deposition. For the suburban area to the south, dust concentrations are always below 50 $\mu g/m^3$ at distances greater than 250m from the construction activity. The dust deposition, expressed as annual average g/m^2/month, shows a similar pattern with all areas beyond 150m being below the recognised critical level for nuisance dust complaints.

The dust deposition limit contours are well within the PM_{10} limit contours, so it is determined that that if dust emission is controlled using measures identified above to meet the PM criteria, dust deposition criteria will also be achieved.

3.11.3 Conclusions and recommendations – air quality assessments

The results of the air quality assessment suggest that construction-related dust from the TMPP would not significantly impact on the amenity of sensitive receivers provided appropriate management procedures as outlined in this report and Appendix L are implemented. An Environmental Management System will need to be implemented for the construction phase to control dust in the nearby residential area to the south. This will require that the mitigation measures outlined above are adopted.

The expansion of the Port monitoring network for dust deposition will assist in the ongoing management of dust impacts.

Air emission from proposed operational activities within the marine precinct have been assessed against relevant criteria. Results suggest that the operational activities assessed consisting of abrasive blasting, fuel storage and moored fishing trawlers will not have a significant impact on any nearby sensitive receivers and air quality objectives will be achieved.

LEGEND

Proposed Marine Precinct

Conc. (microgram/m3; 24 hour average)

150

50

1:10,000 (at A4)

0 50 100 150 200 250

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Job Number 42-15399
Revision A
Date 01 July 2009

Daily Average PM10 Dust Concentration Worst Case Scenario

Figure 3-73

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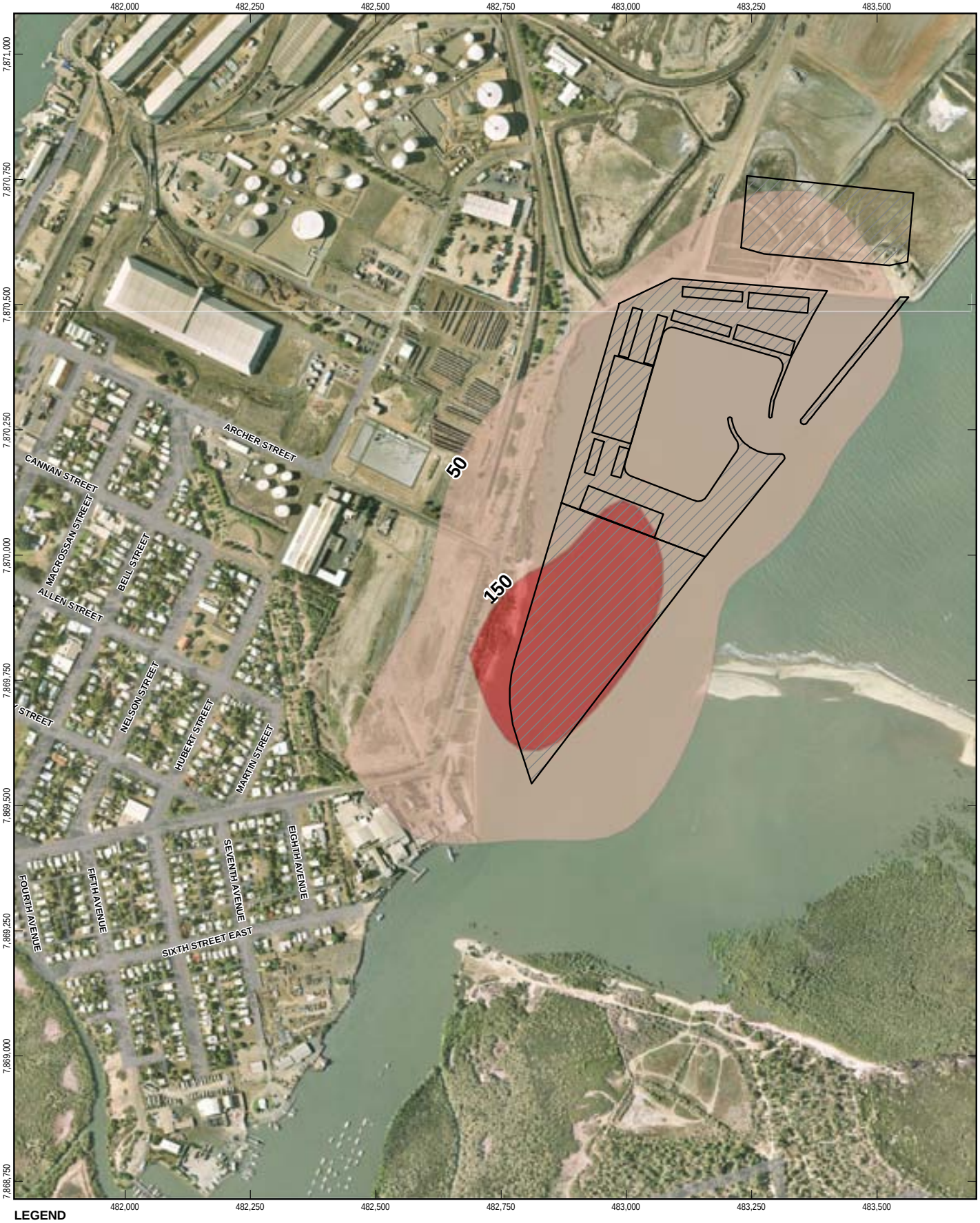
Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct, Aerial image - ©The State of QLD (Port of Townsville LTD) 2009; DCDB - ©The State of Queensland (Department of Environment and Resource Management); Ausplume - GHD. Created by: TH



LEGEND

Proposed Marine Precinct

Conc. (microgram/m3; 24 hour average)

150

50

1:10,000 (at A4)

0 50 100 150 200 250

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Job Number 42-15399
Revision A
Date 01 July 2009

Daily Average PM10 Dust Concentration with Mitigation

Figure 3-74

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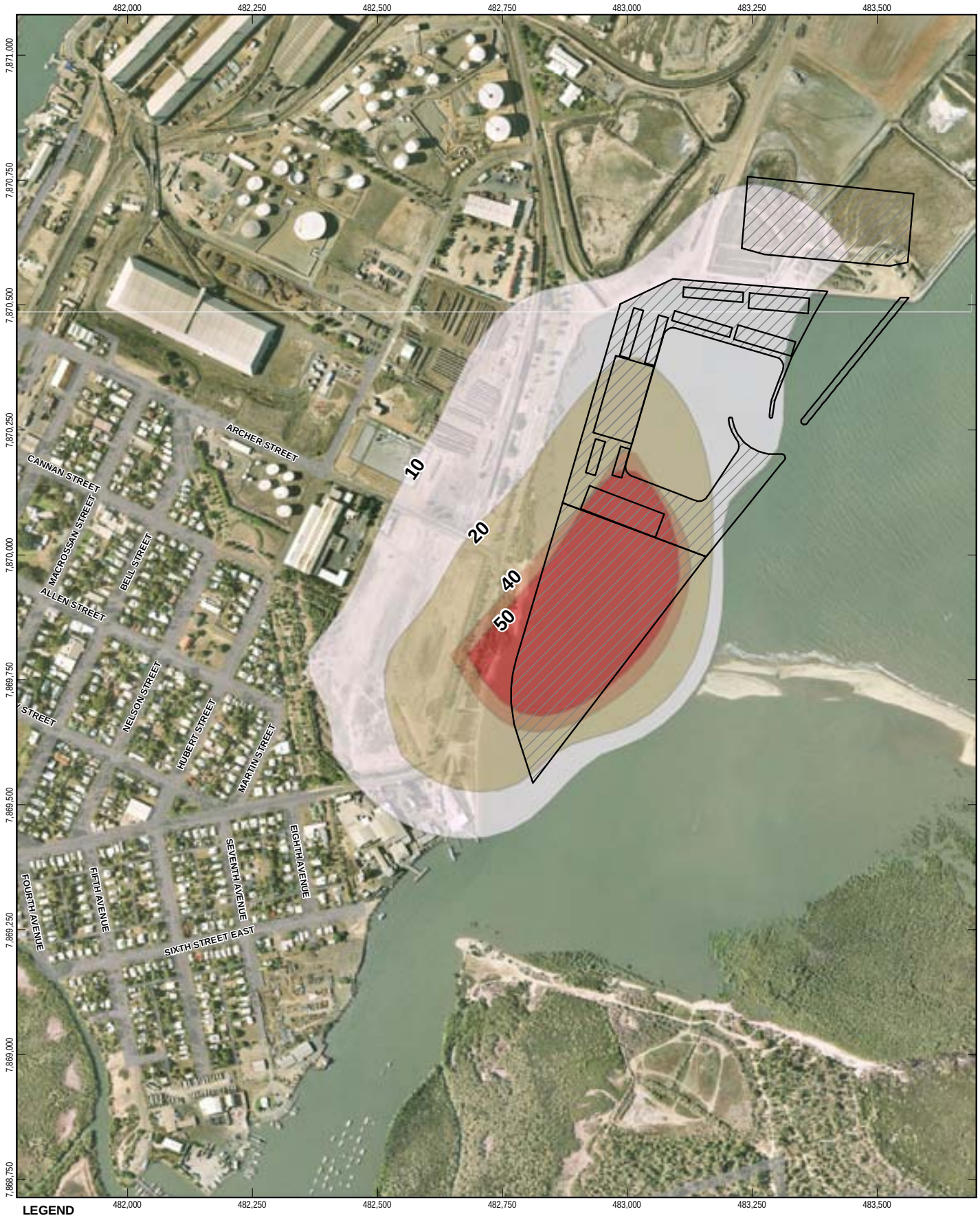
Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct, Aerial image - ©The State of QLD (Port of Townsville LTD) 2009; DCDB - ©The State of Queensland (Department of Environment and Resource Management); Ausplume - GHD. Created by: TH



LEGEND

Proposed Marine Precinct

Average Dust Deposition (g/m2/year)

- 50
- 40
- 20
- 10

1:10,000 (at A4)

0 50 100 150 200 250

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

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Port of Townsville
Marine Precinct EIS

Average Dust Deposition (g/m2/year) from Daily Construction Operations with Mitigation Measures

Job Number 42-15399
Revision A
Date 01 July 2009

Figure 3-75

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct, Aerial image - ©The State of QLD (Port of Townsville LTD) 2009; DCDB - ©The State of Queensland (Department of Environment and Resource Management); Ausplume - GHD. Created by: TH

3.12 Greenhouse gas assessment

3.12.1 Overview

A greenhouse gas assessment was carried out with due consideration of relevant protocols and agreements to assess potential sources of greenhouse gas emissions from the construction and operational phases of the Townsville Marine Precinct project. That assessment, and the methodologies employed, is detailed in Appendix W and key findings are summarised below.

3.12.2 Estimates of greenhouse gas emissions

Current estimates of annual greenhouse gas (GHG) emissions for the state of Queensland (DCC 2008) are 170.9 Mt of carbon dioxide equivalent (CO_2-e), which makes up approximately 29.7% of the national greenhouse gas emissions for Australia. Of the Queensland contribution, 11.9 Mt is from the manufacturing and construction sector, 18.5 Mt is from the transport sector and 3.7 Mt is from industrial processes with the remainder of contributions being from stationary energy, fugitives, agriculture, land use change and waste.

GHG sources from the existing site, prior to the development of the Precinct are primarily from the annual dredging operations carried out by the Port of Townsville. These operations currently vary in the amount of greenhouse emissions produced annually, depending on the amount of dredging required. Many of the facilities that will be located within the Precinct during the operational phase of the project are existing facilities currently located further upstream on the Ross River on nearby in south Townsville and on Ross Creek. These facilities are therefore already contributing greenhouse gas emissions through their existing operations.

The main sources of GHG emissions from the construction phase of the project were identified as:

- Fuel use from the transport of materials from the quarry for the construction of the breakwater and reclamation;
- Embodied emissions of the construction materials, specifically concrete used in the construction of the hardstand areas and building slabs;
- Fuel use from on site machinery; and
- Fuel use from the capital dredging operations including from the disposal of dredge material to the off shore spoil ground.

Based on Reference Design information and knowledge of construction methodologies (refer Section 2.4) an estimation of the GHG emissions from the construction phase was carried out (refer Appendix W). The initial estimate of these emissions totalled approximately 20,200 t CO_2-e.

The main sources of GHG emissions from the operational phase of the project were identified as:

- Electricity use for lighting, cooling/refrigeration and equipment use for each of the facilities;
- Fuel use from on site vehicles and equipment (land and water);

- Maintenance including transport and embodied emissions of materials etc;
- Fugitive emissions (HFCs) from refrigeration facilities;
- Fuel use from transport of staff/visitors and materials to the site;
- Waste generated on site including solid waste and waste water; and
- Maintenance dredging.

Although, from the Reference Design, sufficient information was not available to quantify the greenhouse gas emissions from the operational phase of the TMPP, it is expected that due to many of the industries already existing further up stream, and maintenance dredging requirements not expected to increase, that additional operational emissions from this project will be minimal. As industries currently occupying older facilities may relocate to newer facilities within the Precinct, improved technologies may also provide opportunities for reductions in GHG emissions.

When compared with the annual baseline emissions for Queensland, the GHG emissions potentially being generated from the main sources during the construction phase of this project could be expected to be approximately 0.01% of the annual emissions profile for Queensland. It should be noted that the quantitative estimation of emissions only covers significant sources for which a reasonable level of information was available.

Exact industry base of the Precinct is still being determined and, at this stage in the projects progression, full quantitative assessment of all industry base sources is not possible. A qualitative assessment has been performed for other sources considered likely for the Precinct area given the expected industry base and drawing upon experience within similar projects elsewhere; it would be premature to include these contributions into the total inventory.

Several mitigation options for the construction and operational phases of the project are outlined below. These included choosing options that minimise material use and sourcing materials from the closest possible locations. The possibility of incorporating eco-industrial precinct principles into the design and construction of the Precinct facilities is also noted.

3.12.3 Potential GHG abatement / mitigation options

Methods for reducing GHG emissions are generally based on the following themes:

- Avoid: Identify where and how GHG emissions associated with the proposal can be avoided;
- Reduce: Identify where behaviour or processes can be modified to achieve GHG emission reductions; and
- Switch: Identify where fuel and energy source switching can be used to reduce GHG emissions.

Although the contribution of this project to the overall Queensland GHG emissions profile is minimal (refer above), the following mitigation options could be deployed during the appropriate phase of the TMPP in order to reduce the quantity of GHG emissions as a result of the project.

3.12.3.1 Construction

- The selection of a breakwater option with a reduced footprint would result in a reduction in the quantity of materials required for the construction phase of the project thereby reducing

the potential GHG emissions associated with the transportation of these materials. This has been achieved through a multi criteria assessment of various breakwater options described in Section 1.4.2. Six options for the breakwater design were assessed against cost, operational performance, construction, social and environmental impacts criteria. Option C, the smallest breakwater, provided the best solution across all criteria;

- The potential GHG emissions from the construction of the breakwater and reclamation area could also be significantly reduced by sourcing these materials from the nearest possible quarry. An appropriate source of quarry materials is currently being assessed in parallel with studies being conducted for this EIS. By sourcing quarry material from a quarry 17 km from the site (closest option) as apposed to 120 km (furthest option), the potential GHG emissions from the transportation of materials could be reduced by as much as 85%;
- If a large component of the fill material for the reclamation can be sourced from the capital and maintenance dredging operations close to the reclamation area, the GHG emissions from the transportation of materials will be able to be further reduced. It is understood that potential for acid sulfate soil contamination of sediments may reduce the volume of reusable material. Development options should consider opportunities to maximise reuse;
- There is also scope for GHG emissions to be reduced through the efficient design of the dredging operations to reduce the overall fuel use. These operations will be outlined in the dredge management plan included as Section 8.

3.12.3.2 Operation

- The potential design of the facilities to be constructed on the site could reduce GHG emissions during the operational phase if energy efficient design aspects are incorporated into the planning of the Precinct. Consideration should be given to using solar lighting sources where able in accordance with the Townsville's investment into the Australian Governments Solar Cities program. The Green Building Council of Australia has released an Industrial Pilot rating tool that may be able to be utilised in relation to the design of the precinct buildings and facilities.
- Due to the relocation of the industries previously located upstream into a single location within the Precinct area, there will be an opportunity to investigate creating an eco-industrial Precinct. Because each of these new facilities will be developed in approximately the same timeframe, there is potential to share facilities such as heating ventilation and air conditioning (HVAC), recycling, fuel storage as well as potentially reusing waste heat from the engineering facilities. This requires establishment of appropriate infrastructure planning controls and collaboration between relevant stakeholders.
- Applying energy efficiency and GHG emissions considerations to the purchasing of equipment used on site in the Precinct will also have the potential to reduce overall operational GHG emissions. Making sure that operators within the Precinct are trained in energy efficient practices will also provide an opportunity to reduce overall GHG emissions.

3.13 Noise and vibration

3.13.1 Description of environmental values

The environmental values to be enhanced or protected under the Queensland Environmental Protection (Noise) Policy 2008 are the qualities of the environment that are conducive to:

- Protecting the health and biodiversity of ecosystems;
- Human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to sleep, study or learn and be involved in recreation, including relaxation and conversation; and
- Protecting the amenity of the community.

The *Environmental Protection Act 1994* outlines how to protect Queensland's environment from environmental nuisance. This includes noise disturbance from regulated devices such as air-conditioning systems and also building work, which includes excavating or filling.

For industrial developments there is another mechanism to assist in achieving a balance between the social and economic amenity of the community, and the needs of the individual for sleep and relaxation. The DERM has a guideline for setting conditions related to noise emitted from industrial premise, which are intended for planning purposes, - Ecoaccess Guideline Planning for Noise Control, 2004. The guideline also includes criteria for estimating the probability of sleep disturbance from transient noise.

To determine the existing noise environment of the proposed development area baseline noise monitoring was undertaken using unattended loggers and attended monitoring devices from 3 December 2008 to 10 December 2008 near the subject site. Refer to Appendix K for a detailed description of the methodology used for the monitoring.

Unattended monitoring results are summarised in Table 3-61 and attended noise monitoring results are summarised in Table 3-62. Details of each program are provided in Appendix K. Data was removed from the unattended data records for periods in which wind speeds were over 5 m/s or rainfall occurred as these events interfere with integrity of data recording. Periods of reporting relate to the day, evening and night-time periods defined by the Ecoaccess Planing for Noise Control.

Table 3-61 Summary of Noise Monitoring Results dB(A) – 27 Hubert Street

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Wednesday 3rd Dec	39.8	36.5	-[10]	55.2	48.8	-
Thursday 4th Dec	39.8	35.8	32.8	52.3	45.7	47.3
Friday 5th Dec	39.0	34.5	32.3	49.9	44.7	45.3
Saturday 6th Dec	37.2	34.2	34.1	49.0	48.3	49.2
Sunday 7th Dec	38.2	38.0	34.7	49.2	43.8	44.9
Monday 8th Dec	39.7	38.4	36.9	52.6	49.6	-
Tuesday 9th Dec	40.3	38.8	37.7	51.4	48.1	47.3
Wednesday 10th Dec	41.6	-	35.9	50.2		47.6
RBL and L_{eq} Overall	**39.7**	**36.5**	**34.7**	**51.7**	**47.5**	**47.2**

Table 3-62 Attended Noise Monitoring Results

Location	Time and Duration	L_{A90}	L_{Aeq}	L_{A10}	Comment
282 Boundary Street	Day – 3/12/08 9am 15 mins	52.6	64.3	66.8	Road Traffic Noise (RTN), birds and insects, industrial noise such as reversing alarm.
282 Boundary Street	Evening – 2/12/08 9pm 15 mins	51.0	62.9	65.8	RTN, birds and insects, dogs, distant hum from port
282 Boundary Street	Night – 3/12/08 4.15am 15 mins	46.3	54.6	56.1	RTN on Boundary St, birds and insects, traffic in distance
76 Allen Street	Day – 3/12/08 7.20am 15 mins	47.5	52.0	55.2	Port noise, distant RTN, construction noise
76 Allen Street	Night – 3/12/08 4.20am 15 mins	43.7	51.3	54.9	RTN on distant streets, birds and insects,
5 Nelson Street	Day – 3/12/08 7.45am	43.6	51.9	55.8	RTN on Boundary Road, birds and insects, domestic noise i.e. doors slamming,
5 Nelson	Evening – 2/12/08	42.4	49.1	53.2	RTN on Boundary Road, birds

[10] Note: '-' refers to invalid data that has been excluded from the data set.

Location	Time and Duration	L_{A90}	L_{Aeq}	L_{A10}	Comment
Street	8.12pm				and insects, domestic noise.
5 Nelson Street	Night – 3/12/08 4.50am	42.3	48.3	52.4	Birds and insects, some traffic on Boundary Street, dogs.
50 Sixth Street	Evening – 2/12/08 9.37pm	45.7	51.2	53.0	Birds and insects, domestic noise (television) RTN from surrounding streets.
50 Sixth Street	Night – 3/12/08 6.55am	45.7	50.4	51.2	Birds and insects, industrial noise (impulsive) from nearby boat yard, construction noise, distant RTN noise.
50 Bell Street	Day – 3/12/08 8.14am	42.8	49.4	52.2	Heavy vehicles, distant construction noise, birds and insects, RTN on Bell Street.
50 Bell Street	Evening – 2/12/08 8.24pm	41.3	46.4	49.9	RTN in surrounding streets, birds and insects, dogs.
50 Bell Street	Night – 3/12/08 5.14am	40.9	46.3	48.9	Birds and insects, RTN on surrounding streets, distant heavy vehicles, motorbike.
27 Hubert Street	Day – 3/12/08 8.41am	50.8	56.3	59.7	Lawn mower at nearby church dominant noise source, birds and insects, RTN and distant heavy traffic from port.
27 Hubert	Evening – 2/12/08 7.42pm	48.9	55.9	58.7	RTN from local streets, distant port noise, birds and insects, some domestic noise from houses.
27 Hubert Street	Night – 3/12/08 5.37am	46.7	50.1	50.9	Distant RTN, birds, dog.
Ergon Energy Substation	Night – 3/12/08 6.28am	46.6	64.4	65.0	RTN including heavy vehicles (b doubles) and light vehicles. Industrial noise including reversing alarm, forklift, bulldozer, and domestic noise and wind in leaves.
9 Eighth Avenue	Day – 3/12/08 9.17am	44.4	53.6	55.7	Birds and insects, light and heavy vehicles on Boundary Road, domestic noise including children and dogs, intermittent blower and alarm, construction noise from easterly direction.

Location	Time and Duration	L_{A90}	L_{Aeq}	L_{A10}	Comment
9 Eighth Avenue	Evening – 2/12/08 8.48pm	43.9	52.9	55.0	RTN from Boundary Street, domestic noise, birds and insects, distant reversing/safety alarm.
9 Eighth Avenue	Night – 3/12/08 6.00am	43.1	50.2	50.6	Birds and insects, construction related noise from harbour cold stores, domestic noise, distant alarms, RTN from Eighth Avenue.

3.13.2 Potential impacts

3.13.2.1 Construction noise

Typical noise levels produced by construction plant anticipated to be used on site were sourced from AS 2436 – 1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites and from GHD's internal database.

The power levels were then distance attenuated from the proposed construction site. Propagation calculations take into account sound intensity losses due to hemispherical spreading, with additional minor losses such as atmospheric absorption, directivity and ground absorption ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and thus provide a measure of conservatism.

Received noise produced by anticipated activities, during the construction of the proposal is shown in Table 3-63 for a variety of distances, with no noise barriers or acoustic shielding in place and with each plant item operating at full power. The sound pressure levels shown are maximum levels produced when machinery is operated under full load.

Table 3-63 Predicted Plant Item Noise Levels dB(A)

Plant Activity/dB(A) L_w	Distance of Source to Receiver (m)						
	50	**250**[11]	**350**[12]	500	750	1000	2000
Crane 110	68	54	51	48	45	42	36
Backhoe 108	66	52	49	46	43	40	34
Compressor 100	58	44	41	38	35	32	26
Concrete Pump 109	67	53	50	47	44	41	35

[11] Approximate distance to nearest internal (fishing trawlers) noise sensitive receiver

[12] Approximate distance to nearest external noise sensitive receiver

	Distance of Source to Receiver (m)						
Dump Truck 108	66	52	49	46	43	40	34
Water Tanker 109	67	53	50	47	44	41	35
Compactor 110	68	54	51	48	45	42	36
Pile Driving 130	88	74	71	68	62	56	50

Anticipated noise levels compare to existing daytime ambient noise levels at residential receivers outside the Precinct for all plant activity except pile driving.

Due to the distance between the construction works and the sensitive receivers, noise generating activities should be limited to week days between 6:30 am and 6:30 pm.

Construction of the Precinct will be undertaken in three stages and it is anticipated that fishing trawlers will be located onsite during construction of remaining stages. Noise impact on the fishing trawlers have been considered in terms of sleep disturbance. Due to the nature of trawling operations, occupants may be asleep at any time of the day, so greatest impact on sleep may occur during the daytime period during construction activities. An external noise level of 55 dB(A) L_{max} no more than 10-15 times per night is considered appropriate for assessment purposes (refer Appendix K).

Noise levels from construction activities will likely exceed sleep disturbance criteria during pile driving and some other activities and it is expected that some impact will occur on the sleep patterns of occupants of berthed fishing trawlers.

Occupants of trawlers should be notified of the proposed construction timing and methodology.

3.13.2.2 Construction Vibration

It is possible that construction vibration will be perceived at times by local sensitive receivers. However, the level of annoyance will depend on individuals. Such issues are practically best managed by site monitoring. Circumstances where vibration monitoring should be undertaken are outlined in the construction-related recommendations (refer to Section 3.13.3 of this report).

Distance between the potentially most impacted receivers and site construction activities will generally be in excess of 100m. However, it is possible that some infrastructure and road works be carried out at smaller distances.

The nature and levels of vibration emitted by the site will vary with the activities being carried out on site. Appendix K lists the types of vibrations that may be generated by the site.

From analysis of typical vibration levels of common construction activities the building damage lower limit is normally not exceeded by general construction activities at distances greater than 20m from the nearest sensitive receivers.

In the context of the Project, the nearest sensitive residential receivers will be located further than 350m of the construction activities and as such no appreciable impact from vibration is

expected. The nearest commercial receiver is located at least 50m from the Precinct and as such no appreciable impact from vibration is expected.

3.13.2.3 Construction Road Traffic Noise

Construction related traffic would likely use Boundary Street as the major access route to site during Stage 1 construction and potentially during Stage 2 construction activities. Traffic impacts are assessed under Section 3.4 of this EIS. A Traffic Impact Assessment conducted for the area of the TMPP (GHD, 2009) states observed traffic counts for the existing road network, including Boundary Street, Saunders Street, Benwell Road and Archer Street. Predicted 2011 traffic volumes with and without construction traffic in the report reveal that the greatest traffic increases will be on Boundary Street and will represent an increase in traffic of less than 15%. Most of this traffic will be during the AM and PM peak periods and as this will occur during the day time a small increase in road traffic noise is not considered to be significant.

3.13.2.4 Precinct operation

The occupants of the TMPP are expected to include industrial activities such as boat building, abrasive blasting, surface coating, workshops, storage of goods, and packaging. Other noise generating activities associated with this will include trucks and forklifts, trawlers and boats.

To determine likely operational impacts sound power levels were sourced for several noise generating activities that may be located onsite. Although this list is not exhaustive, it includes some operations that could be considered as worse case. The power levels were then distance attenuated from the proposed Precinct. Propagation calculations take into account sound intensity losses due to hemispherical spreading, with additional minor losses such as atmospheric absorption, directivity and ground absorption ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and thus provide a measure of conservatism.

Received noise produced by anticipated activities, during operation is shown in Table 3-64 for a variety of distances, with no noise barriers or acoustic shielding in place and with each plant item operating at full power. The sound pressure levels shown are maximum levels produced when machinery is operated under full load.

During the Precinct operations, the average sound level experienced at nearby residence is expected to be around 46 dB(A) under worst case conditions. This is similar to existing noise levels in the area and equal to the daytime Project specific noise criteria. It is expected that further noise attenuation will likely occur due to the following:

- Some of these worse case activities will be located within buildings;
- Noise sources may be blocked from a direct line of site to receivers by Precinct infrastructure such as buildings, walls and barriers; and
- Many of these activities will be located further than 350m from the nearest sensitive receivers.

Locating these types of industry within the Precinct should not impact on the amenity of noise sensitive receivers with appropriate planning, design and management procedures in place.

Table 3-64 Predicted Operational Item Noise Levels dB(A)

Plant Activity/dB(A) L_w	Distance of Source to Receiver (m)						
	50	250[13]	350[14]	500	750	1000	2000
Sheet metal forming 105	63	49	46	43	39	37	31
Water jet pump 92	50	36	33	30	27	24	18
Forklift 85	43	29	26	23	20	17	11
Heavy Vehicle 104	62	48	45	42	39	36	30
Shunting 94	52	38	35	32	29	26	20

Not enough detail is known to assess evening and night time impacts of the potential Precinct users on the nearby sensitive receivers, however, night time operations may include loading and unloading of trawlers and some delivery trucks. Without management or mitigation, some activities may exceed the Project specific criteria and also cause sleep disturbance. It is recommended that each user of the Precinct be subject to a noise assessment if planned operations are outside the day time period.

3.13.2.5 Impact on Precinct Users

Potential noise impact on occupants of the Precinct (namely occupants who live aboard fishing trawlers) has been considered as part of this assessment. Noise criteria are expected to be slightly higher than for residential area of South Townsville due to this being an industrial area, however the proposed trawler berths are located closer to significant noise sources. Without detailed information on the Precinct users, it is difficult to assess potential impact. Noise levels identified in Table 3-64, are similar to the developed day time criteria of 48 dB(A) for the trawler location, however it must be noted that as addressed above, noise predictions are on the conservative side.

Noise sources should not exceed sleep disturbance criteria of 55 dB(A) as discussed above.

It is recommended that each user of the Precinct be subject to a noise assessment if planned operations are outside the day time period.

3.13.2.6 Operational road traffic noise

An assessment of operational road traffic noise was undertaken to determine potential increases in road traffic noise along Boundary Street as a result of the TMPP (refer Appendix K). Noise modelling suggests that noise levels in 2017 along Boundary Street will potentially be

[13] Approximate distance to nearest internal (fishing trawlers) noise sensitive receiver

[14] Approximate distance to nearest external noise sensitive receiver

above the DMR criteria of 68 dB(A), both without and with the TMPP. Noise levels have been predicted to be approximately 3.5 dB(A) higher along Boundary Street with the development.

3.13.2.7 Cumulative Impacts

Cumulative noise impact from the proposal and the Townsville Port Access Road corridor development have been considered. To that effect GHD reviewed the Townsville Port Access Road – Eastern Access Corridor Operational Road Traffic Noise Impact Assessment (Department of Main Roads, 2009), which assessed likely future noise conditions for a ten year traffic planning horizon. Sensitive receivers in the reviewed report were the same as receivers addressed in this assessment, including houses along Eighth Avenue, Sixth Street and Boundary Street.

Predicted noise levels at the nearby sensitive receivers ranged from 46 dB(A) to 54 dB(A) $L_{A10(18Hr)}$. The AUSTROADS Research Report , Modelling, measuring and Mitigating Road Traffic Noise (2005), states that the $L_{A10(18Hr)}$ descriptor can be converted equally to the $L_{Aeq(1Hr)}$ descriptor, which remains as 46 dB(A) to 54 dB(A) $L_{Aeq(1Hr)}$. These predicted road traffic noise levels are equal or higher than unmitigated predicted noise levels from the Precinct. Most operational activities within the Precinct will also be located further than the worse case 350m used in the predictions, and hence it is considered that cumulative impacts of the Precinct and the Townsville Port Access Road corridor development will not be a significant issue.

3.13.3 Mitigation measures

Construction activities have the potential to impact on the amenity of nearby noise sensitive receivers without appropriate management procedures in place.

The following management and mitigation measures should be implemented to minimise potential noise impacts:

- Noise generating construction activities should be, where possible, undertaken between the hours of 6.30am to 6.30pm Monday to Saturday. Any works outside these hours should be managed appropriately with actions listed below;
- Where practical, all vehicular movements to and from the construction site must be made only during normal working hours;
- Long term fixed plant such as generators should be located appropriately so as to minimise noise impacts on nearest sensitive receivers. This can include locating plant behind storage containers, stockpiles or other object that may act as a barrier to the sound;
- Residents to be notified of the construction timetable, with extra emphasis on noisy activities such as pile driving;
- Vehicles will be kept properly serviced and fitted with appropriate mufflers; and
- Machines found to produce excessive noise compared to industry best practice will be removed from the site or stood down until repairs or modifications can be made.

Noise and vibration monitoring should be undertaken by a qualified professional and with consideration to the relevant standards and guidelines. Attended noise and vibration monitoring should be undertaken in the following circumstances:

- Upon receipt of a noise and/or vibration complaint. Monitoring should be undertaken and reported within (say) 3 to 5 working days. If exceedances are detected, the situation should be reviewed in order to identify means to reduce the impact to acceptable levels. In case of vibration complaints, both building damage and human perception issues should be considered with regards to the vibration limits outlined in Section 3.13.2.2 – Construction Vibration.

Operation of the Precinct has the potential to impact on the amenity of nearby noise sensitive receivers in South Townsville and occupants of the Precinct (fishing trawlers) without appropriate management procedures in place. In order to protect the amenity of nearby sensitive receivers, any user of the Precinct shall ensure operational noise levels do not exceed the Project specific noise criteria of $L_{Aeq\ 1hr}$ day – 46dB, $L_{Aeq\ 1hr}$ evening – 40dB, and $L_{Aeq\ 1hr}$ night – 28dB for South Townsville and of $L_{Aeq\ 1hr}$ day – 48dB, $L_{Aeq\ 1hr}$ evening – 45dB, and $L_{Aeq\ 1hr}$ night – 31dB for the trawler berths.

The following management measures are available to ameliorate noise impacts:

- Locate the noisiest Precinct users the furthest away from the nearby sensitive receivers;
- Where practicable, limit operating times of noisy industries using the site (i.e. day time only);
- Public awareness for recreational boat users accessing the site outside day time period; and development approvals for individual sites should be subject to a noise assessment to ensure that all industrial premises on the Precinct cumulatively comply with the criteria.

3.13.4 Conclusions – noise and vibration assessments

The results of the assessment suggest that construction related noise and vibration from the Port of Townsville Marine Precinct will not significantly impact on the amenity of sensitive receivers in South Townsville, provided the noise management measures outlined in this report are implemented.

Noise levels from construction activities will likely exceed sleep disturbance criteria during pile driving and it is expected that some impact will occur on the sleep patterns of occupants of berthed fishing trawlers. Occupants of trawlers should be notified of the proposed construction timing and methodology.

Limited information is available at this time on the occupants of the Precinct. Sound power levels were sourced for several noise generating activities that may be located onsite. The power levels were then distance attenuated from the proposed Precinct to predict possible noise impact on nearby sensitive receivers. During the Precinct operations, the average sound level experienced at nearby residence is expected to be around 46 dB(A) under worst case conditions and around 49 dB(A) within the Precinct at the fishing trawler berths. This is similar to existing noise levels in the area and it is expected that further noise attenuation will likely occur.

Locating these types of industry within the Precinct should not impact on the amenity of noise sensitive receivers with appropriate planning, design and management procedures, as outlined in this report, in place.

It is recommended that development approvals for individual sites should be subject to a noise assessment to ensure that all industrial premises on the Precinct cumulatively comply with the

criteria.

Increase in road traffic due to the Precinct has the potential to increase road traffic noise in the local road network. Road traffic noise modelling for the year 2017 has indicated that noise levels at a receiver on Boundary Street with the Precinct operational will potentially be 3.5 dB(A) higher than if the Precinct was not developed. Road traffic noise modelling suggests that noise levels will exceed the DMR Road Traffic Noise Management: Code of Practice 2008 criteria with or without the Precinct.

Therefore based on the information provided, assumptions made, and assessment of results it is expected that the TMPP can meet its relevant noise goals.

3.14 Waste management

3.14.1 Overview

The function of this section is to describe the existing environmental values that may be affected by wastes generated by the project in the context of environmental values as defined by the Environmental Protection Act 1994 and Environmental Protection Policies. This is fully discussed in Appendix X, which describes the waste management assessment undertaken for this project. The assessment provides a detailed assessment of potential waste impact and mitigation measures which may result from the development of the Project.

Waste is an important aspect of any new development both in the construction and operational phases and has the potential to have a significant environmental impact where not addressed properly.

3.14.2 Description of environmental values

3.14.2.1 Waste Definition

The definition of waste as outlined in the *Environmental Protection Act (1994)* (Qld) is as follows:

(a) Leftover or an unwanted by-product, from an industrial, commercial, domestic or other activity; or

(b) Surplus to the industrial, commercial, domestic or other activity generating waste.

3.14.2.2 Legislation, Guidelines and Objectives for Waste Management

Pollution of the marine environment by ships of all types, including fishing vessels, is strictly controlled by the *International Convention for the Prevention of Pollution from Ships 1973 (Amended 1978)* (known as MARPOL). Australia is a signatory to this convention, which is now enforced in over 100 countries.

This convention deals with all forms of waste disposal from ships except the disposal of land generated wastes (eg dredge spoil) by dumping and includes five technical Annexes as listed below:

- Annex I: Regulation for the prevention of pollution by oil (2 October 1983)
- Annex II: Regulations for the control of pollution by noxious liquid substances in bulk (6 April

1987)

- Annex III: Regulations for the prevention of pollution by harmful substances carried by sea in packaged forms (1 July 1992)
- Annex IV: Regulations for the prevention of pollution by sewage from ships (27 September 2003)
- Annex V: Regulations for the prevention of pollution by garbage from ships (31 December 1988)

Parties to the convention must cooperate in the detection of any violations and take action against violators.

Australia is a full member of the International Maritime Organisation and a signatory to MARPOL 73/78 (all annexes). Australia's jurisdiction and marine environmental responsibilities extend to the economic exclusion zone where the Protection of the *Sea (Prevention of Pollution from Ships) Act 1983* gives effect to the core provisions of the MARPOL 73/78 convention. The Australian Maritime Safety Authority (AMSA) applies the Convention in Australian waters. Its regulations are implemented through Commonwealth and State legislation.

It is assumed that all vessels will be required to clear quarantine prior to entering the Precinct and as such the specific requirements of quarantine are not relevant to this project.

In addition to the international and national conventions, legislation and regulations, waste management in ports, harbours, marinas, and shipping terminals in Queensland, at state level is governed by the following legislation:

- Environmental Protection Act (1994);
- Environmental Protection (Water) Policy (1997);
- Environmental Protection (Waste Management) Policy (2000);
- Environmental Protection (Waste Management)Regulation (2000);
- Transport Operations (Marine Pollution) Act (1995); and
- Transport Operations (Marine Pollution) Regulation (2008).

Specifically in Queensland, the *Transport Operations (Marine Pollution) Act (2008)* gives effect to the Annexures I, II, III and V of MARPOL 73/78 where Part Ten of the Act only enables the Queensland government to issue a directive to establish or have established by an owner occupier of a port, terminal or establishment, facility for the receipt or disposal of residues of ships as well as maintain the facility to enable ships to dispose of residues. The act prohibits the disposal of oils, garbage, harmful substances, noxious liquids and sewage in coastal waters.

The Australian Maritime Safety Authority (AMSA) is responsible for the application and enforcement of MARPOL 73/78 in areas of Commonwealth jurisdiction, which is to the limit of the 200 nautical mile exclusive economic zone. State government is responsible for costal waters up to three nautical miles (5.5 km) offshore.

The construction and operation of the TMPP must comply with relevant local, state, federal and international regulatory requirements regarding waste management and should aim to adopt best practice waste management and go beyond compliance where economically feasible options are identified. The "user pays" and "polluter pays" principals outlined in the

Environmental Protection (Waste Management) Policy (2000) (Waste EPP) are central to the management of wastes from such developments. These principals are defined as follows:

The polluter pays principle is the principle that:

> *All costs associated with the management of waste, if practicable, are borne by the persons who generated the waste.*
>
> *The costs associated with the management of waste may include the costs of:*
>
> *(a) Minimising the amount of waste generated; and*
>
> *(b) Containing, treating and disposing of waste; and*
>
> *(c) Rectifying environmental harm caused by waste.*

The user pays principle is the principle that:

> *All costs associated with the use of a resource should, if practicable, be included in the prices of goods and services.*

The project must comply with all regulations outlined in the Waste EPP and adopt the objectives of the legislation into the project's waste management practices. Specifically "minimising the impact of waste on the environment" and "…manage waste under principles of ecologically sustainable development".

With these principles in mind the waste management hierarchy that is also defined in the Waste EPP has been utilised as the basis for reviewing waste handling and management options for the project. The hierarchy encourages waste to be managed in the following order of preference

- Waste avoidance;
- Waste re-use;
- Waste recycling;
- Energy recovery from waste; and
- Waste disposal.

3.14.2.3 Waste Generation

Waste materials associated with the TMPP have been separated according to the waste generating activity.

Primarily, wastes have been divided into those waste streams associated with construction phase and those waste streams associated with the operational phase. Operational phase wastes have been further separated into shipping and boating wastes associated with commercial fishing and recreational boating and marina and associated industry wastes. Waste types likely to be associated with each of the waste generating activities are detailed, along with the associated legislation, typical management practices and the proposed management of the impacts of the waste streams for the TMPP.

Construction Phase Waste

Waste management practices for construction sites in Queensland are based on the principals and requirements outlined in the following documents:

- Environmental Protection Act 1994 (Qld);
- Environmental Protection (Waste Management) Policy 2000 (Qld); and
- Environmental Protection (Waste Management) Regulation 2000 (Qld).

Whilst detailed quantification of waste streams from the construction phase of works will be completed during preliminary design, this section outlines the likely waste streams.

The most significant wastes generated during the construction phase of the POTL project are likely to be excess spoil from earthworks and foundations, excess concrete and building material waste.

Liquid waste arising from the construction phase are likely to be limited to stormwater runoff, groundwater from dewatering, sewage from toilets and ablution facilities for construction workers and small quantities of chemicals which along with the sewage should be collected and disposed of off-site to an approved waste facility unless there is a trade waste permit in place for the site.

It is expected that only minor quantities of hazardous wastes such as paints and oils will be generated and authorised waste contractors can readily manage these.

Emissions to air are discussed in Section 3.11.

Table 3-65 summarises the primary waste materials, along with the source and provides a description of the wastes that are likely to be associated with the construction phase of the project.

Table 3-65 Construction Phase Waste Materials

Material	Source / Description
Fill	Excavated material such as sand, gravel, clay, soil and rock that has been mixed with another waste or excavated from areas that are contaminated with manufactured chemicals as a result of industrial, commercial, mining or agricultural activities.
Virgin Excavated Natural Material (VENM)	Excavated material such as sand, gravel, clay, soil and rock that is not mixed with any other waste or contaminated by any other activity.
Concrete	Mixture of cement, sand and aggregates. May include additives or substitutes such as fly ash.
Asphalt	Any materials containing bituminous hydrocarbons. May contain additives such as concrete. Includes recycled asphalt pavement (RAP)
Timber	Wood materials used for formwork or other construction purposes.
Besser blocks and other brick products	Broken or offcut besser blocks and other brick products may be mixed together. This can include small amounts of concrete or plaster render.
Glass	Sheet glass used for doors, windows, partitioning, etc.

Material	Source / Description
Plasterboard	Composite material of gypsum and cardboard used for interior panels of buildings.
Steel	Metal building products and materials e.g. reinforcing steel, sheet roofing (galvanised steel or zincalume), structural columns and beams, etc.
Non-ferrous metals	Metal building materials other than steel e.g. aluminium, brass, copper, etc.
Mixed waste	Mixed waste of which no one material comprises 50% or more of the load, e.g. paper and plastic packaging etc.
Paints and other chemicals	Paint and other chemicals used in various construction activities.

Operational Waste

Operational wastes have been broken into those wastes directly associated with shipping and boating (e.g. wastes produced onboard) and those associated with the operation of the marina (e.g. commercial / industrial operations).

Inventory of Shipping and Boating Wastes

The major components of the liquid and solid waste streams associated with shipboard operation include the following:

- **Solid**
  - General, non-hazardous wastes;
    - Paper;
    - Metals;
    - Glass;
    - Plastics;
  - Fishing nets and other equipment;
  - Medical wastes;
  - Hold sweepings;
  - Galley waste;
  - Fish / other animal wastes;
  - Batteries ; and
  - Fluorescent and mercury vapour lamp bulbs.
- **Liquid**
  - Waste oil;
  - Oily mixtures including fuel residues;
  - Oily mixtures containing chemicals;
  - Tank wash water;

- Noxious liquids;
- Sewage (grey water); and
- Sewage (black water).

An inventory of Precinct waste is summarised in Table 3-66.

Table 3-66 Inventory of Precinct waste

Material	Description / Source
Industrial	***Manufacturing, seafood processing and packaging, ship building, fit-out, repair, maintenance etc.***
Paper and cardboard	Paper from packaging of goods, cardboard boxes (e.g. packing of seafood products) etc.
Plastic	Plastic packaging form industrial operations, other waste plastic associated with repair maintenance of vessels, plastic containers from various industries (e.g. fish processing), shrink wrap and packing tape.
Foam	Foam containers (e.g. seafood storage / transport), packaging, protective covers, other foams used in vessels, floats and other items.
Non ferrous metals	Scrap metals such as aluminium / brass from maintenance or industrial operations, paint tins etc.
Steel	Scrap from maintenance or industrial operations.
Abrasive blasting material	Abrasive blasting material (e.g. sand) and associated contaminants.
Paint chips	Paint chips and material from maintenance/repair of boats.
Fibreglass and related products	Fibreglass, resin, hardener, foams from vessel maintenance / repair and other industrial process.
Biological waste	Fish and other waste from processing and packaging. Organisms from anti fouling maintenance.
Oil / fuel / residues	From service, repair, maintenance and other industrial processes
Chemical wastes	Anti-fouling, cleaning and other industrial chemicals, adhesives, glues, etc.
Sewage grey water / black water	Sewage from site facilities
Timber	Wood products used in repair and maintenance of vessels and in various industrial processes, pallets, formwork, etc.
Paint	Paint used in repair and maintenance of vessels.
Glass	Sheet glass, screens bottles and containers.

Material	Description / Source
Batteries	Lead acid and other batteries from vessels and other machinery used in the industrial processes at the site.
Commercial	***Retail, administration, restaurants, etc.***
Paper	Food packaging, wrapping, other product packaging, office paper, etc.
Plastic	Packaging, bottles, other containers, wrapping, shrink wrap, packing tape, etc.
Glass	Glass bottles, jars, etc.
Metals	Aluminium drink cans, other food cans, etc.
Food waste	Left over food from restaurants and other services.
Sewage grey water / black water	Sewage from toilets, showers, sinks, kitchens and other facilities.
Mixed waste	Mixed waste of which no one material comprises 50% or more of the load, e.g. paper and plastic packaging etc.

3.14.3 Potential impacts and mitigation measures

3.14.3.1 Overview

This section describes the existing environmental values that may be affected by the projects wastes. Waste streams identified and outlined in the inventory are assessed with reference to the environmental values described in other sections of this EIS.

Given the environmental values of the surrounding area of the project site, effective waste management will be an important aspect of any development in the area including the marine industrial allotments, trawler fleet, pile mooring and public boat ramp, car and trailer parking bays.

The waste streams expected to be generated by each component of the project are detailed with an assessment of the potential environmental impacts of the wastes and options for waste management aimed at protecting environmental values are also provided.

3.14.3.2 Construction Waste

As construction involves the change of an existing environment there is an inherent impact on the environment associated with all construction. The challenge in any construction activity or development is to undertake the construction with as little impact as possible. With regard to construction waste management, preplanning and adherence to the waste management hierarchy is integral to the minimisation of impacts associated with the construction phase of any project. Table 3-67 builds on the inventory of construction waste provided by detailing the environmental values affected by the waste type and the potential impacts on the environmental values associated with each waste type. Detail on management of the impacts highlighted and options for the implementation of the waste hierarchy are provided in the discussion that follows Table 3-67.

Table 3-67 Construction Waste

Material	Description	Environmental value / potential impacts	Management options
Fill	Excavated material such as sand, gravel, clay, soil and rock that has been mixed with another waste or excavated from areas that are contaminated with manufactured chemicals as a result of industrial, commercial, mining or agricultural activities.	Water, soil, flora, fauna. Degradation of water quality, contamination of other soils / sediments though leaching. Toxicity to aquatic flora and fauna.	Remediate contaminants (if present) and utilise fill on site. Remove fill from site to an appropriately licensed facility for treatment and resale. Ensure disturbance and stockpiling of fill is conducted in a manner that minimises the potential for environmental impacts e.g. implement appropriate sediment and erosion controls, do not mix with clean material etc.
Virgin Excavated Natural Material (VENM)	Excavated material such as sand, gravel, clay, soil and rock that is not mixed with any other waste or contaminated by any other activity.	Water, flora, fauna. Degradation of water quality, sediment and erosion control issues. Issues associated with high turbidity on aquatic flora and fauna.	Implement sediment and erosion controls prior to excavation or stockpiling. Only excavate where required and avoid excavation in the vicinity of waters. Locate stockpiles outside of drainage lines and area where there is potential for runoff during rain events.
Concrete	Mixture of cement, sand and aggregates. May include additives or substitutes such as fly ash.	Water, soil, flora, fauna. Degradation of water quality, increased turbidity. Toxicity to aquatic flora and fauna.	Ensure lined, bunded concrete wash out areas are provided. Ensure concrete and related products are stored / stockpiled appropriately e.g. covered, bunded, sediment and erosion control measures in place.

Material	Description	Environmental value / potential impacts	Management options
Asphalt	Any materials containing bituminous hydrocarbons. May contain additives such as concrete. Includes recycled asphalt pavement (RAP)	Water, soil, flora, fauna. Degradation of water quality. Contamination of soil and sediment. Toxicity to flora and fauna.	Ensure excess asphalt and related products are disposed of appropriately. Ensure tar and other related chemicals are stored in bunded, covered locations.
Timber	Wood materials used for formwork or other construction purposes.	Visual amenity.	Provide stockpile area for excess / waste timber. Utilise excess / waste timber in other construction processes where possible.
Besser Blocks and other Brick products	Concrete blocks and Clay bricks, which may be mixed together. This can include small amounts of mortar or plaster render.	Visual amenity Degradation of visual amenity	Provide stockpile area for excess / waste bricks / roof tiles. Utilise in other construction processes where possible. Dispose of to recycling facility.
Glass	Sheet glass used for doors, windows, partitioning, etc.	Visual amenity. Degradation of visual amenity.	Provide separated stockpile / storage where appropriate. Dispose of to recycling facility.
Plasterboard	Composite material of gypsum and cardboard used for interior panels of buildings.	Visual amenity. Degradation of visual amenity.	Provide separated stockpile / storage where appropriate. Reuse / recycle where possible (likely offsite).
Steel	Metal building products and materials e.g. reinforcing steel, sheet roofing, structural columns and beams, etc.	Water, soil, visual amenity. Contamination of water and soil through decomposition. Degradation of visual amenity.	Provide separated stockpile / storage where appropriate. Reuse where possible. Dispose of to recycling facility.

Material	Description	Environmental value / potential impacts	Management options
Non-ferrous metals	Metal building materials other than steel e.g. aluminium, brass, copper, etc.	Water, soil, visual amenity. Contamination of water and soil trough decomposition. Degradation of visual amenity.	Provide separated stockpile / storage where appropriate. Reuse where possible. Dispose of to recycling facility.
Mixed waste	Mixed waste of which no one material comprises 50% or more of the load, e.g. paper and plastic packaging etc.	Water, soil, visual amenity, flora, fauna. Contamination of water and soil. Kill or injure fauna through ingestion or entanglement.	Provide waste receptacles. Provide recycling receptacles to fit with local recycling system where possible. Avoid commingling with other separated waste streams.
Paints and other chemicals	Paint and other chemicals used in various construction activities.	Water, soil, flora, fauna.	Provide specific disposal facility. Provide covered / bunded facility for storage prior to disposal to appropriate facility.

Management of impacts

In order to manage the impacts of the construction of the project and to minimise the amount of waste generated by the construction process it is recommended that a waste minimisation strategy be developed for the construction phase. A number of key items are required to be addressed in order to achieve waste minimisation and capitalise on recycling opportunities, these are as follows;

- Coordinate and communicate the strategy to site project managers, supervisors, workers and contractors;
- Appoint a responsible person (site manager) to oversee the implementation of the waste minimisation plan, promote the plan and reward best performances where possible;
- Develop reporting arrangements to monitor waste minimisation; or alternatively, ensure disposal and recycling contractors separate monitor and recycle all site waste as far as practicable so that the objective of the plan are met;
- Involve any waste contractors before construction commences to ensure waste management strategies are compatible with collection systems; and
- Provide relevant training and ongoing education to ensure the strategy is effectively implemented.

In addition to the overall objectives of the waste minimisation strategy, specific options that can be utilised to address the principles of the waste management hierarchy in order of preference are provided below:

Waste Avoidance

- Use designs that minimise the generation of waste during construction and allow waste management facilities during the building operations;
- When selecting a product or material consider the durability of materials and future cost savings of buying an item once and reusing it in a number of ways over the life of the development;
- Include clauses in contracts that discourage over supply of materials and the generation of waste;
- As far a possible accurately estimate the quantities of materials required for the job to avoid over supply;
- Minimise the handling and transport of materials on and off-site; and
- Implement erosion and sediment control procedures to ensure that sediment content in stormwater is appropriately managed to minimise erosion on site.

Waste Reuse

- Ensure waste is separated into recoverable and non-recoverable streams. Also ensure new and undamaged recovered waste materials are kept separated;
- Establish a specific area within the site for the storage and removal of different streams of recovered waste materials. It should be secure and access restricted to authorised personnel;

- Mulch or chip and reuse vegetation wastes in landscaping (except for mangroves);
- Crush large quantities of concrete, brick and other suitable materials and use as roadbase footings (where specifications can be met) retaining walls, drainage etc.;
- Organise pallet returns with follow on deliveries with suppliers where possible;
- Plan to use excess or waste materials effectively, for example:
  - identify which waste materials will be generated (eg concrete, timber, plasterboard, fill etc) and determine how they could be reused;
  - coordinate use of material between jobs, excess materials can be used on other sites if required;
  - consider how excess or waste material could be used if they become available (e.g. fill, drainage material, soil conditioners, framing etc);
  - advertise the availability of free recovered waste materials locally;
  - maximise the separation of wastes and minimise the contamination of recoverable materials;
- Stockpile unused waste material for future use, ensure stockpiles are well managed;
- Reuse off-cuts where possible and store appropriately in the interim; and
- Engage a recovery contractor to remove recoverable materials from site.

Waste Recycling

- Consider using products and materials with recycled content where possible. Check the performance of recycled content products to ensure they meet engineering specification;
- Notify suppliers that recycled content products are preferred where other technical specifications are also met;
- Use fixtures / materials in fit-outs that can be reused in later refurbishments; and
- Consider using fly ash as a component of concrete to reduce the use of virgin materials.

Waste Disposal

- Collect data and record the movement of waste and recovered materials on and off site. Require contactors to supply this information as part of the contract;
- Identify the specific locations of potential sources of waste material (e.g. site sheds and offices, particular trades, particular work activities or areas);
- Develop disposal procedures such as the types of containers to be employed, clear and appropriate signage, suitable location for bins and stockpiles;
- Provide relevant training and ongoing education to ensure efficient disposal (e.g. minimal contamination, maximum resource recovery);
- Utilise chemical toilet and ablutions facilities for construction workers or drain waste water to holding tanks that can be emptied by a contractor; and
- Early installation of stormwater control devices and cut off drains to manage runoff from construction areas to ensure appropriate disposal and handling of stormwater sources.

Specific reference should be given to the typical types of construction materials likely to be used

in North Queensland and at this development, namely:

- Sheet metal (galvanised corrugated steel etc) used for roofing and in shed construction;
- Concrete (besser) blocks used in building construction.

It is considered likely that these materials will form a large fraction of the materials used in construction.

Sheet metal can be recycled and should be separated from general mixed waste. A specific metal recycling bin should be provided during construction for waste metals to be placed. Generally scrap metal skips will be provided by scrap metal contractors on request.

Concrete blocks can also be recycled with waste concrete and should be separated from general waste. A designated waste concrete area should be provided during construction and concrete blocks (off-cuts or waste) should be stockpiled here prior to removal to a concrete recycling facility. It is noted that most landfills provide concrete recycling.

3.14.3.3 Operational waste

Wastes associated with the operation of the marina and the affected environmental values, potential impacts and management options have been further broken down into shipping and boating waste (wastes generated on board) and industrial and commercial wastes (wastes generated on land). Table 3-68 details the environmental values, potential impacts and management options associated with shipping and boating wastes whilst Table 3-69 deals with those wastes generated on land by industrial and commercial operations.

Table 3-68 Shipping and Boating Waste

Material	Environmental value	Potential impacts	Management options
Paper	Visual amenity, flora.	Degrade visual amenity. Kill / injure fauna via ingestion, entanglement	Provide receptacles for general waste and recyclables at appropriate locations. Provide separate facilities for commercial and recreational users.
Metals	Visual amenity, fauna.	Degrade visual amenity. Kill / injure fauna via ingestion, entrapment.	Provide receptacles for general waste and recyclables at appropriate locations. Provide separate facilities for commercial and recreational users.
Glass	Visual amenity, fauna.	Degrade visual amenity. Kill / injure fauna via ingestion, entrapment.	Provide receptacles for general waste and recyclables at appropriate locations. Provide separate facilities for commercial and recreational users.
Plastics	Visual amenity, fauna.	Degrade visual amenity. Kill / injure fauna via ingestion, entanglement, entrapment.	Provide receptacles for general waste and recyclables at appropriate locations. Provide separate facilities for commercial and recreational users.
Fishing nets and other equipment	Visual amenity, fauna.	Degrade visual amenity. Kill / injure fauna via ingestion, entanglement.	Provide receptacles for general waste and recyclables at appropriate locations. Provide separate facilities for commercial and recreational users.

Material	Environmental value	Potential impacts	Management options
Hold sweepings	Visual amenity, water, soil, fauna.	Degrade visual amenity. Increase nutrient loading in marina waters, or contaminate water and soil with toxic substances. Kill / injure fauna via contamination, ingestion, entanglement.	Ensure hold sweepings are contained and disposed of to an appropriate receptacle. Prescribe procedures for hold sweeping disposal such as removal by waste removal contractor.
Galley waste	Visual amenity, odour, water, fauna, flora.	Degrade visual amenity, create odour issues. Increase nutrient loading in marina waters which will inturn impact on flora and fauna. Create pest issues.	Provide specific receptacles for commercial users or ensure galley wastes are removed directly from vessel by waste removal contractor. Provide sufficient general waste receptacles for public use.
Fish / other animal wastes	Visual amenity, odour, water, flora, fauna.	Degrade visual amenity, create odour issues. Increase nutrient loading in marina waters which may inturn impact on flora and fauna. Create pest issues.	Provide specific receptacles for commercial users or ensure fish and other animal wastes are removed directly from vessel by waste removal contractor. Prescribe procedure for commercial users. Provide fish cleaning preparation areas with special disposal receptacles for public use.
Batteries	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contaminate marina waters and / or sediment. Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Provide battery recycling transfer area where customers can deposit battery before battery recycling contractor collection. Provide contact details of battery recycling contractor for pickup service.

Material	Environmental value	Potential impacts	Management options
Fluorescent and mercury vapour lamp bulbs	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contaminate marina waters and / or sediment. Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Provide a separate disposal receptacle where items such as these can be deposited prior to removal by contractor.
Waste oil	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contaminate marina waters and / or sediment. Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Provide pump out facility or appropriate access / locations for sucker trucks to remove [1]. Provide separate waste oil deposit facility for commercial and recreational users. Prescribe waste oil removal procedures for both commercial and recreational users.
Oily mixtures including fuel residues	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contaminate marina waters and / or sediment. Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Provide pump out facility or appropriate access / locations for sucker trucks to remove [1]. Provide separate deposit facility for commercial and recreational users. Prescribe removal procedures for both commercial and recreational users.

Material	Environmental value	Potential impacts	Management options
Oily mixtures containing chemicals	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contaminate marina waters and / or sediment (may include contaminants such as soaps, cleaners or engine coolant). Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Provide pump out facility or appropriate access / locations for sucker trucks to remove [1]. Provide separate facility for commercial and recreational users. Prescribe removal procedures for both commercial and recreational users. Avoid mixture of chemicals which may result in health and safety issues.
Tank wash water	Water, soil, flora, fauna.	Contaminate marina waters and / or sediment if containing contaminants (may include contaminants such as oils, fuel and residues, soaps, cleaners or engine coolant). Increase nutrient loading in marina waters where containing fish / food waste, which may inturn impact on flora and fauna. Kill / injure flora and fauna via toxicity / eutrophication. Bioaccumulation and health and safety issues.	Provide pump out facility or appropriate access / locations for sucker trucks to remove [1]. Provide separate facility for commercial and recreational users. Prescribe removal procedures for both commercial and recreational users. Avoid mixture of chemicals which may result in health and safety issues.

Material	Environmental value	Potential impacts	Management options
Noxious liquids	Water, soil, flora, fauna.	Contaminate marina waters and / or sediment. Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Provide pump out facility or appropriate access / locations for sucker trucks to remove [1]. Provide separate facility for commercial and recreational users. Prescribe removal procedures for both commercial and recreational users. Avoid mixture of chemicals which may result in health and safety issues.
Sewage grey water / black water	Visual amenity, air, water, flora, fauna.	Degrade visual amenity. Objectionable odour. Contaminate marina waters. Increase nutrient loading in marina waters. Kill / injure flora and fauna via toxicity and eutrophication. Health and safety issues.	Provide pump out facility or appropriate access / locations for sucker trucks to remove [1]. Provide separate facility for commercial and recreational users. Prescribe removal procedures for both commercial and recreational users.

[1] The marina management may provide pump out facility for specified types and quantities of liquid waste or direct liquid waste disposal to an appropriate liquid waste management contractor. For example marina management may prescribe that “oily bilge water not contaminated with soaps, cleaners or engine coolant and less than 150L may be pumped via the onsite pump out facility. For oily bilge water contaminated with soaps, cleaners or engine coolant or more than 150L boat owners should contact the appropriate liquid waste management contractor for removal via sucker truck.

Table 3-69 Commercial and Industrial Waste

Material	Environmental value	Potential impacts	Management options
Industrial, manufacturing, repair, maintenance, etc.			
Paper Paper from packaging of goods, etc.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Not readily biodegradable. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna.	Minimise packaging in production and select products with minimal packaging. Provide paper recycling facilities to commercial premises. Ensure waste receptacles have sufficient capacity and are emptied as frequently as required.
Plastic Plastic packaging form industrial operations, packing tape, shrink wrap, other waste plastic associated with repair maintenance of vessels, plastic containers from various industries (e.g. fish processing)	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Not readily biodegradable. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna. Kill / injure fauna via entanglement, entrapment, ingestion.	Minimise plastic waste in production processes, select products with minimal plastic packaging. Select / use / produce products with recyclable / reusable plastic. Provide plastic recycling receptacles to commercial and industrial clients. Include public place recycling receptacles to fit with local recycling practice.

Material	Environmental value	Potential impacts	Management options
Foam Foam containers, packaging, protective covers, other foams used in vessels, floats and other items.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Not readily biodegradable. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna. Kill / injure fauna via entanglement entrapment, ingestion.	Minimise foam waste in production processes, select products with minimal foam packaging. Reuse where possible. Provide recycling receptacles for Expanded Polystyrene (EPS). Potential to include in recycling bins for separation at Material Recovery Facility (MRF).
Non ferrous metals Scrap metals such as aluminium / brass from maintenance or industrial operations, paint tins etc.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna.	Minimise scrap in production / repair / maintenance. Reuse in next or another process (e.g. repair / maintenance). Provide recycling facilities / collection service. Provide recycling receptacles in public places and for commercial users for cans / tins etc.
Steel Scrap metals from maintenance or industrial operations	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna.	Minimise scrap in production / repair / maintenance. Reuse in next or another process (e.g. repair / maintenance). Provide recycling facilities / collection service.

Material	Environmental value	Potential impacts	Management options
Abrasive blasting grit Abrasive blasting grit and associated contaminants.	Air, water, soil, flora, fauna.	Contamination to air of fine particles including silica and heavy metals. Nuisance dust Contamination of water, soil by heavy metals and other contaminants associated with surfaces requiring blasting such as paints. Potential leaching of contaminants to soil and water. Contaminants may be toxic to flora and fauna.	Ensure abrasive blasting is conducted in contained environment to prevent discharge to air, water or soil. Ensure blasting material is collected and disposed of appropriately.
Paint chips Paint chips and material from maintenance / repair of boats.	Air, water, soil, flora, fauna.	Contamination of water and soil (sediment) by antifouling, anticorrosive paints and products (potential contamination by various metals and chemicals including TBT, PCB's lead, zinc, copper). (Contamination of air and subsequently water and soil via application of new paint) Contaminants may be toxic to flora and fauna. Bioaccumulation issues.	Ensure paint removal via abrasive blasting or high pressure water is conducted in enclosed, controlled facility. Abrasive blasting material to be collected and disposed of appropriately. High pressure water runoff to be controlled and treated to remove all contaminants prior to release to harbour (may require disposal to sewer via trade waste agreement)[1].

Material	Environmental value	Potential impacts	Management options
Fibreglass and related products Fibreglass, resin, hardener, foams from vessel maintenance / repair and other industrial process.	Air, water, soil, flora, fauna.	Release to air of toxic substances including vapours from mixing and curing processes, via evaporation etc. Objectionable odour. Contamination of water, soil from toxic chemicals. Contaminants may be toxic to flora and fauna. Contamination of other products such as rags etc. Potential fire or explosions.	Minimise production of waste through planning and good work practice. Include ventilation and treatment systems for air contaminants in facilities used for fibreglass related activities. Localise or isolate high emission and hazardous waste producing activities. Store in covered, bunded facility with at least 110% capacity bunding. Install spill containment infrastructure. Do not allow mixing of hazardous and non hazardous materials. Ensure waste chemicals and contaminated materials such as rags are collected and disposed of appropriately.
Biological waste Fish and other waste from processing and packaging. Organisms from anti fouling maintenance.	Visual amenity, air, water, flora, fauna.	Degrade visual amenity, create odour. Increase nutrient loading in marina waters which may inturn impact on flora and fauna. Create pest issues.	Fish and other related biological waste may be able to be reused in other processes such as fertilizer / feed production. Contain fish and other waste in sealable containers and dispose of to appropriate facility daily or as required. Prohibit disposal to waters also prohibit disposal of waters contaminated with biological waste to marina waters.

Material	Environmental value	Potential impacts	Management options
Oil / fuel / residues From service, repair, maintenance and other industrial processes.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contaminate marina waters and / or sediment. Kill / injure flora and fauna via toxicity. Bioaccumulation and health and safety issues.	Ensure facilities have spill containment infrastructure (e.g. triple interceptors).
Chemical wastes Anti-fouling, cleaning and other industrial chemicals, adhesives, glues, etc.	Air, water, soil, flora, fauna.	Release to air of toxic substances including vapours from mixing or via evaporation etc. Objectionable odour. Contamination of water, soil from toxic chemicals. Contaminants may be toxic to flora and fauna. Bioaccumulation issues. Potential fire or explosions.	Minimise production of waste through planning and good work practice. Include ventilation and treatment systems for air contaminants in facilities. Localise or isolate high emission and hazardous waste producing activities. Store in covered, bunded facility with at least 110% capacity bunding. Install spill containment infrastructure. Do not allow mixing of hazardous and non hazardous materials. Ensure waste chemicals and contaminated materials such as rags are collected and disposed of appropriately.

Material	Environmental value	Potential impacts	Management options
Sewage grey water / black water Sewage from site facilities.	Visual amenity, air, water, flora, fauna.	Degrade visual amenity. Objectionable odour. Contaminate marina waters. Increase nutrient loading in marina waters. Kill / injure flora and fauna via toxicity and eutrophication. Health and safety issues.	Ensure facilities are connected to town sewer system or onsite wastewater treatment system. Ensure pump out facilities are controlled and bunded as to minimise spillage. Ensure correct fittings are used when pumping into pump out facilities.
Timber Wood products used in repair and maintenance of vessels and in various industrial processes, pallets, formwork, etc.	Visual amenity, soil, water, flora, fauna.	Degrade visual amenity. May be contaminated with other chemicals from repair or maintenance works. Potential for contaminants to be released to waters and soil. Contaminants may be toxic to flora and fauna.	Minimise waste timber through good work practice and planning. Reuse timber where possible. Recycle uncontaminated timber products. Do not mix uncontaminated and contaminated timber waste. Dispose of contaminated timber products appropriately.

Material	Environmental value	Potential impacts	Management options
Paint Paint used in repair and maintenance of vessels.	Air, water, soil, flora, fauna.	Release to air of toxic substances including vapours from mixing or via evaporation etc. Objectionable odour. Contamination of water, soil from toxic chemicals. Contaminants may be toxic to flora and fauna. Bioaccumulation issues. Potential fire or explosions.	Minimise production of waste through planning and good work practice. Include ventilation and treatment systems for air contaminants in facilities. Do not allow painting in harbour waters, where painting is required vessels should be in dry dock and appropriate controls in place. Localise or isolate high emission and hazardous waste producing activities. Store in covered, bunded facility with at least 110% capacity bunding. Install spill containment infrastructure. Do not allow mixing of hazardous and non hazardous materials. Ensure waste paint and contaminated materials such as rags and brushes are collected and disposed of appropriately.
Glass Sheet glass, screens bottles and containers.	Visual amenity.	Degrade visual amenity.	Reuse containers, sheets etc where possible. Provide glass recycling receptacles for industrial users. Provide commingled recycling facilities that can accept glass for public use.

Material	Environmental value	Potential impacts	Management options
Batteries Lead acid and other batteries from vessels and other machinery used in the industrial processes at the site.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Contamination of water, soil from toxic chemicals. Contaminants may be toxic to flora and fauna. Bioaccumulation issues.	Provide battery disposal facility for the marina or ensure waste management contractor is available to collect batteries as required. Store batteries in covered bunded facility prior to removal to battery recycling facility by appropriate waste contractor.
Commercial – Retail, administration, restaurants, etc.			
Paper Food packaging, wrapping, other product packaging, office paper, etc.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Not readily biodegradable. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna.	Minimise packaging in service and select products for use / sale with minimal packaging. Provide paper recycling facilities to commercial premises. Provide public place recycling facilities. Ensure waste receptacles have sufficient capacity and are emptied as frequently as required.
Plastic Packaging, bottles, other containers, wrapping, etc.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Not readily biodegradable. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna. Kill / injure fauna via entanglement, entrapment, ingestion.	Minimise plastic waste in service, use / sell products with minimal plastic packaging. Select / use / sell products with recyclable / reusable plastic. Provide plastic recycling receptacles to commercial clients. Include public place recycling receptacles to fit with local recycling practice.

Material	Environmental value	Potential impacts	Management options
Glass Glass bottles, jars, etc.	Visual amenity.	Degrade visual amenity.	Provide glass recycling receptacles to commercial premises. Include public place recycling receptacles to fit with local recycling practice.
Metals Aluminium drink cans, other food cans, etc.	Visual amenity, water, soil, flora, fauna.	Degrade visual amenity. Potential leaching of contaminants to water and soil. Contaminants may be toxic to flora and fauna.	Provide recycling receptacles to commercial premises. Include public place recycling receptacles to fit with local recycling practice.
Food waste Left over food from restaurants and other services.	Visual amenity, air, water, flora, fauna.	Degrade visual amenity, create odour. Increase nutrient loading in marina waters which may inturn impact on flora and fauna. Create pest issues.	Minimise production of food waste through good work practice and planning. Provide food waste receptacles to commercial premises such as restaurants. Ensure sufficient waste receptacles are located in public areas and ensure these are emptied as required.
Sewage grey water / black water Sewage from toilets, showers, sinks, kitchens and other facilities.	Visual amenity, air, water, flora, fauna.	Degrade visual amenity. Objectionable odour. Contaminate marina waters. Increase nutrient loading in marina waters. Kill / injure flora and fauna via toxicity and eutrophication. Health and safety issues.	Ensure facilities are connected to town sewer system or onsite wastewater treatment system.

Material	Environmental value	Potential impacts	Management options
Mixed waste Mixed waste of which no one material comprises 50% or more of the load, e.g. paper and plastic packaging etc.	Visual amenity, air, water, soil, flora, fauna.	Degrade visual amenity, create odour. Potential leaching of contaminants to water and soil. Potential to increase nutrient loading or waters, eutrophication. Contaminants may be toxic to flora and fauna.	Minimise mixed waste by providing and promoting recycling opportunities for both commercial premises and in public places. Provide separate receptacles for commercial premises and public. Ensure receptacles have lids, have sufficient capacity and are emptied as required.
Timber Wood products used in industrial processes, pallets, etc.	Visual amenity, soil, water, flora, fauna.	Degrade visual amenity. May be treated with chemicals. Potential for contaminants to be released to waters and soil. Contaminants may be toxic to flora and fauna.	Minimise waste timber through good work practice and planning. Reuse timber where possible. Recycle uncontaminated timber products. Do not mix uncontaminated and contaminated timber waste. Dispose of contaminated timber products appropriately.

[1] Runoff from high pressure cleaning (using water), unlike material from abrasive blasting, is often not associated with contamination of harbour waters and sediment; however this pathway may be a significant source of contaminants in harbour waters and sediment (Johnsen, A. and Engoy, T.)

3.14.4 Mitigation measures

Shipping and Boating

The waste facilities catering for shipping and boating (commercial and recreational), should be able to receive MARPOL 73/78 Annex V wastes (garbage) and Annex I wastes (waste oil and oily mixtures) as well as being capable of handling any other wastes in the quantities that would normally be handled or discharged (e.g. by a fleet of 50 trawlers and 40 potential recreational berths / pile moorings).

Management options for shipping and boating wastes for both commercial and recreational users are described below.

In the absence of any specific guidelines for marinas within Queensland, these management measures have been based on the ANZECC (1997) *Strategy to Protect the Marine Environment – Best Practice Guidelines for Waste Reception Facilities at Ports, Marinas and Boat Harbours in Australia and New Zealand*.

Solid Waste

- For general solid waste including galley waste specific receptacles are required. The location of receptacles should be accessible for both clients, marina personnel and removal contractor. Typically mobile garbage bins at the end of each pier of the marina would be required. In addition, receptacles at any public boat ramp and car and boat parking area would be required. Furthermore these facilities should be accessible to users of pile moorings;
- The sizing of bins would be dependent on the contractor however it is likely that the sizing would be one of the following:
  - 1 m^3 steel skip bins;
  - 240 L mobile plastic garbage bin (“wheelie bin”);
- Receptacles for all types of waste received at the facility should be clearly labelled and sign posted. Furthermore waste storage areas should be designed so that wind and pests including birds and other animals cannot cause spreading of waste and disease;
- Information on the correct use of each facility should be displayed and readily visible on signs at the containers or receptacles;
- Additional facilities should be provided for recycling and/or reuse of suitable materials including glass, aluminium and steel, paper, plastic and batteries. Appropriate facilities may include:
  - Centralised recycling area, where marina users can segregate their recyclable material; or
  - Co-location with general solid waste (garbage bins) for non hazardous recyclables;
  - Considering the Townsville Regional Council already operates a two bin system with a separate receptacle for recycling, it would be appropriate for the marina operators to fit into this system, as such, a separate receptacle for commingled recyclables (paper, plastic, glass, cans) would be recommended;

- Spare bins should be available to ensure there is always backup capacity;
- Procedures should be put into place with the selected waste management contractor for unscheduled collection in the event that receptacles become full; and
- People who have caught fish should be encouraged to take fish home to clean or an appropriate cleaning facility should be provided.

Liquid Waste

The provisions of liquid waste reception facilities should consider the following:

- Type of liquid waste being received, any risk associated with the storage combinations of liquid wastes, segregation where necessary;
- Use of standard fittings, with adaptors where necessary;
- Treatment and disposal methods;
- Transport access; and
- Statutory approvals to store and operate.

In addition reception facilities for sewage specifically need to consider the following:

- Type of sewage, namely; septic sewage, sullage, galley waste, chemical toilet sewage, grey water, sludge from anaerobic treatment systems;
- Frequency of use and necessary capacity;
- Constraints of the receiving sewage treatment systems such as maximum daily delivery rates;
- Limitations of sewage transfer such as pump capacity and pumping rates;
- Minimisation of odour releasee to the surrounding environment;
- Protection from accidental spillage during waste transfer; and
- Provisions of a freshwater hose for flushing out vessel sewage holding tanks.

A number of options are available for the reception of liquid waste (including sewage) at the marina, including:

- Direct discharge of sewage to onsite storage tanks in a centralised location via the use of pumping systems for treatment or storage prior to discharge or removal by an appropriate waste contractor. In addition this should include a centralised recycling station for waste oil and grey water, solvents and thinners;
- Discharge directly into the local sewage system; and
- Direct removal by a waste management contractor via sucker truck.

A combination of these options is likely to be required, which may involve direct removal by a waste management contractor via a sucker truck for trawling vessels and removal to a storage or treatment facility for recreational vessels.

For non-sewage liquid waste typical treatment includes a settling tank or pit, which may double as a flow equalisation tank, followed by a corrugated plate interceptor then a filter designed to suit the specific waste types encountered. Discharge may be to sewer or via a waste

management contractor.

Commercial and Industrial Operations

Waste management at the commercial and industrial facilities at the marina including boat building, maintenance, repair facilities, restaurants and seafood processing or markets must comply with the regulations outlined in the Waste EPP and detailed in section 2.1.2 of this report. The operators of these facilities should adopt the objectives of the legislation into their operation and waste management practices. Specifically these facilities should adopt processes that achieve alignment with the waste management hierarch, which is as follows;

- Waste avoidance;
- Waste re-use;
- Waste recycling;
- Energy recovery from waste; and
- Waste disposal.

Specifically boat building, maintenance, repair and cleaning should be conducted only in designated area so as to optimally manage associated solid and liquid wastes. The following guidelines are provided as a means to minimise environmental impacts associated with wastes from maintenance, repair and cleaning:

- Maintenance work should be performed inside buildings or under cover where possible, to reduce contamination to stormwater;
- All maintenance activities should be performed over impenetrable surfaces that are properly drained to a collection facility to prevent contaminated or toxic materials entering the waters;
- Abrasive blast cleaning (eg sand blasting) should be performed within spray booths or suitable enclosures so all wastes and residues can be contained, collected and properly disposed of;
- High pressure water cleaning should also be performed within a controlled environment and waters from the process should be collected and treated. Washing of hulls on land by mechanical scraping is preferable to high pressure water cleaning as it can produce wastewater contaminated with marine organisms, hull paint and fragments of hull material. High pressure systems must only be used where proper collection, treatment and disposal facilities are available;
- Vacuum sanders and grinders should be used to minimise potentially polluting dust where possible;
- Boat cleaning should be performed in a way that minimises release of marine organisms and harmful paints into waters;
- Chemicals should be kept in a secure area and each container labelled clearly to make disposal and possible recycling easier;
- Areas used for storage of chemicals including paints should be covered and bunded to contain spills;
- Recycling of chemicals such as oils and solvents should be encouraged with remaining unwanted chemicals being disposed of to an appropriate facility or removed by an

appropriate waste management contractor;

- Spill plans should be developed and appropriate spill response kits should be stored and kept easily accessible;
- Appropriate legislative requirements in relation to the use and storage of chemicals should be adhered to in the design and operation of the marina area;
- Recycling facilities should be included and should fit with existing recycling program for commingled recycling. Recycling of batteries, fluorescent globes, etc should be conducted and appropriate waste management contractors should be engaged for collection; and
- Consideration should be given to access to waste and recycling receptacles by waste management contactors.

Wastes associated with seafood processing and packaging specifically include expanded polystyrene containers, cardboard boxes, shrink wrap, packing tape and other plastic products. There are various opportunities for reuse and recycling of these products which should be investigated with regard to the specific types, quantities and quality (e.g. contamination) of the wastes produced. Where possible existing recycling programs should be utilised.

3.15 Cultural heritage

3.15.1 Description of environmental values

3.15.1.1 Background

The proposed TMPP includes reclamation of approximately 34 hectares of land at Lot 773 adjacent to Benwell Road. The Precinct development area consists of a narrow strip of reclaimed land (Benwell Road beach) and sub-tidal areas at the mouth of Ross River.

The most notable feature of the development areas for the TMPP is the very high level of past disturbance and landscape/seascape modifications that date back to the earliest days of the European settlement of Townsville (circa 1864).

Appendix Y provides a history of the development of the 'Townsville Harbour', which illustrates the dramatic alterations to the natural environment (and the cultural landscape) of this section of the Townsville coastline and its waterways (refer Taylor 1980 for a detailed history of the Townsville Harbour).

In brief, in 1864, upon the European settlement of Townsville, Melton Black selected a site on Ross Creek for a harbour. At this time, a sand bar at the mouth of the creek and a rock bar inside the creek allowed only shallow vessels to navigate the creek channel (Pringle 1989). In the 1870s the need for a port at Townsville became urgent with the opening of the western goldfields. As early as 1871 major works were being undertaken at Ross Creek to remove rocks from the bed of the creek to make it navigable for vessels (Taylor 1980:25). In 1883-84 the first dredging of the Townville Harbour was undertaken.

Dredging has been carried out to maintain Townsville's navigation waterways for over 100 years (SKM 1991:22). Pringle (1989) has carried out a detailed investigation of the long-term effects of dredging in Cleveland Bay (and especially at the Townsville Port) and notes that the history of dredging in Cleveland Bay is closely linked to the development of the Port of Townsville.

Pringle (1989) has reported that near the Ross River mouth large scale coastal changes have taken place and these are directly linked to dredging. A detailed investigation of recent coastal processes in the vicinity of the mouth of Ross River is provided under Section 3.8 of this EIS.

Benwell Road beach at Lot 773 (in the TMPP development area) is currently a narrow sandy beach with extensive mudflats exposed at low tide. Near the Port entrance on Benwell Road the shoreline is lined with mangroves which have colonised the area in relatively recent times. Benwell Road beach is a popular recreational area for local South Townville and Railway Estate residents and it is known to be a good area for collecting yabbies and bait. Social uses of the area are addressed in detail under Section 4 of this EIS.

The beach is reclaimed land that is permanently leased to the Port for port-related uses. It is designated as Strategic Port Land in the Port Land Use Plan. Tenure of Lot 773 is addressed in detail under Section 3.2 of this EIS. This beach was planned for redevelopment by the Port in the 1990s, but was not required at that time. Port of Townsville has allowed continued public access to the beach area until such time as the land is required - it is now required as part of the proposed TMPP.

Analysis of historical aerial photographs of the Port and the Benwell Road section of coastline dating from 1941 to 2007 shows that the existing Benwell Road beach did not exist prior to 1977 (Refer Appendix Y). In the 1941 and 1964 aerial photographs this area comprised extensive sand and mudflats on the western side of the mouth of Ross River. What appear to be some vegetated sand dunes or beach ridges near the mouth of the river (refer Figure 6 in Appendix Y) are no longer in existence. If these coastal deposits were in fact sand dunes or old beach ridges they might possibly have contained intact Aboriginal archaeological sites and remains.

By 1977 reclamation works had begun with much work conducted between 1964 and 1977 (Figures 7 and 8 in Appendix Y). Overall, the evidence from the aerial photographs illustrates that between 1941 and 2007 there have been dramatic changes to the configuration of the coastline near the mouth of Ross River and along the coastline that now forms the Benwell Road beach.

The high level of previous disturbance and landscape/seascape modification within the POTL project areas has important implications for archaeological and cultural heritage potential. These implications are discussed in detail following.

3.15.1.2 The Aboriginal cultural landscape

Approach and Methodology

Unfortunately, there are few detailed specific references to Ross Creek and Ross River in the ethnographical literature, and by necessity the following literature review refers to the broader Cleveland Bay coastline and the immediate Townsville coastal plain.

This literature review attempts to place the Ross River project area in the context of the wider Aboriginal cultural landscape of Townsville (Gurambilbarra). Before the European settlement of Townsville in 1864, the Aboriginal Traditional Owners occupied a vast area across the Townsville coastal plains. The existing Shire boundaries in the region are of course modern constructs, which are not particularly relevant to traditional Aboriginal territories, clan group boundaries and Aboriginal subsistence and settlement patterns.

Background ethnographical and anthropological information derives from extended research by

Nicolaas Heijm (Segue Pty Limited). Heijm's anthropological research in the Townsville region began in 1990. To the present, it has covered the bulk of ethnographic and oral history material dealing with the Murri (Aboriginal) society of the region. He has searched the correspondence files of the Queensland Colonial Secretary, the Queensland Aboriginal Protectorates and other records at Queensland State Archives, as well as the 19th century Townsville newspapers (including the Port Denison Times, Cleveland Bay Express, Cleveland Bay Herald, Townsville Herald, North Queensland Herald, Townsville Daily Bulletin and others). Heijm's research has included several dozen anthropological fieldtrips in the greater Townsville region (including Palm Island), which have involved standard anthropological participant observation methodology and directed oral history interviews with Aboriginal Elders and others.

Aboriginal History and Ethnography

An Historical Sketch of Townsville (Gurambilbarra)

As there are few detailed specific references to Ross Creek and Ross River in the ethnographical literature, a literature review was undertaken to support this study for the broader Cleveland Bay coastline and the immediate Townsville coastal plain. The review is provided in detail in Appendix Y. Key points are summarised following.

The Ross River study area is part of a traditional country called Gurambilbarra in the Townsville language15. Its name is derived from Gurambil, the language name of Cape Pallarenda, and can be translated as "people of Cape Pallarenda". The reference to Cape Pallarenda in the name is metonymic, for Gurambilbarra includes the catchment basins of the Ross and Black Rivers and extends inland as far as the Hervey Range and eastwards to include Magnetic Island. The Cape was the main living place of the area before the European settlement of the region. Historical records, among them Dalrymple (Dalrymple and Smith 1860) and Rowe (1931), indicate that a large number of people lived at Gurambil before the founding of Townsville in 1864.

Price's wordlists of 1885 provide local Aboriginal language names for areas located within or immediately adjacent to the TMMP. Relevant language names as follows (the phonemic transcriptions in brackets were produced by N. Heijm):

- Ross Creek "Cal'ghimg'a" (Galgimga);
- Ross River "Cal'bee'dee'ra" (Galbidira);
- Ross Island "Muth er'el" (Madhil); and
- Magazine Island "Go-Your" (Guyur).

Captain Cook's expedition of 1770 provides the earliest documented reference to Aboriginal people at Townsville. Our knowledge of the Aboriginal use of the shores of Cleveland Bay will now always be limited by the destruction of much of the prehistoric archaeological record of the area (cf. Kennedy 1947, 1948). However, documentary and ethnographic data show the area was an important part of a foraging territory that included Cape Pallarenda, the dunes, flats and

[15] The "Townsville language" might be thought a perverse way of referring to a language considerably older than the city. But although we know about names of particular dialects, no name has been recorded for the regional language as a whole, neither of the names that have historically been attached to it, neither "Coonambella" (in Price 1885) nor "Wulgurukaba" (in Tindale 1974), are proper language names. It is quite possible the language had no proper name. In the absence, a more descriptive but more cumbersome label might be the "the Palms Islands-Magnetic Island-Ross and Black River language" but for the purposes of this report, the "Townsville language" keeps things simple.

shores of the Town Common area and the riverine habitats of the Ross and Black River corridors. It further included Magnetic Island: the first European settlers observed a steady traffic of people canoeing over from the Cape to forage the island's rich resources[16].

The Traditional Owners of Townsville are placed in their country through the creation story of Gabul, the Carpet Python, for whom the central place or site on the Townsville mainland is the Ross River.

According to Heijm's anthropological research, the Ross River formed an important track of Gabul. Heijm's account of the Gabul myth cycle for the Herbert River and Ross River areas is outlined in summary in Appendix Y. The Gabul story recounts the travels of Gabul or Carpet Python down the Herbert River, through the Hinchinbrook channel to what are now the islands of the Palm group and Magnetic Island, and up the Ross River. The Gabul myth cycle highlights the point that the Ross River forms a significant and integral part of the Aboriginal cultural landscape, in a broad area of the coastline extending from the Herbert River to Townsville.

The Founding of Townsville and Early Settlement History

Early in November 1864 the partnership of Robert Towns and John Melton Black set in motion their plans for the construction of Townsville. On 5 November, Black and a work party of sixteen men arrived at Cleveland Bay (Black 1865). Actions taken to effect establishment of a new town resulted in conflict between the Europeans and Traditional Owners. Examples of some of the conflicts are provided in Appendix Y.

In the first decades of Townsville's existence, Kissing Point seems to have marked a frontier between the town and the quarter to which Aboriginal people were restricted. The city's first municipal boundary in fact ran just north of Kissing Point; joining the coast at Rowes Bay in the vicinity of the present Rowes Bay Caravan Park. The boundary had been gazetted early in 1866, a few months after the first buildings went up (Gibson-Wilde 1984:63).

In 1869, the first move to "letting them in" was made when a party of prominent "gentleman of Townsville" ventured to make peaceable contact with the Cape Pallarenda people. Their efforts reflected a shift in the character of the frontier engagement from open hostility to bringing Aboriginal people onto the stations.

Murri people paid several visits to Townsville in the weeks that followed. In June 1869 about 100 Murri people from "Dotswood and Hinchinbrook[17]" arrived on Ross Island. There they consulted with people "on the beach" before crossing to the mainland where they began to appropriate such items of European material culture as took their interest. Concerns regarding their inappropriate dress and incidents of theft, particularly of cattle, ensued. The Townsville Council was still attempting to restrict the entry of Aboriginal people into the town more than a decade later.

After about 1885, there are regular reports of Aboriginal people living along the shores of Cleveland Bay. Kissing Point appears to have remained one of the main living and meeting

[16] The canoe of the region, called a *wulguru* was constructed of three strips of bark sewn together with lawyer cane. The design enabled covering fairly large distances – say those between Kissing Point and the Palm Islands – by riding tidal currents.

[17] Presumably not Hinchinbrook Island, but from the area of Hinchinbrook Station inland from the southern half of Halifax Bay.

places. A detailed account of a review of the literature supporting this notion is provided under Appendix Y.

Around 1890 a new living place was established at Rowes Bay between Jason and Mundy Creeks. It is likely that military operations at Kissing Point, which began in earnest in 1889, pushed people out to Rowes Bay. The new camp was in a good spot for foraging, particularly for the “black prawn” and Burdekin Plum that occurred there, but the Town Common and the shores of Rowes Bay and Cape Pallarenda continued to be used. Cape Pallarenda was a favoured spot for oyster collecting and Shelley Beach, on the northern shore of the Cape, for spear fishing. Initially the Rowes Bay people had used gunyas - huts constructed of a framework of cane arches thatched with grass. In subsequent decades, they began to use sheet metal attached to timber frameworks, producing the humpy style of accommodation. The Rowes Bay people treated their camp as an exclusive area and allowed few whites into its inner precincts. Conversely, the people from the camp rarely ventured into the central part of Townsville although some of the children eventually attended Belgian Gardens State School.

In 1893 an additional camp was established on Castle Hill (North Queensland Herald, 22 February 1893). It was located above the present day Stagpole Street until cyclone Leonta destroyed it in 1903. The people who were living there are said to have moved to Rowes Bay at that time. By then the Rowes Bay camp had probably become the largest in Townsville (Townsville Daily Bulletin, 25 December 1902). It was arranged along a spit that in those days extended northwards from Kissing Point and was separated from the main shore at Rowes Bay by a mangrove swamp in the outlet of Jason Creek. The mangroves provided seclusion and enabled residents to control entry to the camp.

Oral history reports suggest that the population at the Rowes Bay camp began to decline after about 1920. Some reports attribute this decline to the influenza epidemic of 1919. This is certainly possible, but no records of the effect of the epidemics in the Townsville region have yet been found. Records show that areas adjacent to Townsville were affected. A major factor for the decline was probably the Queensland Government’s regime of forcibly “removing” people not employed by Whites under employment “agreements”, mostly to the settlements at Yarrabah and Palm Island.

Highland (1993) notes that Ross Island was a long-standing Aboriginal encampment area predating the 1920’s. Highland notes that by 1889 there were two main living camps on the fringes of Townsville – one at North Ward and the other at Ross Island. Langan (n.d.) reports that from about 1868 there was a large native encampment on Ross Island and that the blacks in that area were in the habit of regularly visiting other tribes who lived at Rowes Bay and Cape Pallarenda. He reports that there was a rocky bar across Ross Creek and at low tide the local Aboriginal people used it as a crossing place.

The Aboriginal archaeological record

Cultural Heritage Register and Database Searches

A search of the Queensland Department of Natural Resources and Water (NRW) Cultural Heritage Register and Database is an established procedure for cultural heritage investigations in Queensland, and it is one of the criteria for addressing the Cultural Heritage Duty of Care Guidelines under the ACHA.

In response to the search request for POTL lands, the NRW advised the following:-

"…….no Aboriginal cultural heritage is recorded on the Cultural Heritage Database and Register in your specific search area, from the data provided by you. However, it is probable that the absence of recorded Aboriginal cultural heritage places reflects a lack of previous cultural heritage surveys of the area. Therefore, our records are not likely to reflect a true picture of the Aboriginal cultural heritage values of the area".

"All significant Aboriginal cultural heritage in Queensland is protected under the Aboriginal Cultural Heritage Act 2003, and penalty provisions apply for any unauthorised harm. Under the legislation a person carrying out an activity must take all reasonable and practical measures to ensure the activity does not harm Aboriginal cultural heritage. This applies whether or not such places are recorded in an official register, and whether or not they are located in, on or under private land".

"Aboriginal cultural heritage which may occur on the subject property is protected under the terms of the Aboriginal Cultural Heritage Act 2003, even if Natural Resources and Water has no records relating to it".

Searches were also carried out of Federal cultural heritage registers and databases, including the Australian Heritage Database and the Register of the National Estate. There are no listings on the Australian Heritage Database for the POTL project areas. The search results are presented in Appendix Y.

The Register of the National Estate contains one listing for the "Ross River to Alligator Creek Coastal Area". This area is listed as an 'Indicative Place' based on its 'Natural Values'. Cultural values are not included in this listing. The "Ross River to Alligator Creek Coastal Area" is located outside the boundaries of the TMPP. However, the northern boundary of this 'Indicative Place' (on the east bank of the Ross River) lies immediately adjacent to the Marine Precinct development area. The listing includes "about 3,880 hectares comprising the coastal plains east-south-east of Townsville from the south bank of Ross River to the west bank of Alligator Creek, and including the area along the coast to 1 km offshore". The listing also notes "Ross River south bank is an important wildlife habitat".

Previous Archaeological Research

Much of the following information relating to the Aboriginal archaeology of the Townsville region has been sourced from unpublished consultancy reports for Environmental Impact Studies or related impact assessment projects (eg: for infrastructure development such as roads, powerlines, pipelines, residential subdivisions, industrial developments, mining, coastal reclamation works, etc). A detailed review of some relevant archaeological research is provided in Appendix Y and was undertaken to provide a contextual and chronological framework for the current investigation for the TMPP (see also Bird and Heijm 2007). A summary of key findings follows.

Archaeological research in Townsville over the past two decades has recorded a diversity of Aboriginal archaeological sites, including shell middens, stone artefact scatters, rock shelters with paintings and cultural deposits, scarred trees, stone quarries, ceremonial places and burial sites. By far, the most common Aboriginal archaeological sites are coastal and estuarine shell middens and low-density stone artefact scatters. The results of many archaeological investigations clearly show that coastal beach ridges and hinterland granitic outcrops have the

highest archaeological potential of all landforms in the wider Townsville region.

Several previous archaeological investigations provide a chronological framework for the Aboriginal occupation of the Townsville coastal plain. So far, the majority of the known (coastal) Aboriginal archaeological sites date to within the last 1,000 years. However, several hinterland sites (rock shelters with intact well preserved cultural deposits) have revealed basal dates for Aboriginal occupation approaching 4,000 years BP.

A highly significant Aboriginal cultural heritage site has been recorded at Sandfly Creek (on the Cleveland Bay coastline to the south of Ross River). Archaeologists first recorded the Sandfly Creek Aboriginal burial ground in the early 1990's. Hatte (1994) recorded at least ten human burials eroding from secondary sand dunes along an old Holocene shoreline south of Ross River. The burials were associated with other cultural material including shell, stone artefacts, stone manuports and hearthstone. Following Hatte's preliminary study, Bonhomme and Craib (1995) attempted to determine the full extent of the burial site by using ground-penetrating radar to detect possible sub-surface deposits of bone. The results of this latter work proved inconclusive.

In March 2004 a cultural heritage study was carried out at the proposed Happy Valley Reserve for Aboriginal Purposes (Bird, Heijm and Hatte 2004). This Reserve is located some 4 km northwest of Ross Creek and Ross River. Local Aboriginal people have used Happy Valley as a camping place for almost a century (in conjunction with the historical camps at Rowes Bay). Today, at any one time there may be between 30 and 100 people living on the site.

While the cultural heritage survey at Happy Valley did not locate any archaeological evidence for the prehistoric Aboriginal occupation of the area, anthropological research revealed that this location has continuing high socio-cultural significance to local Aboriginal people (Bird, Heijm and Hatte 2004).

The cultural significance of Happy Valley is particularly relevant to the current investigation at POTL, as it highlights that there are enduring (complex and integrated) indigenous cultural values along this sector of the Cleveland Bay coastline (incorporating Ross Creek, Ross River, Rowes Bay, Kissing Point and Cape Pallarenda). Bird and Heijm’s recent (2005) cultural heritage report regarding the Aboriginal cultural heritage values of Kissing Point (Garabarra) provides further confirmation that the Cleveland Bay coastline has an enduring cultural significance to Aboriginal Traditional Owners.

Detailed cultural surveys along the channel of Ross River were carried out in 2003 for the (then) Thuringowa Council’s Riverway Project (Bird 2003a). While the cultural surveys did not locate any tangible Aboriginal archaeological sites on the riverbanks, the Traditional Owners reported that the river maintains a high level of cultural significance to them. While landscape disturbance and modification since European settlement have greatly altered the natural landscape along the river channel, the cultural significance of the river to the Traditional Owners has not diminished (Bird 2003a). Both archaeological and ethnographic records indicate that major watercourses such as Ross River were focal points for Aboriginal subsistence and settlement, in the immediate post-contact and settlement period. In pre-contact times there is no doubt that Ross River and Ross Creek would have provided a plethora of natural resources, playing an important role in the local Aboriginal economy and subsistence cycles.

In October 1999 Bird undertook cultural surveys for the proposed Townsville Port Access Road

Project (Eastern Transport Corridor) by the Department of Main Roads (Bird 1999). The development corridor traverses Heleen Downs Station (Collinta Holdings) and sections of the east bank of Ross River. Three Aboriginal cultural sites were located, including a low-density shell scatter, a small scatter of stone artefacts and a small cluster of bone (the latter has since been confirmed as macropod bone, rather than human bone). All of the recorded sites were found on the beach ridges on the eastern side of Ross River. The shell scatter contained several shell species including *Telescopium telescopium, Nerita sp., Terebralia sulcata* and *Anadara sp*. Most of the shell was heavily fragmented. A single small flake of milky quartz was associated with the shell, scattered around the base of a large Burdekin plum tree.

Despite a general paucity of Aboriginal cultural remains, there was clear evidence in the form of shell scatters and stone artefacts that Aboriginal people occupied this area. Importantly, the surface archaeological evidence recorded near the mouth of Ross River is similar to the type and density of surface archaeological remains originally discovered at Sandfly Creek. The discovery of the extensive archaeological deposits at Sandfly Creek (including human burials) was made following clear and grade operations in preparation for sand mining. Hatte (1994) notes that the main cultural deposit at Sandfly Creek was buried within the beach ridge system, some 30 to 50 cm below surface level.

During the Port Access Road cultural heritage study, some oral history was recorded from Aboriginal Elders regarding the use and occupation of the coastal plains east and south of the Ross River (Bird 1999). There is surviving oral history to indicate that in post-contact times some Aboriginal camps were located under the large mango trees lining Stuart Creek. Some senior Traditional Owners noted that lagoons and wetlands on the coastal plains south of Ross River once had a plethora of food and other natural resources that were targeted and exploited by Aboriginal people (see also Bird 2006). The east bank of Ross River was reported to be a ‘well known place’ for collecting oysters.

In summary, and to reiterate the results of archaeological research round Townsville, the coast and immediate hinterland were a focus for Aboriginal activity, at least in the late Holocene period (over the last 4,000 years BP). There is increasing archaeological evidence to indicate that Aboriginal people targeted certain landforms for subsistence activities and occupation sites, including coastal beach ridges and sand dunes, major and/or reliable watercourses, and hinterland granitic rock outcrops and shelters. Archaeological research confirms that relict coastal beach ridges commonly contain Aboriginal shell middens, stone artefact scatters, hearth areas and sometimes, human burials. Rock shelters and overhangs often contain rock paintings (usually in red ochre) and cultural deposits (often with human burials). Both major and ephemeral watercourses tend to have archaeological evidence for campsites in the form of hearths and low-density stone artefact scatters. Highly disturbed areas on the Townsville coastal plain have frequently been found to contain very little intact or surviving archaeological evidence for Aboriginal occupation, given the prolonged and intensive European settlement of the region.

3.15.1.3 Site Inspection of the TMPP area

The literature review, provided in detail in Appendix Y and summarised above, highlights the fact that a diversity of Aboriginal archaeological sites has been recorded along the coastal fringes of Cleveland Bay, and in areas surrounding the proposed TMPP in Ross River. At this stage, a systematic archaeological survey of the TMPP area has not been undertaken and

consultation with the Aboriginal Parties has generally indicated that a further cultural field inspection (in addition to the site inspection on 24 July 2008) is not warranted.

The majority of the TMPP development area is sub-tidal, inter-tidal or reclaimed land (Benwell Road beach). Based on the available geomorphological evidence and the history of Townsville Port reclamation works, the coastal beach deposits along this narrow strip of coast can reasonably be expected to be no more than a few decades in age. On this basis, there is no expectation that prehistoric Aboriginal archaeological sites will be located along this section of very recent coastline.

The only possible archaeological potential of the coastal deposits might be for historical archaeological sites. The term 'historical' is used very tentatively in this regard as it would seem unlikely that sites or relics more than a few decades in age will be located within these very recent (reclaimed) deposits.

Cursory inspection of the Benwell Road beach with the Aboriginal Parties on 24 July 2008 revealed that the narrow coastal fringe has dense cover of grasses and coastal dune vegetation such as *Ipomoea pes-caprae* (goat's-foot convolvulus). Vegetation of this area is discussed in greater detail under Section 3.10.4 of this EIS. Even if cultural (surface) surveys were attempted in this area (to assess the possible potential for historical archaeological sites), there is negligible to zero ground surface visibility at the current time. This was confirmed during a further recent site visit to Benwell Road beach by the project archaeologist on 23 January 2009.

The predicted cultural heritage and archaeological potential of the TMPP is further considered in the section below. It must be noted that based on the available geomorphological, historical and environmental evidence the project archaeologist has assessed the overall prehistoric archaeological potential of the development areas as negligible (with the exception of the east bank of Ross River in areas above highest astronomic tide [HAT]).

While the potential for historical archaeological sites in the development areas might also be reasonably assessed as low, the issue of cultural monitoring for existing land areas (Benwell Road beach and east bank of Ross River) during development works is considered below.

3.15.1.4 Aboriginal cultural values of the TMPP

Identified Aboriginal Cultural Values

This cultural heritage study has provided clear evidence that the Cleveland Bay coastline, including the TMPP project area at Ross River, have significant Aboriginal cultural heritage values. This evidence comes from various sources including ethnography, ethnohistory, anthropology, oral history, the (surrounding) Aboriginal archaeological record, and most importantly, from the Aboriginal Traditional Owners themselves.

This cultural heritage investigation has found that the enduring Aboriginal cultural heritage values of the TMPP area are as follows:-

- The TMPP project site is part of Gurambilbarra traditional homelands. Both the land and sea country in the project areas remain significant components of the Aboriginal cultural landscape of the greater Townsville region. The Traditional Owners (Aboriginal Parties) retain an enduring 'connection to country'. They describe the project area as having immeasurable cultural and spiritual values. Their 'connection to country' has not diminished despite the historical dispossession of land and sea country, and despite the dramatic

alterations to the physical configuration and the cultural integrity of the landscape since European settlement;

- Ross River has an Aboriginal language names – “Cal’bee’dee’ra” (Galbidira) (after Price 1885 with phonemic transcriptions by N. Heijm). This language name is in itself of significant heritage value as very few language names survive for local landforms and landmarks in the Townsville region;
- Ross Creek and Ross River are integral components of the local Aboriginal creation story – the Gabul (Carpet Python) myth cycle - which explains the creation (and configuration of the landscape) of the Halifax Bay and Cleveland Bay coastlines;
- The coastal area now occupied by POTL (including Ross Creek, Ross River and what was once part of Ross Island) was used traditionally for fishing, foraging, camping and for other cultural purposes. There is some evidence to indicate that it was a popular meeting place for large gatherings of Aboriginal people and that corroborees were sometimes held in this area. It formed an integral part of a large foraging and living area on the Cleveland Bay coastline that included Cape Pallarenda, Rowes Bay, the Town Common, Ross River channel and Magnetic Island;
- Land areas adjacent to and surrounding the Cleveland Bay coastline, including POTL lands, contain tangible archaeological evidence for the Aboriginal use and occupation of this landscape, in the form of shell middens, stone artefacts, scarred trees, rock shelters with paintings, ceremonial sites and burial places (eg: Sandfly Creek Aboriginal burial ground south of Ross River). It is reasonable to assume that much archaeological evidence has been obliterated by the prolonged European settlement and alteration of this landscape (especially along the coastal fringe) and that many more archaeological sites once existed along the shores of the bay;
- Current archaeological evidence indicates that Aboriginal people occupied the Cleveland Bay coastline in the late Holocene period (over at least the last 4,000 years BP);
- Ross Creek, Ross River and Ross Island represented one of the historical frontiers between European and Aboriginal societies in the first decades of Townsville’s existence. The picture that emerges from the historical record is that Aboriginal people continued to occupy this area for many decades following the European settlement and occupation of Townsville; and
- Parts of the TMPP area (Benwell Road beach) are visited by Traditional Owners and local Aboriginal people, mainly for the purposes of fishing, yabbying, collecting shellfish and other recreational activities.

Feedback from Endorsed Aboriginal Parties

Feedback from Aboriginal Parties regarding the TMPP was compiled during the various project meetings between July and September 2008, including the site inspection on 24 July 2008. A summary of the main discussion points, concerns and issues relative to cultural heritage and other matters is presented in Appendix Y. Matters of concern included:

- Aboriginal cultural values of the project area;
- Potential impacts to flora and fauna;
- Social impacts and the impact assessment process;

- Contemporary use by Traditional Owners of Benwell Beach Road;
- Recognition and acknowledgement of Traditional Owners; and
- Archaeological potential of sub-tidal areas.

This feedback has supported development of the potential impacts and mitigation measures in the following Section.

3.15.1.5 The European cultural landscape

To complement the Indigenous Cultural Heritage studies conducted for this project, similar studies examining potential for impacting European Cultural Heritage as a result of the TMPP have been undertaken. The detailed studies are also reported under Appendix Y.

An examination of the history of the area associated with the TMPP has identified two distinct locales within the current study area of importance from a European heritage perspective. The Port of Townsville and the suburb of South Townsville have inter-related but differing histories that have influenced their development and are discernible in their contemporary built environment and cultural landscape.

The suburb of South Townsville has a mature heritage environment, which is recognised by the listing of places on the QHR and the Townsville Local Heritage Database. This suburb has been surveyed as part of the creation of the (former) Townsville City Council's Local Heritage Database, a 1993 Urban Conservation Study undertaken by Woods Bagot Pty Ltd, and for register entries on the local heritage database and the Queensland Heritage Register.

This previous study means the suburb's heritage values and places are well known allowing the assessment of potential impacts and the recommendation of management practices designed to mitigate any potential impacts.

Searches of the relevant Commonwealth, State and local heritage registers for these key locales indicates there are nine places of heritage significance within the current study area. One of these places appears only on the Queensland Heritage Register (QHR), a further seven appear only on the Townsville City Council's Local heritage Database, and one place, the Victoria Park Hotel, appears on both registers. There are currently no places in the study area that appear on any Commonwealth registers.

A field survey confirmed the location and condition of each of the nine places of heritage significance and included a visual assessment of the proximity of each place to the Precinct.

The TMPP will take place entirely on reclaimed inter-tidal land and the site survey confirmed that there are no places of heritage significance in the footprint of the TMPP. The survey also confirmed that currently there are no places of potential heritage significance that are likely to be affected directly or by the project. Additionally, archival research undertaken as part of this study did not reveal any evidence that would suggest a high probability for the discovery of items of historic cultural significance during the reclamation works for this project.

Although direct impacts are unlikely there is potential for indirect impacts to identified places of European cultural importance. This is discussed further below.

3.15.2 Overview of potential impacts and mitigation measures

This defines and describes the objectives for protecting or enhancing cultural heritage environmental values, describes how nominated quantitative standards and indicators may be achieved for cultural heritage management, and how the achievement of the objectives will be monitored, audited and managed.

The environmental harm to Indigenous cultural heritage values in the vicinity of the project is to be managed under the cultural heritage management plan (CHMP) developed specifically for the project. The CHMP provides a process for the management of cultural heritage places both identified and sub-surface at the project sites. The development of the CHMP has been negotiated with all stakeholder representatives.

3.15.2.1 Assessment of potential Indigenous cultural heritage impacts

This cultural heritage investigation has provided clear evidence that the proposed TMPP at Ross River is located within a broad cultural landscape that retains significant Aboriginal heritage values. As assessment of the potential impacts of the proposed TMPP on these identified cultural heritage values is outlined below. The assessment of impacts is based on two main criteria: i) potential impacts to Aboriginal cultural values, and ii) potential impacts to the Aboriginal archaeological record.

3.15.2.2 Impacts to Aboriginal cultural values

All development projects along the Cleveland Bay coastline have the potential to negatively impact on the Aboriginal cultural heritage values of this significant cultural landscape. Consultation with Traditional Owner representatives during the course of this investigation has generally indicated that they have no major cultural heritage objections to the TMPP, and on this basis they have entered into discussions and a CHMP agreement with POTL. This is despite the fact that this project will significantly alter the current configuration of the coastline with reclamation of land and the possible construction of an additional breakwater.

The Traditional Owners generally feel that the current project will have no greater impact on cultural values than the many previous development projects which have resulted in dramatic alterations to the original configuration of the coastline and waterways of Cleveland Bay. As previously noted, reclamation and construction works for the Port have been undertaken periodically since the European settlement of Townsville in the 1860's (Taylor 1980). In more recent times major development works have been undertaken for the Strand redevelopment, construction of the Casino Complex and Townsville Entertainment Centre, existing marinas and breakwaters. Despite these many developments and alterations to the landscape, Aboriginal people maintain their 'connection to country'.

In short, while alterations to the environment in the further development of the Port of Townsville will impact Traditional Owner cultural values, Cleveland Bay, the Townsville coastline and major waterways such as Ross Creek and Ross River will nevertheless continue to be fundamental and significant places in their culture.

Throughout this investigation the Traditional Owners have reiterated that they maintain an active interest in 'caring for country'. On this basis, they wish to take an active role in managing the cultural heritage and environmental values of the project areas, via ongoing discussions with POTL and the existing CHMP.

3.15.2.3 Impacts to the Aboriginal archaeological record

The potential for locating intact prehistoric Aboriginal archaeological sites and materials is assessed as very low to negligible for the TMPP. The reasons for this assessment are outlined in detail in Appendix Y Any land areas with some predicted residual archaeological potential (for historical and/or prehistorical archaeological sites and/or values) are also considered and discussed (eg: Benwell Road Beach and the east bank of Ross River).

The archaeological potential of sub-tidal areas in Cleveland Bay can reasonably be assessed as very low to negligible on the basis of many factors, but primarily the prolonged history of major taphonomic disturbance and alteration to the seabed and watercourses, mainly as a result of dredging. This report has considered the long-term impacts of dredging at the mouth of Ross River and Ross Creek at Townsville Port (Pringle 1989). Over more than 100 years regular dredging has taken place at the Port to maintain navigable channels at Ross River and Ross Creek. The end result of the long-term dredging operations is that intact sub-tidal coastal deposits simply do not exist within the TMPP area.

Given the long history of dredging at the Port and the fact that maintenance and capital dredging works are still carried out by POTL on a periodic basis, the age of sediments in the upper layers of sub-tidal areas at Ross River and Ross Creek are relatively recent. Based on information provided by POTL and discussed at the project meeting on 24 July 2008, the age range of the upper layers of sub-tidal sediments (from maintenance and capital dredging works) for the TMPP are estimated at between 2 to 30 years old. If any prehistoric Aboriginal archaeological sites were once located in sub-tidal deposits in the TMPP area then it must be concluded that these would have long been obliterated by the prolonged and repeated dredging in this section of Cleveland Bay.

Some Traditional Owners have raised the issue of the archaeological remains (Aboriginal stone artefacts) found at the Nelly Bay Harbour development site on Magnetic Island and the possibility for similar archaeological finds within the TMPP area (cf. Gorecki and Greer 1988; Mardaga-Campbell, Greer and Hatte 1989; Northern Archaeology Consultancies 2002). From an archaeological perspective there is very little similarity between the two locations, and particularly their archaeological and geomorphological contexts. The stone artefacts at Nelly Bay were discovered on an old emerged intertidal reef flat, probably dating to 5 or 6,000 years ago. At the POTL project sites there are no emerged intertidal reefs and the project sites consist of sub-tidal and/or reclaimed lands (with the exception of the east bank of Ross River).

Many areas along the Cleveland Bay coastline that were inhabited by Aboriginal people no longer exist as a result of modern development and landscape modification. For example, from the ethnographic record we know that sizeable camps of Aboriginal people resided at Murder Island and Magazine Island. These areas were obliterated for ensuing developments, no doubt along with their prehistoric archaeological record. It is well documented that granite from Magazine Island was used as fill in reclamation works and for construction of major Port developments including breakwaters, jetties and bridges (Taylor 1980). Where archaeological evidence does survive on the coastal fringe it is often located in the more outlying (and less

disturbed) areas of Townsville (eg: Sandfly Creek burial ground to the south of Ross River).

In addition to the long history of human impacts to the landscape and seascape of the TMPP this coastline has also been subject to periodic cyclonic events. Pringle (1989) and Taylor (1980) have described major erosion and deposition of sediments as a result of cyclones and storm surge at the mouths of Ross Creek and Ross River in the recent past. Cyclones have the potential to alter the configuration of the coastline and its archaeological record as demonstrated by Bird (1992) at Wunjunga in the Lower Burdekin region. Some 50% of coastal shell middens recorded in 1987 were obliterated by cyclonic storm surge in 1989 and 1992 as a result of cyclones Charlie and Aivu. The configuration of the coastline was dramatically altered by a major breach in coastal dunes as a result of the combination of storm surge and inland flooding pushing through a narrow weakened section of sandy coastline. It is reasonable to suspect that erosion and deposition of sediments as a result of past cyclones have had some impact on the archaeological record along the Cleveland Bay coastline and the TMPP area.

This cultural heritage investigation suggests that there are two areas associated with the TMPP where there may be some level of (residual) archaeological and cultural heritage potential.

The first area to be considered is the east bank of the Ross River. Potential impacts to the coastal margins on the east bank may occur if a breakwater is constructed as part of this project. Previous archaeological surveys of the east bank of the river for the Townsville Port Access Road project (Bird 1999) have located low-density Aboriginal archaeological sites such as shell middens and stone artefacts within the dune complexes on this eastern side of the Ross River. There is a high level of cultural sensitivity from the point of view of the Traditional Owners in this relatively undisturbed area of dunes and old beach ridges, given their contextual similarity and geographical proximity to the beach ridges at the Sandfly Creek Aboriginal burial ground.

Non-indigenous cultural sites including a concrete bunker dating to World War 2 and the remains of a 1930's Townsville City Council sewage plant (concrete tanks and other structures) are also located on the east bank of Ross River (see Appendix Y and Bird 1999 for a detailed discussion on the cultural finds on the eastern bank).

The Main Roads development corridor on the east bank for the Townsville Port Access Road is to be subject to a stringent cultural monitoring program during development works (as per an existing [2005] CHMP between Department of Main Roads and the Bindal and Wulgurukaba peoples). On that basis, any proposed work by POTL on the east bank of Ross River would therefore be expected to be subject to cultural monitoring. It is noted that at this stage, the potential impacts to the east bank as a result of the TMPP have yet to be fully determined, pending ongoing assessment of the various proposed breakwater options. A cultural monitoring program for any proposed works above highest astronomic tide (HAT) on the east bank would ensure that any unrecorded cultural sites or values could be identified, documented and managed appropriately during the course of the development project (see Recommendations below).

The second area to be considered for potential cultural heritage impacts is the coastal strip at Benwell Road beach. As previously noted in this report the prehistoric archaeological potential of this area is assessed as negligible, based on the fact that the beach is reclaimed land that is only a few decades old. There is some potential that historical archaeological sites or relics (Aboriginal and/or non-indigenous) might be located in these coastal deposits, but again the

point is emphasized that the term ‘historical’ is used tentatively in this context, given the maximum age of this coastal strip.

Quite apart from the project archaeologist’s assessment of cultural heritage potential, the Traditional Owners have indicated that they feel that cultural monitoring of the Benwell Road beach area is warranted for development works in this area. The Traditional Owners feel that there is some potential for historical ‘Murri’ camps to be located in this area.

The request for cultural monitoring by Traditional Owners along this section of coast (on the margins of Ross River) goes more to the issue of acknowledging the enduring and immeasurable Aboriginal cultural values of this area and its cultural sensitivity, than to addressing issues of ‘archaeological potential’. That is, the request for cultural monitoring is more about addressing intangible cultural values and ‘caring for country’ than it is about management of the archaeological record. An Elder from the Aboriginal Parties made some important comments during the consultation process to sum up the Traditional Owners point of view regarding the need for cultural monitoring along Benwell Road beach, regardless of the archaeological assessment of this area.

“Townsville Port has had this land for many years; they have been using and changing this land since white people came; we have been locked out of this land; land that our ancestors owned and lived on; the sites left by our old people, middens and such, are gone now. We need to monitor the land to make sure there are no sites there and so we can still care for our country”.

It is noted that the Department of Main Roads has advised that the Benwell Road beach and adjacent area is planned for resumption as part of the Townsville Port Access Road (Eastern Access Corridor) project. On that basis, there is a possibility that Main Roads will resume this land and begin to develop it for the road corridor, prior to any development works by POTL. Main Roads is addressing their cultural heritage duty of care in this regard via separate discussions with Aboriginal Parties (ongoing at the time of writing) and as part of an existing CHMP between Main Roads and the Bindal and Wulgurukaba peoples.

Since relative sea level stabilization some 6,000 years ago there is no doubt that Aboriginal people occupied and utilised the coastal fringes of Cleveland Bay, including the Ross Creek and Ross River project areas. As already noted, the inherent difficulty in locating traces of this early occupation along the present shoreline is the high degree of disturbance which has occurred from both modern developments (over the past 150 years), and ongoing natural geomorphic processes. Areas we know to have been frequented by Aboriginal people, at least in the early settlement period, were the immediate coastal fringe, the mouth of watercourses and associated sand bars, mangrove forests, sand dunes and beach ridges. All of these areas have been subject to dramatic change over time.

In conclusion, from an archaeological perspective it is predicted that it is highly unlikely that the proposed TMPP will have any major detrimental impacts to the prehistoric and historic Aboriginal archaeological record of Cleveland Bay (either along the coastal fringe and foreshore, or within the sub-tidal marine zone).

3.15.3 Project recommendations – Indigenous cultural heritage

The following Recommendations are made as a result of the Indigenous cultural heritage investigations for the TMPP (and Port Expansion projects).

These Recommendations are made following consultation with the Aboriginal Parties and as a means to address cultural heritage management issues for the proposed projects. It is noted that some of the listed recommendations have been addressed as per the existing (September 2008) project CHMP (as indicated below where appropriate).

[Postscript 18 March 2009: These recommendations were discussed and amended at a meeting between POTL and the Aboriginal Parties on 17 March 2009. Postscripts are added below where appropriate. Amended recommendations have been added to the project CHMP as Schedule 1].

Recommendation 1

It is recommended that a cultural monitoring program be implemented by POTL for any proposed extractive works to impact the east bank of Ross River above highest astronomic tide (HAT) as part of the Marine Precinct project.

At this time the potential impacts, if any, to the east bank of Ross River are not fully known as a result of the ongoing EIS investigations regarding proposed breakwater design and construction options for the Marine Precinct project.

The Aboriginal Parties request that POTL inform them of the outcomes of the ongoing EIS studies and the final project decision and recommendations regarding breakwater construction design and options.

It is recommended that there be further discussions between POTL and the Aboriginal Parties as a means to agree on and confirm the timing, duration, number of personnel, logistical and other arrangements for a cultural monitoring program for any extractive works to be undertaken above HAT on the east bank of Ross River.

[Postscript 18 March 2009: Updated information was provided by POTL relative to a new proposed breakwater option for the Marine Precinct project. It is noted at this time that no works are proposed for the east bank of Ross River and that the current proposed breakwater (as at 18 March 2009) is intended to be generally as shown in Figure 2-2 of this report). See also Schedule 1 of the project CHMP.]

Recommendation 2

The Aboriginal Parties request that a cultural monitoring program be implemented by POTL for any proposed development works to impact the Benwell Road beach (Lot 773) as part of the Marine Precinct project.

Considering the history of extensive reclamation of this area, it is recommended that there be further discussions between POTL and the Aboriginal Parties regarding any requirement for cultural monitoring at Lot 773.

[As already noted, it is possible that Main Roads will resume part of Benwell Road beach for the construction of the Townsville Port Access Road (Eastern Access Corridor) prior to the Marine Precinct project. In this case, the issue of cultural monitoring for this parcel of land will not be

the responsibility of POTL. The duty of care to address cultural heritage management issues for the development of this land will pass to the landholder/developer, which in this case will be Department of Main Roads].

[Postscript 18 March 2009: Recommendation 2 amended and agreed upon as follows as per Schedule 1 of the project CHMP:-

"That a cultural monitoring program be implemented by POTL for any proposed extractive works to impact the Benwell Road beach above highest astronomic tide (HAT) as part of the Marine Precinct project. Provided that if monitoring occurs pursuant to a cultural heritage management plan prepared by Main Roads for the same area, monitoring under the POTL CHMP need not occur".]

Recommendation 3

Recommendation 3 refers to an adjacent project and is, accordingly, not reproduced here.

Recommendation 4

In the event that any Aboriginal cultural heritage sites, materials or values are discovered during development operations in the POTL project areas, the following recommendation should apply:-

All development work and other activities at that location should cease, pending a thorough inspection of the find/s by representatives of the Aboriginal Parties. Optimally, the finds should be demarcated and protected from any potential impacts with pegs, flagging tape and/or other appropriate temporary barriers with a reasonable buffer area around them (the 'reasonable' buffer zone to be determined by the Site Supervisor or other appropriate on-site personnel). Development work can continue outside the demarcated buffer zone. Following their assessment of the find/s, the Aboriginal Parties will provide advice on appropriate management action. Depending on the cultural significance of the find/s, the Aboriginal Parties and/or the development proponent may wish to seek independent technical advice from the project archaeologist and/or the Cultural Heritage Coordination Unit, Department of Natural Resources and Water. Development work at the location of the finds should not recommence until appropriate cultural heritage management action has been implemented to the satisfaction of all stakeholders (Refer CHMP, Section 3.7 and Schedule 1).

Recommendation 5

In the unlikely event that human skeletal material is discovered during development works, it is recommended that all development operations cease immediately within 100 m of the remains. Optimally, the finds should be demarcated and protected from any potential impacts with pegs, flagging tape and/or other appropriate temporary barriers. The Queensland Police, Cultural Heritage Coordination Unit of the Department of Natural Resources and Water, as well as Aboriginal Traditional Owner representatives should be contacted as a matter of urgency. Currently, the Queensland Police, Department of Natural Resources and Water and Aboriginal Traditional Owner groups have established policy and procedures to ensure that confirmed indigenous burials are treated in a manner consistent with Aboriginal traditions. Minimal disturbance to the remains should be a priority, and advice should be sought from Aboriginal Elders on ways to deal with the material in a culturally appropriate and sensitive manner. A copy of the Department of Natural Resources and Water 'Burial Policy' is available from NRW and/or

the project archaeologist (Refer CHMP, Section 3.8 and Schedule 1).

Recommendation 6

Personnel and contractors involved in the development project should undertake a cultural heritage induction prior to commencement of development operations. Workers must be provided with information on the types of Aboriginal cultural heritage sites likely to be found in the project area, along with specific guidelines to follow in the event of the discovery of cultural finds, or suspected cultural finds. Workers should be made aware of the provisions of the Aboriginal Cultural Heritage Act 2003 and in particular, the 'Duty of Care Guidelines' under this legislation (Refer CHMP, Section 3.6 and Schedule 1).

Recommendation 7

During the course of this cultural heritage study the Traditional Owners have raised some concerns regarding environmental aspects relating to the proposed development project (such as potential impacts to sea grass beds, fish habitat, water quality, pollution, dugong and turtle populations in Cleveland Bay, etc). On this basis, the Traditional Owners request that they have the opportunity to review and provide feedback on expert environmental reports compiled as part of the EIS process.

[Postscript 18 March 2009: Recommendation 7 amended and agreed upon as follows as per Schedule 1 of the project CHMP:-

"POTL shall provide each of the Endorsed Parties with a CD copy of the Environmental Impact Statement (EIS) once it goes on public display. On each occasion that the Port meets with the Endorsed Parties, the Port shall provide an update on issues arising out of the EIS. The Port shall continue to provide to the Endorsed Parties Fact Sheets and newsletters on progress of the EIS".]

Recommendation 8

The Traditional Owners request that POTL acknowledge and recognise the Aboriginal history, use and occupation of the Ross River and Ross Creek project areas via story boards, interpretive signage, naming of Port precincts and/or street names, or other appropriate means as agreed upon by the Parties, as part of the Marine Precinct and Port Expansion projects (Refer CHMP, Section 4 and Schedule 1).

Recommendation 9

Once endorsed by the Aboriginal Parties and POTL it is recommended that the above-listed recommendations are incorporated into the existing (September 2008) Cultural Heritage Management Plan for the Marine Precinct and Port Expansion projects, in the form of an appropriate Schedule or Addendum (see Schedule 1 of CHMP, dated 17 March 2009).

3.15.3.1 Assessment of potential European cultural heritage impacts

Potential direct impacts

The proposed project will be constructed entirely on reclaimed seabed where there are no identified places or items of European cultural heritage significance. As a result there are no known places or items of European heritage significance that will be directly impacted by the project. However, should an item of potential heritage significance be discovered during the

construction phase of the project, work around the item should cease and an appropriately qualified heritage assessor should be contacted to provide an assessment on its significance and appropriate management measures.

Potential indirect impacts

Research and surveys undertaken to complete the European cultural heritage study indicated there are nine places of heritage significance in the study area that are adjacent to the proposed TMPP. These included the following locations:

- St John's Anglican Church Precinct;
- Victoria Park Hotel;
- St Patrick's Church;
- Souths Football Clubhouse;
- 265 Boundary Street – example of historical residential building type;
- 1 Hubert Street – example of historical residential building type;
- 25 Hubert Street – example of historical residential building type;
- 64 Allen Street – example of historical residential building type; and
- 77 Allen Street – example of historical building approach.

These places may be indirectly impacted by the project. Possible indirect impacts have the potential to affect the contributory nature of the environmental setting of places and the contribution this setting makes to their heritage significance. These potential impacts may include:

- Destruction or disturbance of an element of cultural heritage;
- Impact on its settings through inappropriate siting or design;
- Introduction of new environmental inputs such as noise or pollution;
- Potential damage to the physical fabric of historic buildings or historic landscapes; and/or
- Changes to the visual amenity of the place.

Importantly indirect impacts also have the potential to enhance a place's heritage significance through the restoration of a historical vista, removal of unsympathetic buildings or other built elements, and/or the re-instigation of a significant historical or community practice.

Potential indirect impacts to the heritage significance of places in the study area or to the historic themes associated with the project area that may occur during the construction and operation phases were identified and assessed. These are detailed in Appendix Y. All potential impacts were rated as highly unlikely to occur.

Although it is highly unlikely that the heritage values of places or areas within the current study area will be adversely affected by the TMPP, the study reinforced the need to adopt the mitigation measures proposed under the relevant sections of this report to mitigate against increased traffic, alteration of the visual amenity of the environment and increased noise potential associated with the construction and operation of the Precinct.

A potential enhance of the local areas heritage values may stem from potential increased patronage of the Victoria Park Hotel resulting from an increased demand on existing public services. Otherwise, there are not predicted to be any detractive indirect impacts to European cultural heritage values of areas adjacent to the TMPP area and, accordingly, no recommendations are proposed.

3.16 Health and safety

3.16.1 Description of environmental values

The main community values for public health and safety that may be affected by the construction, operations and decommissioning of the TMPP are air quality and noise levels. The Environmental Protection Policy (Air) and Environmental Protection Policy (Noise) goals are described separately in this EIS under Air Quality and Noise sections (refer 3.11 and 3.13).

The health and safety aspects of the dredging, and construction of a reclamation bund, operations at the Precinct and decommissioning include the following:

- Air environment:
  - Qualities of the air environment that are conducive to human health and well being;
  - Qualities of the air environment that are conducive to protecting agricultural use of the environment; and
  - Dust and odour.
- Noise environment:
  - Qualities of the acoustic environment that are conducive to human health and wellbeing, including ensuring a suitable acoustic environment for individuals to sleep, study or learn or be involved in recreation, including relaxation and conversation
  - Qualities of the acoustic environment that are conducive to protecting the amenity of the community.

Data recorded by Port of Townsville indicated that there were no events during the 2005/06, 2006/07 and the 2007/08 periods where PM_{10} exceeded the old EPP (Air) goal (up to end of 2008) of 150$\mu g/m^3$ as a 24-hour average. DERM annual reporting for 2007 states, carbon monoxide (CO) and lead levels are reasonably expected to be consistently below the relevant NEPM standard. Similarly, nitrogen dioxide levels are expected to be consistently below 40 percent of the NEPM standards. The 1-hour sulphur dioxide statistics at and above the 90th percentile at both Pimlico and Stuart are lower than for all other regions in Townsville. The 1-hour and 4-hour NEPM standards for ozone were always met. Further details are provided in the Section 3.11 of this EIS.

During the Precinct operations, the average sound level experienced at nearby residence is expected to be around 46 dB (A) under worst case conditions. This is similar to existing noise levels in the area and it is expected that further noise attenuation will likely occur. Further details are provided in the Section 3.12 of this EIS.

Mosquito and biting midge have public health implications. The location of the TMPP, within the coastal environs, will bring humans in close contact these biting insects. Mosquitos are known carriers of malaria, dengue fever, Ross River virus, Barmah Forest virus, Japanese encephalitis

and Murray Valley encephalitis. Polluted waters, freshwater swamps, brackish waters, construction sites, water storage tanks and drains are breeding sites for mosquitos. Mosquito life cycle depends on environmental factors such as temperature and humidity. Townsville area has saltmarsh mosquitoes (*Aedes vigilax, Culex sitiens, Verrallina funerea*) dengue fever (*Aedes aegypti*) and freshwater mosquitoes (*Aedes aegypti, Aedes notoscriptus, Culex annulirostris, Verrallina funereal, Aedes vittiger, Aedes alternans and Mansonsia uniformis*).

Biting midge do not currently transmit human disease in Australia but can be a severe pest if adult midges are in abundance. Impact on humans is primarily due to irritation and skin reaction from bites. Blisters and weeping serum may occur from the site of bite. Biting midge are attracted to human settlement and are found resting on screens, fences and vegetation. They are active during dull still days with high humidity.

3.16.2 Potential impacts and mitigation measures

3.16.2.1 Potential Impacts on Workforce

A total of approximately 200 workers will be employed during the construction phase of the Project. The potential number of workers likely to be present during operational phases is estimated at approximately 550 (both direct and local flow-on). Flow on effects will, however, be largely dependent on the types of business and industry which locate within the TMPP. Potential safety hazards associated with construction and operation activities include drowning when working over water on barge or vessel, injury or fatality while handling dangerous goods, suffocation during working in confined space, electrocution and injury to self or others while undertaking lifting activities. Table 3-70 outlines potential health and safety hazards to personnel on site during the construction and operation of the Precinct. To increase site safety and to assist in preventing injuries during construction or operation phase it is recommended that persons on site wear appropriate Personal Protective Equipment (PPE) such as hard hat, safety glasses, steel capped boots, high visibility vests, ear protection, dust masks or any other specific PPE as required.

Details of wastewater treatment and reuse are not known at this stage. However, water recycling measures are being considered by the POTL within the Precinct. Individual facilities within the Precinct will also be encouraged to adopt the water recycling measures. The project area is likely to have breeding sites for mosquito and bitting midge. The recreational, commercial and industrial development is expected to expose a number of people including workers to mosquitos and bitting midges.

3.16.2.2 Impacts on Community

Air Quality Impacts

Dust is the predominant health and safety issue for communities during construction as well as operations. Odour has been considered and is likely to be well below levels of concern.

Dust impacts to the community during construction of the reclamation area are unlikely to be substantial due to separation distances and the moist nature of the dredged material being used to reclaim.

Dust emissions from construction and operation can be managed to ensure that adverse impacts do not occur at sensitive locations offsite. Mitigation measures for dust during

construction and operations are outlined in the Section 8. Air dispersion modelling for PM_{10} dust concentration show that, using appropriate mitigation measures for construction, dust concentrations in the suburban area to the south are always below 50 $\mu g/m^3$ at distances greater than 250 m from the construction activity. The dust deposition, expressed as annual average g/m^2/month, shows a similar pattern with all areas beyond 150 m being below the recognised critical level (2 g/m^2/mth annualised = 24 g/m^2/year) for nuisance dust complaints.

Noise Level Impacts

Modelling of noise generation associated with construction activities under a scenario of no noise barriers or acoustic shielding in place and with each plant item operating at full power was shows that anticipated noise levels compare to existing daytime ambient noise levels for all plant activity except pile driving. Hence, the predicted noise levels are considered to be acceptable. In general the quietest equipment will be used in conjunction with appropriate management measures. Noise mitigation strategies will be considered and implemented during evenings and night time work periods. AS 2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites” will be applied where possible.

Operational noise will largely be dependent on the types of business and industry that will locate within the TMPP. It is unknown at this stage the exact occupant details of the Precinct, however, it is expected that these will include industrial activities such as boat building, abrasive blasting, surface coating, workshops, storage of goods, and packaging, all of which are likely to operate within sheds. Other noise generating activities associated with this will include trucks and forklifts, trawlers and boats. Received noise produced by anticipated activities, during operation with no noise barriers or acoustic shielding in place and with each plant item operating at full power have been calculated. During the Precinct operations, the average sound level experienced at nearby residence is expected to be around 46 dB (A) under worst case conditions. This is similar to existing noise levels in the area and equal to the project specific noise criteria.

It is expected that noise attenuation will likely occur due to activities being located inside buildings, the blocking of noise sources from site receivers due to adjacent buildings, walls and barriers. In addition, the location of the Precinct, being at a distance of more than 350 m from the nearest sensitive receivers, further mitigates the potential for impact.

Mosquito and Biting Midge

Activities associated with the development and operation of the TMPP are likely to result in the creation of breeding sites for mosquito and biting midge. However, POTL and individual facilities will have to ensure that it does not enhance mosquito breeding and disease transmission.

Populated areas, which are in the path of the dominant prevailing wind from mosquito and biting midge breeding sites, may be regularly affected by biting insects that are carried by wind. The range could be from few metres to few kilometres depending on the climatic conditions and type of mosquito species.

Table 3-70 Qualitative Summary of Hazards, Consequences and Mitigation Measures

Activity	Hazard	Consequence	Mitigation Measures
Construction dust	Struck by wind blown particles, (i.e. from unloading trucks, traffic)	Injury to personnel, environment impact	HSE awareness, JSA, competent workers, dust suppression, PPE (eye protection must be worn at all times when onsite - signage), watering of roads
Construction works	Noise - excessively noisy Plant and equipment	Injury to personnel, damage and Environment damage	Competent workers, HSE awareness, JSA, PPE, in compliance with noise regulations, boundary noise criteria.
Exposure to chemicals/ dangerous goods	Inappropriate handling, leaks, inappropriate storage	Fatality, injury to personnel, time delays.	HAZOP used during design, maintenance to include inspection of storages, pipelines and connections of chemical storages, chemical storages designed in accordance with Australian Standards and *Dangerous Goods Safety Management Regulation 2001*, copies of MSDS at site.
Fitness for work	Drugs, alcohol, fatigue, mental state and stress	Injury to personnel, fatalities, environment damage, equipment damage	Pre-employment screening. Drug and alcohol policy. Fatigue awareness. Induction training
General site work	Poor housekeeping	Slips, trips and falls for persons. Obstruction to vehicle movements	JSAs, HSE awareness, supervisor monitoring, emergency response procedures and services.
Loading and unloading of goods and equipment	Dropped object, slips, trips, falls, moving loads, inappropriate rigging.	Injury to personnel, damage to equipment. time delays	Job Safety Analysis (JSA), safe work instructions, competent and certified personnel, controlled laydown areas, supervision and training.
Manual handling	Ergonomics, inappropriate body position, unstable footing, excessive loads, poor lifting practices.	Injury to personnel, loss of working hours, time delays	Induction to workers and re-training on safe manual handling practices, increase awareness on health and safety issues and first aid training.
Natural events	Lightning, strong winds, flooding	Injury to personnel, equipment damage	Controls as per the ERP, JSAs to specifically consider imminent weather conditions.

Activity	Hazard	Consequence	Mitigation Measures
Pre-inerted vessels, equipment and containers, fumes and vapours from paints.	Asphyxiation, chemical Inhalation, pressure	Injury to personnel, fatality, time delays	JSA, HSE awareness, competent workers, confined space entry procedure.
Security	Unauthorised access	Injury to personnel and environment damage	Security fencing, security personnel, controlled access, perimeter patrols.
Third Party onsite	Third parties are less familiar with site safety and environmental requirements and pose enhanced risk to themselves and others.	Injury to personnel, fatalities, environment damage, equipment damage	Inductions for all contractors and visitors, escort all short term visitors. Site entry procedure
Vehicle traffic on site	Vehicle collision, pedestrian and vehicle collision	Fatality, Injury to personnel, time delays damage to vehicle/ equipment	Vehicle movement plan for the site for construction as well as operation phase, signage, scheduling of larger deliveries. Only certified and authorised drivers on work-site, lower speed limits on site, high visibility clothes.
Working in wet weather	Wet conditions, slips, trips, falls, electrocution.	Injury to personnel, time delays	Proper drainage at the construction working area, proper laying of cables, insulated hooks and stands, earth leakage circuit breaker. Suitable undercover work areas to be provided.
Working in hot conditions	Dehydration, exposure to sun	Heat stress, heat stroke, sun burns, time delays	Health Safety and Environment (HSE) awareness programs, induction to include working in heat, use of PPE, provision of drinking water, JSA
Working with equipment and tools	Faulty tools, defective equipment.	Injury to personnel, damage to equipment. time delays	JSA, training to workers, competent workers, HSE awareness, inspection and maintenance program.
Working at heights on platforms, man boxes, baskets etc	Changes to scaffolding, fall from heights, dropped objects, manual handling, incorrect assembly.	Fatality, injury to personnel, time delays	JSA, training to workers, competent workers, HSE awareness, review of work packages, safe work instructions on use of equipments, procedure for working at height. All scaffolding will be constructed under the supervision of a certified scaffolder.

Activity	Hazard	Consequence	Mitigation Measures
Working in confined spaces	Dropped objects, manual handling issues, restricted access.	Injury to personnel, potentially poor body position, asphyxiation, long term health problems.	JSA, HSE awareness, training to workers, competent workers, confined space procedure, low voltage lights.
Working with compressed air	Hoses become uncoupled, hose burst, inappropriate use of air	Injury to personnel, time delays	JSA, HSE awareness, competent workers, inspection and testing.
Working with electrical	Contact with electricity - general (defective electrical leads, electric leads in contact with metal, electric leads in damp areas, etc.)	Electrocution, time delays	Elevating cables, insulated hooks and stands, earth leakage circuit breaker. Inspection and maintenance program including testing and tagging for all electrical tools/equipment onsite. Use of battery operated tools and low voltage lighting (where practicable).
Mosquito and biting midge	Biting to humans	Fever, fatigue, itching and skin reaction, time delays	Minimise areas of stagnant water or ponding of surface waters. Regular monitoring and control measures at breeding sites.

3.16.2.3 Management Plans

Health and Safety

The management plan for health and safety is summarised as follows:

Health and Safety Management Plan	
Elements	Incidents and hazards in the workplace
Management Objectives	To provide a healthy and safe workplace for employees, clients contractors and visitors.
Performance Criteria	Adhere to applicable Australian and other recognised standards, applicable code of practises and relevant statutory provisions, especially the Dangerous Goods Safety Management Act, 2004 and Workplace Health and Safety Act, 1995 Implementation of Hazard and Operability Study Implementation of Safety Management System. Implementation of Emergency Response Plan. Preparation of JSA's to manage workplace risks.

Implementation Strategy	**Responsibility**
Develop and implement a Hazard and Operability Study (HAZOP) system during detailed design to identify all potential causes of chemical leakage and spillage or hazards to workers and ensure that appropriate protective systems are implemented.	Respective Industries within the Precinct through Design Contractor
Develop and implement a Safety Management System to address hazards associated with construction and operation and specify safe working procedures. Submit the Safety Management System to the Department of Emergency Services CHEM Unit for approval prior to the commencement of construction.	Construction Contractor/ Developers Project Manager
Develop and implement an Emergency Response Plan in conjunction with local authorities and emergency services. Submit the Emergency Response Plan to the Department of Emergency Services CHEM Unit for approval prior to the commencement of construction.	Construction Contractor/ Developers Project Manager
Maintain site security systems.	Construction Contractor/ Developers Project Manager

Ensure contractors working on-site adhere to the Safety Management System and complete JSAs as appropriate.	Construction Contractor/ Developers Project Manager
Provide personnel with training in chemical management and spill response and workplace health and safety.	Construction Contractor/ Developers Project Manager
Provide personnel involved in Emergency Response with appropriate training.	Construction Contractor/ Developers Project Manager

Monitoring	◗ Maintain a training register for all staff and contractors. ◗ Undertake regular monitoring of the performance of staff and contractors in terms of compliance with Safety Management System.
Reporting	◗ Daily or weekly reports (as appropriate) will be completed on-site and reviewed by each Supervisor and / or Superintendent. ◗ Immediately notify Superintendent and DERM in the event of an uncontained spillage. ◗ Report all incidents and investigate. ◗ Incident or non-compliance corrective action shall be closed out by senior management according to an agreed responsibility and timescale. ◗ Workplace Health and Safety representative will be responsible for enforcing all occupational and public health directives and keeping all related records and communications.
Corrective Action	◗ The Construction Manager and the Environmental Representative are to be notified in the event of non-compliance. ◗ Redesign control measure if inadequate. The following constitute incidents or failure to comply with occupational and public health policies: – directives and procedures contained in the site safety system are not being followed; – directives and procedures contained in the site safety system are not being enforced; – site safety system does not encompass all required topics and situations; – high rate of work-related injury and illness; or – the emergency response plan is not prepared or implemented. In the event of an incident or failure to comply, a selection of

	the following actions will be undertaken as appropriate: – investigate why the incident occurred and investigate and implement mitigating measures; – ensure safety information provided is adequate and up-to-date and revise regularly as – appropriate; – ensure employees, contractors and visitors to the site are familiar with the procedures and – policies relevant to their positions; – ensure safety directives and procedures are enforced; and ensure safety documents are readily available to everyone on the site.

Mosquito and Biting Midge Management Plan

The Local Government Association of Queensland has produced a Mosquito Management Code of Practice (LGAQ 2002) which contains detailed advice to be followed for the control of mosquitos in Queensland. It is necessary that this is followed by POTL and the facilities that will be housed within this Precinct. Queensland Health (2002) has published guidelines to minimise mosquito and bitting midge problems in new development areas. This document provided advice on how to prevent or minimise the impact of mosquitoes and other biting insects in new development areas. Water storage tanks must be constructed and installed in accordance with Division 2, Part 1A, Public Health Regulation 2005.

During the operational phase of the TMPP, the following should be considered:

- If POTL or Occupiers of the Precinct use recycled water for irrigation, surface ponding must be prevented by appropriate irrigation scheduling;
- Regular maintenance of all structures associated with storage or treatment of recycled water is necessary to minimise mosquito breeding. This will include clearing of water plants from the edges of the storage to reduce habitat for larvae;
- Open water recycled storages must be monitored regularly to identify presence of mosquito larvae; and
- If a potential health risk from mosquito breeding is identified, biological control using natural predations such as aquatic invertebrates or known fish that prey upon the larvae should be introduced.

The Management Plan for mosquito and biting midge is summarised as follows:

Mosquito/Biting Midge Management Plan	
Elements	Incidents and hazards due to mosquito and biting midges
Management Objectives	Policy: To prevent the occurrence of potential mosquito/biting midge breeding sites and the presence of adult mosquitoes/ biting midge.

Performance Criteria	The number of potential mosquito/biting midge breeding sites created on-site is to be minimised by preventing water from ponding.

Implementation Strategy	**Responsibility**
Depressions in the ground surface will be filled to prevent the ponding of water. Pools of stagnant water will be drained and/or the areas filled.	Construction Contractor/ Developers Project Manager
Storage containers capable of ponding water will be either discarded after use or stored in an inverted position (care will be taken to ensure that ponding does not occur in rubbish storage areas)	Construction Contractor/ Developers Project Manager
Avoid creation of continuous belt of dense foliage trees as a part of landscaping. Ensure removal and replacement of vegetation conforms to policies set by different government department.	Design Contractor/ Developers Project Manager
All ponds and on-site excavations filled with water will be inspected for the presence of mosquito larvae on a weekly basis by the Environmental Representative	Construction Contractor/ Developers Project Manager
Erosion and washdown practices will be controlled to prevent sediment and debris forming standing water pools in natural water courses adjacent to the site. Mosquitoes will not breed in flowing water	Construction Contractor/ Developers Project Manager
If larvae are detected in large numbers, contact Queensland Health for assistance in choosing a suitable treatment method. Treatment could either be aerial, ground or adulticiding (fogging).	Construction Contractor/ Developers Project Manager

Monitoring	The Environmental Representative will inspect any potential mosquito breeding areas following rain to monitor the presence of mosquito larvae. The representative will also monitor the frequency of mosquito bites on the site to identify where mitigation measures are not currently successful and to see whether adult eradication programs should be implemented. The Environmental Representative will inspect any potential biting Midges breeding sites including boulder covered foreshores where boulders lie on a mud-sand-shell base and wave action is moderate in a band near high tide levels, clean sandy sores subject to moderate tidal actions, sandy shores in canal estate developments, muddy sand to pure mud areas

	and subterranean tunnels.
Reporting	◗ The Environmental Representative will record when and where any larvae or mature mosquitoes are found on-site, as well as when and where any incidences of bites may occur. ◗ Should a large number of larvae or bites be experienced, the Townsville City Council will be contacted for advice on appropriate remedial measures.
Corrective Action	Should an incident or failure to comply occur, a selection of the following actions will be taken: ◗ An investigation will be undertaken into why directives are not being carried out; ◗ Employees will be re-educated on desired practices; and ◗ Work policies and procedures will be changed to improve the situation.

3.16.3 Summary

The potential risk to health and safety from the project construction and operations activities and their impact on the workforce and communities exists.

The implementation of workplace health and safety procedures and the management plans will minimise the potential risks to acceptable levels.

3.17 Cumulative impacts

Any proposed development has the potential to impact upon the environmental, social or economic values of a region as a result of its development. It also has the potential to produce a cumulative impact upon those values when the proposed activity is conducted in combination with other developments. The typical effect is a compounded impact resulting from the interaction of multiple stressors from different projects. To have complete understanding of the full impact potential of a proposed development it is necessary to assess the potential cumulative impacts that may result from the project in combination with other projects in addition to assessing the direct and indirect impacts attributable only to the project of interest.

An assessment of cumulative environmental impacts considers the potential impact of a proposed development in the context of:

- Previous developments to provide context to environmental resilience;
- Existing developments to understand direct potential confounding impacts; and
- Future developments to consider all potential and indirect environmental impacts.

The assessment enables all potential impacts of a project to be understood in relative context and not in isolation from other projects. Assessment of previous developments should be conducted in context of the current baseline conditions of the environment. In this regard for the

TMPP the existing environment has been characterised through studies conducted to complete this EIS and is reported in the preceding sections of this document. Economic and social impacts from the TMPP are presented under Sections 4 and 5 of this document and, in accordance with the ToR, the cumulative impacts of relevance to these sections are noted here and detailed in the following sections.

As discussed under Section 1 of this document the TMPP does not directly relate to any other actions being undertaken by the POTL. However, the TMPP is associated with the Department of Main Roads project (TPAR) for a low-level fixed bridge of 7 m at Highest Astronomical Tide (HAT) across the Ross River, which has a programmed construction completion of its 'last span' by mid 2011. Construction of the TPAR in conjunction with the TMPP has potential to result in cumulative impacts for a range of ecological and other variables. The resultant combined effect of the two projects in conjunction may be greater than the impact of each project in isolation and, therefore, it is important to assess the cumulative impacts that may result from these two developments.

A number of other coastal developments are also being undertaken in the Townsville region concurrently. These include:

- Investigations related to the Townsville Port Expansion (POTL);
- Development of Breakwater Cove and the Townsville Ocean Terminal (City Pacific Ltd) and
- Development and expansion of Berths 12, 10 and 8 within the Townsville Port (POTL).

While none of these projects is directly related to the TMPP in regard to construction and development processes, there is potential for cumulative environmental impacts to the region resulting from concurrent or successive developments, for example potential cumulative dredging impacts.

Beyond the Townsville region, port, sewage and other coastal infrastructure development plans are underway and likely to be developed and the environmental impacts assessed in isolation from Townsville developments.

Impacts from future developments related to the TMPP and of relevance to this cumulative impact assessment are not able to be quantified and, accordingly, it is appropriate to examine cumulative impacts across all developments from a qualitative perspective. In this regard the methodological approach to assessment of cumulative impacts for the TMPP has been to

- Describe the existing baseline conditions of relevance to the TMPP;
- Ascertain potential direct and indirect impacts from the TMPP development;
- Identify mitigation and management measures for each identified impact;
- Ascertain which of the identified impacts may be confounded by concurrent or successive other developments within the local region;
- Qualitatively describe how identified impacts are compounded; and
- Identify mitigation and management measures against the compounded impact potential.

This approach has been undertaken in each of the preceding sections where cumulative impacts identified have been discussed in detail. In accordance with the ToR the following summarises identified cumulative impacts and mitigation measures for each of the

environmental considerations of the TMPP. The structure of this section mirrors that of the preceding sections for ease of cross reference.

3.17.1 Land

The Precinct and Breakwater will be developed wholly within port limits and within the Ross River. The land based components of the project will be developed on reclaimed land with limited existing use except for some public recreation. The proposed works are consistent with the POTL Land Use Plan 1996. No other projects being developed in parallel are predicted to impact upon public recreation and cumulative impacts for this are not expected. Relocation of upstream industries into the Precinct provides alternative opportunities for public access to the coast in addition to those being considered through the Precinct itself. Hence, there are not predicted to be any cumulative impacts in relation to land use and land use planning resulting from the TMPP.

3.17.2 Landscape character and visual amenity

The project site is located within an area that has existing industrial development including both port and land based activities. While individual developments may have a minimal impact on the visual landscape the cumulative impact is a continuing industrialisation of the visual environment of this area. This is particularly the case with the land reclamation, which will create additional land beyond that currently available or which has been intended for industrial development.

While the ongoing industrial and port development diminishes the naturalness of the visual outlook in this sector of the visual landscape, this development also provides a unique landscape that combines the background of the mountains with the inter-tidal zone of Cleveland Bay and the Ross River.

Residual impacts – construction

It is not anticipated that there will be any residual landscape or visual impacts arising from the construction phase of the project.

Residual impacts – operation

Some impacts resulting from the project are unavoidable and cannot be mitigated for during operation. The project will alter the surrounding landscape and the visual experience of the visual receptors. However, these changes must be seen within the context of the existing local environment.

Foremost amongst residual visual impacts is the creation of a new land area within Ross River adding to the existing port facilities, and the creation of the breakwater facilities. In addition the construction of industrial and port related development will increase the extent of this type of land use in the visual landscape. As industrial and port development is located immediately adjacent to the site it is not considered to be a new element in the visual outlook.

The change in view will be permanent form all viewpoints with increased prominence when viewed from a number of viewpoints as these either provide extensive uninterrupted outlooks over the site, or are located within close proximity and therefore not visually or physically separated from the impacts.

Site wide, in terms of the assessment criteria this equates to a moderate adverse residual landscape impact, with medium visual sensitivity due to proximity of the receptors to the site. Therefore, the assessment of significance of residual impacts is considered to be of moderate significance. The assessment of a moderate impact on the landscape and visual amenity, and not higher, considers the nature of the surrounding industrial development in this location, the duration of viewing opportunities, and the nature of the proposed works.

The management of the construction process through the site EMP and the requirements of the environmental approval will help ensure that any adverse impacts resulting from the construction of the project on landscape and visual amenity are minimised or mitigated.

3.17.3 Transport and associated infrastructure

The construction and operation of the Precinct and all other proposed developments in the PoT direct vicinity will result in an increase in traffic to and from this area of Townsville. There is also a need to develop infrastructure to support the proposed developments. Potential for cumulative changes in vessel movement impacts are addressed below under Nature Conservation.

Infrastructure

Given Lot 773 is currently an intertidal marine sand/mud flat there are no existing services and infrastructure in this area. As identified under Section 2.6, construction of the Precinct will require that services infrastructure (sewerage, storm water, telecommunications etc.) be developed to supply the Precinct for its lifespan. No cumulative impacts resulting from concurrent development of other projects upon these services are anticipated. Reduction of any potential direct impacts, particularly from reclamation works, could be achieved by concurrently developing the Precinct and the Services Corridor adjacent to the Precinct.

Transport

Operational completion of the first stage of the development will coincide with completion of the TPAR in December 2011. The transport corridors for construction activities of the TPAR, TMPP and other concurrent projects are expected to be the same up to the first stage of completion. It is expected that following completion of the TPAR construction traffic for all developments will be mobilised to the port district via the TPAR. This will facilitate completion of Stages 2 and 3 of the Precinct. Until that access is operational traffic routes through South Townsville are expected to be impacted in a cumulative manner. In particular, traffic assessments have considered routes that traverse along the Bruce Highway, Stuart Drive, Abbot Street, Saunders Street, Benwell Road and Archer Street.

This study has shown that the Boundary Street / Saunders Street intersection will require upgrade prior to 2011 to enable continued performance under an increased growth in background traffic in the area. This intersection upgrade is not a Precinct specific issue but one related to continued growth in the region realised to 2027. Consideration will also need to be given to upgrading the Benwell Road / Archer Street intersection prior to 2027 to accommodate predicted increases in background traffic.

The impact of the traffic generated by the development is not considered by DMR guidelines to be significant at a number of utilised intersections because the development traffic contributes less than 5% of the background traffic.

Construction related traffic generated by the site will have a negligible impact on the adjacent road network at the 2011 horizon at which time the TPAR will provide alternative access opportunities to the port industrial precinct. Hence, the assessment has demonstrated that there are no foreseeable traffic related impacts, including in response to cumulative impacts, that should prohibit the proposed development from proceeding.);

3.17.4 Climate and climate change

A number of climate change projections for temperature, rainfall, sea level rise and severe storm frequency have been noted for a 100 year time span for the Townsville region under Section 3.5. The impacts of climate change are likely to affect many infrastructure projects with a projected lifespan greater than 30 years. Therefore an assessment of this project's vulnerabilities to climate change was undertaken. It was noted that the detailed design process for the Precinct will need to consider future climate change predictions are addressed adequately to reduce risks to proposed infrastructure. However, none of the concurrent projects are expected to compound any identified influences of the predicted climatic changes on the TMPP.

3.17.5 Surface waterways and Groundwater resources

The TMPP site represents wholly intertidal and subtidal marine environment in its current state. During rainfall surface water runs off adjacent lands into this site and, hence, into the surrounding marine environment. Similarly, groundwater flows have been demonstrated to run from adjacent areas to the Precinct location. Reclamation works to be undertaken as part of the TMPP may impact upon the groundwater flows temporarily during construction of the TMPP and these potential impacts were addressed under Section 3.7. Given the location of parallel projects in relation to the Precinct, it is likely that only the TPAR could have any cumulative impact on surface and groundwater flows in the vicinity of the TMPP. This may be realised as a result of compounded impacts from mounding associated with construction of the TPAR in conjunction with the TMPP reclamation works. Groundwater levels may be raised and the direction of flow may alter until an equilibrium is reached during reclamation works. Surface water flow directions may be altered due to land built barriers to their natural progression downstream that exists currently. Inappropriate waste management could lead to contamination of the watertable or run off of contaminated material into the surrounding environment. Detailed design approaches for the TMPP and the TPAR should take these matters into consideration and develop appropriate construction and impact management strategies to address the potential cumulative impacts upon these systems.

3.17.6 Coastal processes and sedimentation

The coastal processes that operate in the vicinity of the proposed Precinct at the mouth of the Ross River have been investigated by examining sediment inputs and the processes that effect such including longshore sediment transport and historical sediment movement regime for the area. This has been done in conjunction with an assessment of the influence of waves on sediment movements. From this a description of the existing littoral transport regimes has been developed and is provided under Section 3.8. The effect of the proposed development on those processes has been assessed in the context of concurrent works and historical patterns of

change and the likely operation issues for the Precinct in terms of sediment movement have been identified.

The existing Port development blocks any influence of coastal processes in the vicinity of the Precinct on the coastal areas north-west of the Port. The establishment of a Precinct, the TPAR or additional Port infrastructure will not influence this fact. The Port development (including the Port areas beyond the original coastline, breakwaters, other reclaimed areas, and the dredged entrance channel) effectively isolates the processes that occur south-east of the Port from the areas to the north-west.

The proposed Precinct will have no additional contributory effect causes of any existing coastal degradation to the west of the Port and hence will have no influence on the state of the beaches to the west in either the short or long term.

Breakwaters proposed to be parallel to the existing dredged channel will affect sediment movement into the channel near the outer sand banks. Where the breakwater crosses the active littoral zone, it can be expected that there will be a slow build-up against the breakwater extending away to the south-east. The rate of build-up will be commensurate with the prevailing longshore transport rate. Construction of the TPAR, the TOT or other port infrastructure not expected to compound this process or influence it in any way.

The coastal processes in the vicinity of the Precinct comprise both onshore/offshore and longshore components and are influenced by the proposed breakwater structures in a number of ways. However, the processes are capable of moving sediment at only relatively slow rates due to the low wave climate and hence any changes will take time to develop and will be restricted to the local area. It is concluded that it is unlikely that there will be any significant affects on coastal processes from the construction of the Precinct on the coastal areas beyond around 500m south-east of the breakwater structures and that the predicted effects on this area of coastline will not be compounded by parallel developments.

3.17.7 Hydrodynamic investigations

Hydrodynamic model investigations have been undertaken to examine potential impacts upon bed shear stresses, flushing, water circulation patterns, potential for sediment resuspension and flooding impacts resulting from the TMPP. These investigations have been conducted on the reference design footprint of the TMPP to understand the direct impacts of that development. Investigations have also been conducted to understand the potential compounded influences from the TPAR and Precinct on water movement within this local area. These are described in detail in Section 3.8.

Studies demonstrate that the breakwater provides protection and hence both the marina and navigation channels in the Ross River show little change in bed shear stresses with limited potential for any significant risk for erosion or siltation in this region during simulated storm wave conditions. The developed case maintains an adequate level of flushing with only minor influences on existing circulation patterns. These patterns are not expected to be effected by construction of the TPAR.

With the Ross River discharging directly into the Precinct area and the potential for the TPAR to constrict this discharge prior to the Precinct it is important to consider whether there are any potential implications for erosion or flooding. Information on the Precinct configuration has been

provided to the TPAR project to assist in this assessment process. TPAR studies are continuing and finalised information to support examination of cumulative impacts is still pending. Information reviewed from the hydraulic assessment for the TPAR, provided in draft form in May (QDMR 2009), has been used to support development of the potential for cumulative impacts for this study.

It is understood that the optimum design configuration for the TPAR was determined with a number of bounding objectives, including achieving no more than 30mm afflux at adjacent suburbs in a 100 Year ARI event. It is also understood that the TPAR project has determined appropriate construction approaches to reduce potential for scouring and erosion of the TPAR footings. The Precinct is not expected to compound this potential and the breakwater may act to decrease erosion potential.

As reported QDMR (2009) assessment of potential flooding impacts was undertaken for the following cases:

- The preferred Eastern Access Corridor (EAC) design only;
- The preferred EAC design with the future railway corridor; and
- The preferred EAC design with a future marine precinct development.

The flood levels in both the base case and the design cases were used to assess afflux at surrounding suburbs. The velocities at the structures were used to review the potential for scour with scour protection measures identified. The model was also used to assess the changes in extents of tidal inundation.

The preferred EAC design has ensured affluxes less than 30 mm adjacent to the adjacent residential areas of Cluden, Oonoonba and South Townsville in a 100 Year ARI event. The construction of the railway corridor also maintains affluxes less than 30mm adjacent to the residential areas in a 100 Year ARI event. The inclusion of a marine precinct adjacent to the mouth of the Ross River increases potential flood levels between the Ross River Bridge and the Breakwater by no more than 50 mm. The increase in flood levels upstream of the Ross River Bridge is less than 0.01 m. The increases upstream result in a combined afflux of 30 mm immediately downstream of some properties in South Townsville. However, the report does not differentiate the relative impact of the TPAR compared to the Precinct in this assessment and the findings are for the cumulative impact of the two developments. It is noted that there are no significant changes in water levels at the bridges and major culverts between the design case and the design case including the marine precinct.

Overall, it is concluded that the combined influence of the TPAR and Precinct does not significantly affect the flood levels, with only minor impacts downstream of the Ross River Bridge (QDMR 2009) which will need to be considered as part of the detailed design for the Precinct.

The Ross River is highly regulated, with the Ross River Dam and several weirs constructed. This provides a mitigated pattern of flood flows discharging from the Ross River past the Precinct into Cleveland Bay. It is noted that for flood events occurring at low tide, the flood will tend to be contained largely within the existing channel, with shallow sandbanks to the north-east of the river mouth acting as a constraint. Under increased severity there is expected to be branching (separating) flow between the breakwaters and also along the tail of the eastern

breakwater. These predicted changes at the ends of the proposed breakwaters have implications for breakwater design. From an environmental impact perspective, there will only be minor changes in erosional and depositional characteristics for these conditions. Completion of TPAR studies may provide additional information to support these findings but is unavailable at this time.

3.17.8 Water and sediment quality

Parallel development of projects in the Townsville region is not expected to impact upon the water and sediment quality in the area except for in regards to dredging impacts. The key impacts of a typical dredging and reclamation project are:

- Impacts on water quality and light penetration through the generation of turbid plumes;
- Direct impacts on marine flora through removal of actual or potential habitat and sediment deposition;
- Direct impacts on marine fauna through removal of habitat and food source; and
- Indirect impacts on marine flora through changes in coastal processes such as magnitude and direction of tidal currents, water levels, waves and flushing (either through dredging of new areas or introduction of new marine structures) and reduction in water quality, which impacts on light availability.

Key drivers that can change the extent and severity of these impacts is the length of the dredging campaign, the type of equipment used and the way in which it is operated, the type of sediments to be dredged and whether or not these dredging campaigns occur concurrently or sequentially.

For instance, if the capital dredging for the TMPP, as defined under Section 2 of this EIS, occurs while another dredging program occurs, the spatial extent of turbid plumes could overlap and, accordingly, the impact of the combined two plumes above background water quality concentrations would need to be considered. Dredging approaches considered for the TMPP include backhoe and cutter suction cutter suction dredgers. These typically generate less of a turbid plume compared to trailer suction hopper dredgers, reducing the extent and migration of turbid plumes resulting from the proposed capital dredging programs. Where there is a risk of confounding impacts of multiple dredging programs on water quality, the dredging approach, scheduling of the dredging and the concurrent locations of the dredgers should be considered to reduce the likelihood of confounding impacts beyond those likely from a single program.

Should reclamation activities for the TMPP coincide with construction works of the TPAR there is potential that water quality in the vicinity of the TMPP may be compound due to the combined effect of construction and decant activities. If this is likely to occur the measures that need to be employed to manage the quality of the decant waters from the TMPP to achieve the required water quality trigger values need to be appropriate to that construction timeline. This might involve construction of more internal cells to increase retention time and allow adequate settling of fine particles. This may also increase the length of time that the decant waters are being discharged, which would increase the length of time the receiving environment would be exposed to the discharge of turbid waters. However, if the decant waters meet the appropriate water quality trigger values, the impacts on the receiving environment should be appropriately

mitigated. Water quality trigger values should be reviewed with this consideration in mind should multiple projects proceed concurrently.

Ocean disposal of material from construction of the TMPP has been examined during the conduct of this project through a desktop review of recently completed work (WBM 2009 Draft) in consideration of previous study findings. Disposal of material related to the TMPP is not predicted to have significant influence on the ecology of Cleveland Bay. Ocean disposal at the existing ground has occurred on a regular basis for some years and the seagrasses (eg see Rasheed and Taylor 2008) and other benthic systems (eg see Cruz 2000) in the immediate vicinity of the spoil ground have been shown to be well adapated to the existing disturbance regime (including dredge disposal) of Cleveland Bay and appear resilient to dredging impacts.

Impacts may occur, however, if spoil from a number of projects is deposited simultaneously. Likely impacts from cumulative disposal approaches would include an increase in the size and persistence of any disposal plumes, which could have flow on effects for light dependent sensitive ecosystem receptors, including seagrass meadows. Mitigation strategies for ocean disposal impacts relating to this project have been proposed under Section 3.8 and 3.9. Future projects will need to identify whether they might occur concurrently with the dredging activities associated with this project and whether mitigation and management measures need to be altered to provide adequate mitigation of impacts.

3.17.9 Nature conservation

3.17.9.1 Terrestrial ecology and wading avifauna

The project area (Lot 773) is currently intertidal and subtidal land that will be reclaimed to construct the Precinct. There is a small (<1.5 ha) patch of fragmented vegetation fringing the project area which will also be removed during the construction process to enable the services corridor for the Precinct to be developed. Given the limited relevance of the Precinct to the terrestrial ecology of the area, the identified impacts to the terrestrial ecology of the area from construction of the Precinct are not expected to be compounded by the parallel construction of the TPAR or other proposed projects.

Increases in traffic activity for the operation of the proposed facilities may affect a cumulative impact on the terrestrial ecology resulting from multiple developments in the area. Of principal concern are impacts to vegetation and terrestrial communities on the east bank of the Ross River associated with construction, operation and potential increased traffic use of the TPAR to access the Precinct. A byproduct of the TPAR may be an increased ability to access intertidal areas on the east bank of the Ross River. This area supports mangrove and sclerophyll communities, and subsequently also fauna, and the offshore area is of regional importance supporting wading and migratory avifauna that are protected under international conservation agreements. Increased access potential carries a risk of increased disturbance of vegetation, resident mammals and feeding shorebirds.

Measures to mitigate against potential impacts to the east bank from construction and use of the TPAR will have been identified in the studies conducted for the TPAR. Adoption of those measures by the TPAR project should seek to mitigate any cumulative impacts. However, to avoid any potential additional impacts the following guidelines should be considered for the construction of the TMPP:

- Impacts to the foreshore and mangrove communities on the east bank should be avoided. This includes avoidance of impacts to the presence and extent of the high tide bank through changes in sedimentation patterns from infrastructure construction. It also extends to avoiding increased access to the area from boating activity. This is a critical area for beach stone curlews and other avifauna, with suitable nesting locations in this area, and also for the water mouse (if present);
- Mudflats and other open areas should be retained and kept weed free. These areas offer suitable habitat for avifauna including Radjah shelducks, black-necked storks and white-rumped swiftlets;
- Sedimentation from Port works should be carefully managed and contained to avoid impacting on crocodile habitat; and
- Sclerophyll vegetation on the east bank should be retained. Standing stags and dead timber on the ground should be retained – if woody weeds are cut down the wood should be left in situ (with seeds and reproductive material removed). These areas offer important habitat resources for the rusty monitor, and the coastal sheathtail bat and the white-rumped swiftlet will utilise flyways over canopies to hawk for insects.

3.17.9.2 Aquatic ecology

Construction of the Precinct about the mouth of the Ross River will result in marked disturbance of the marine benthic habitats within this area. The main potential construction impacts include removal of benthic habitat, declines in water quality associated with construction events and potential impacts to marine megafauna from vessel operations. The main potential operational impacts include continuous disturbance of benthic marine systems, impacts to water quality, impacts to marine megafauna from vessel operations and increased potential of pollution to the marine environment from changed use. Mitigation strategies against each impact were identified in the Section 3.10.6 under Table 3-55.

Other proposed construction projects within the vicinity of the Precinct are likely to also involve adverse effects on the marine environment similar to those resulting from the TMPP. Parallel construction and operational approaches have the potential to result in compounding or cumulative impacts.

The benthos that will be directly affected by construction of the Precinct is known to occur in other locations within Townsville region including in other locations within the Port, Rowes Bay, Pallarenda and Magnetic Island. It is not considered to be a community or ecosystem of high value either in its own right or as a critical feeding ground for other, higher order, species. Cumulative removal of this type of seabed community is not expected to have a negative effect on the importance of the benthic marine habitats of the Townsville region. Nor it is anticipated to reduce biodiversity of the region significantly.

The mud flat across Ross River from the Project Area hosts a similar diversity to the benthos of the area that will be removed as a direct result of construction. Strategies to avoid impacting the mud flat site, and maintenance of the mud flat in perpetuity should be considered, as noted above, to provide opportunities within the immediate area of the Precinct for continued presence of taxa that will be removed as a result of construction of the Precinct. Development of the inner harbour of the Precinct will provide future opportunity for some of the Lot 773 area to be

recolonised with benthic taxa from adjacent environs like the mud flat. This may partially offset some of the habitat losses associated with direct removal. Creation of interstitial rocky shore habitat both intertidally and subtidally through provision of rock revetment walls of the Precinct and development of the breakwater may also partially offset some of the habitat losses associated with direct removal.

Megafauna species were noted within the Ross River area with only stingrays noted to be using Lot 773 as a potential feeding site. Stingrays could be targeting (as a food source) the benthic infauna and epifauna occurring within the sediments of Lot 773 and surrounding areas, including the small crustaceans and bivalve molluscs reported in this study. Similarly, crab and fish fauna were also noted within this area and are likely to also be targeting benthic fauna as a food source. As noted above, these benthic communities are not unique to the Townsville region and are well represented to the north and south of the Port environ. Removal of the benthic habitat associated with Lot 773 is, therefore, not likely to negatively affect the stingray, crab or fish populations of the Townsville region. This conclusion is also supported by sightings of similar taxa using the mud flat on the eastern bank of the Ross River across from the Precinct area. As noted above, maintenance of the mud flat environ would provide a continued opportunity for these fauna to use the mouth of the Ross River for feeding.

Construction activities associated with the TPAR, Port Berths, Cove and TOT will also all likely impact negatively upon the benthos occupying areas of the seabed in the direct vicinity of each development. The cumulative impact of this habitat removal in conjunction with the development of the Precinct is not expected to negatively effect prevalence of the benthic flora and fauna detected during this survey in the Townsville region given they are well represented. Including in areas that will not be affected by construction activities to the north and south of the Port environment such as Cape Pallarenda and around Magnetic Island.

Megafauna other than stingrays, including turtles, dugong or dolphins, were not noted to be using Lot 773. This observation is supported by a lack of key food groups for these megafauna within the area, including, but not limited to, seagrasses. Seagrasses were found offshore of the mouth of Ross River, a finding consistent with that reported by Rasheed and Taylor (2008). As noted under Section 3.17.8 there is potential for degraded water quality to impact these offshore meadows particularly if dredging activities for proposed development activities coincide and produce a larger or more persistent plume than anticipated by any single activity. Potential water quality impacts quality impacts are examined under a detailed study provided as Appendix J of this EIS and summarised in Section 3.9, which includes information on construction dredging assessments and dredge plume potential. Cumulative impacts and mitigation measures are noted under Section 3.17.8 and further discussion is provided following.

Seagrass communities are recognised as important ecosystems for maintenance of seabed stability, water quality and biodiversity (Collier and Waycott, 2009). In addition to their intrinsic value, seagrasses are known to act as nursery grounds for juvenile fish, which may be targeted by commercial and recreational fishers, or be an important food source for other fish and megafauna species. Seagrasses are also an integral food for marine megafauna including turtles and dugongs. Collier and Waycott (2009) identify a number of natural and anthropogenic activities that may impact the persistence of seagrass meadows and cite high sediment loads as a particular feature of the Townsville region. Rasheed and Taylor (2008) note that

seagrasses in the vicinity of the Townsville port are likely adapted to high levels of turbidity both as a result of naturally occurring high turbidity for the area and also in response to existing levels of maintenance dredging and shipping activities. These compounding influences on turbidity are, however, recognised to be short-lived and events to which the meadows have some resilience. Significant impacts may occur to the presence, taxonomic composition or biomass of meadows when the severity or duration of any particular impact exceeds levels of natural variation (Carruthers *et al.,* 2002, Erftemeijer and Lewis, 2006 and Orpin *et al*. 2004). Rasheed and Taylor (2008) and Collier and Waycott (2009) both note considerable risk of impact to seagrass meadow prevalence in the Townsville region from prolonged periods of reduced water quality resulting from compounding influences.

Given the ecological importance of seagrasses within this region, and the considerable risk of cumulative impacts to seagrass meadows from concurrent project development, consideration should be given to monitoring the presence and prevalence of seagrass meadows and the quality of associated water bodies adjacent to the port to determine if any negative influences from construction and operational activities affect these sensitive ecosystem receptors. Management response plans to declines in water quality and / or prevalence of seagrass meadows linked to development of the Marine Precinct should be developed. These may include, for instance, alteration of dredging activities (frequency, duration) to enable water quality levels to return to background conditions if unacceptable declines in water quality during dredging from dredging activities were detected.

Additional cumulative impacts that may result from increased traffic activity associated with construction activities in the mouth of Ross River (TPAR and Precinct) include increasing potential for boat strike of megafauna or increased avoidance of the area by fauna. Development of a construction vessel management plan taking into consideration cumulative impact potentials and addressing management strategies including speed limitation, extension of 6 knot speed restricted area to the offshore breakwater, need for observation for marine megafauna, appropriate strategies to avoid interaction with megafauna and reporting of any interactions should be considered.

Direct impacts as a result of increased or changed utilisation of Lot 773 area will not likely be compounded by cumulative impacts from other projects once the reclamation activities for construction have occurred. This area is already heavily utilised by public groups undertaking activities including, but not limited to, dog walking, fishing, beach collection and picnicking. Beach collection activities range from shell collection through to sourcing of bait species for estuarine fishing. It is estimated that at least 30,000 people visit the beach on an annual basis for various recreational activities. Reclamation and construction of the industrial precinct will remove the capacity for this activity to continue. As adjacent areas subject to development do not offer the same/similar recreational opportunities there is little potential for any cumulative impacts from adjacent developments. Boating (tinny) activities and jet-ski activities that currently use the beach area for recreational purposes will still be able to access the Ross River for recreational activities after completion of the TPAR construction. Only vessels greater than 6m in height will be restricted entry to the river upstream of the bridge after completion of this access corridor. Fishing, picnicking and beach walking currently do not occur in the footprint of the other development projects occurring in the Townsville region and there are no anticipated cumulative impacts to the loss of these activities.

Coastal impacts of the proposed Precinct have been assessed under Section 3.8 of this EIS, a detailed report is provided as Appendix R. From that information it is known that the sand spit at the mouth of Ross River is highly mobile and changes shape according to seasonal and flood influences. This area is also currently utilised by all-terrain vehicles, including four-wheel drives and quad-motorbikes. The mud / sand interface between the sand spit and mud flat area are also accessed and utilised by recreational fishers seeking bait for estuarine fishing. This practice occurs on an almost daily basis during calm fishing conditions. Thus, the sand spit does experience a degree of impact despite its isolation from the road. Avoiding impact on this area for extractive activities will assist in maintaining recreational opportunities for fishers and beach visitation for a subset of the current recreational users of Lot 773.

Dog walkers and beach picnickers would not have ready access to the sand spit area and given the sensitive nature of bird communities using the area (refer Appendix V) this should not be encouraged. Increased or changed utilisation may result in unfavourable impacts upon these preserved marine environments and the communities they support. Opportunities to mitigate against any increased impacts may include development of public education information regarding bird nesting and include exclusion of access to sites during critical nesting periods. Overfishing of bait species, such as yabbies (*Callianassa sp.*), that are currently sourced from this habitat may eventuate in self-regulation of this activity. Increased effort would likely reduce yield and result in recreational fishers sourcing their bait from other areas where greater return for fishing effort is achievable. Otherwise, if overfishing is noted to be reducing populations of bait species to non-sustainable levels, measures to manage influences may also need to be considered including public education approaches. Exclusion of access to the sand spit area during bird breeding season would provide a level of indirect protection to the bait species being targeted. These mitigation opportunities would need to be considered by managers of the sand spit, particularly if cumulative/additional or changed impacts to the sand spit/mud flat area were detected following completion of the TMPP and TPAR.

Expected construction activity impacts identified in Table 3-55 are likely possibilities under any of the other proposed adjacent projects. As a consequence, concurrent construction impacts in adjacent sites and, therefore, compounding of the identified impacts is also possible. Consistency in application of mitigation measures identified for this project should be considered for all other projects to reduce potential for cumulative impacts. In particular development of management plans for dredging, construction, waste management and hazardous material risks should be undertaken for the Marine Precinct such that the potential for cumulative effects, from other adjacent developments are considered and accounted for. This project, under identified mitigation strategies, is not expected to have any significant or long term negative impacts upon the ecological communities supported within this region.

3.17.10 Air quality

Dust is the predominant impact likely to occur from construction and operation of the Precinct. Dust impacts to the community during construction of the reclamation area are unlikely to be substantial due to separation distances and the moist nature of the dredged material being used to reclaim. Dust emissions from construction and operation can be managed to ensure that adverse impacts do not occur at sensitive locations offsite. Mitigation measures for dust during construction and operations are outlined in the Section 8 and include options like wetting or

sealing of access roads. Parallel construction of adjacent projects, including the TPAR, have potential to increase the dust load within the local airshed. However, similar dust and air quality mitigation measures should be adopted by those adjacent projects to address the impacts likely from those projects. Hence, if all proposed mitigation measures are adopted no cumulative impacts on air quality are predicted.

3.17.11 Greenhouse gas assessment

Although, from the Reference Design, sufficient information was not available to quantify the greenhouse gas emissions from the operational phase of the TMPP, it is expected that due to many of

When compared with the annual baseline emissions for Queensland, the GHG emissions potentially being generated from the main sources during the construction phase of the TMPP could be expected to be approximately 0.01% of the annual emissions profile for Queensland (refer Section 3.12). The exact industry base of the Precinct is still being determined and, at this stage, full quantitative assessment of all operational impacts is not possible. However, it is noted that operation of the Precinct will make a contribution to the annual emissions profile for Queensland. However, as many of the industries likely to occupy the Precinct are already operating within the local area, and given that maintenance dredging requirements not expected to increase, additional operational emissions from this project are considered to be minimal. It is likely that relocation of industries using older facilities to the Precinct may provide for a reduction in current GHG emissions from those industries through the introduction of new technologies.

Several mitigation options for the construction and operational phases of the TMPP are outlined in Section 3.12. These included choosing options that minimise material use and sourcing materials from the closest possible locations. All other projects proposed for construction in the vicinity of the Precinct would also contribute GHG to the existing annual emissions profile of Queensland, however, the concurrent development of these projects is not predicted to increase the individual contribution of any of these projects and may, due to efficiencies in equipment mobilisation, provide avenues for decreasing the overall emission contribution. For instance, mobilising equipment to develop the services corridor at the same time as the Precinct increases the efficiency of the construction of both of these projects and would likely realise a small net decrease in GHG emissions compared to independent development of each of these projects.

3.17.12 Noise and vibration

Modelling of noise generation associated with construction activities under a scenario of no noise barriers or acoustic shielding in place and with each plant item operating at full power shows that anticipated noise levels from the TMPP construction compare to existing daytime ambient noise levels for all plant activity except pile driving, which will be managed through appropriate construction management plans so as to not impact upon sensitive receivers, including occupants of the Precinct. Hence the only predicted cumulative impact on noise and vibration from construction activities relates to underwater impacts resulting from dredging and construction of marine structures. Sequential or concurrent dredging and marine construction projects (eg TPAR plus TMPP) have the potential to result in impacts on marine fauna that are

sensitive to changes in the underwater noise environment. As noted under Section 3.17.9.2, sensitive marine animals, including turtles, dolphins and dugongs, have not been found to be using the TMPP site during this EIS investigation. They are known to use the Port environment and the mouth of the Ross River. Mitigation measures to avoid impacting upon these sensitive megafauna have been proposed under Section 3.10.7 for this project. These are applicable to potential cumulative impacts, as noted under Section 3.17.9.2, and include measures like using a partial strike to warn nearby megafauna of construction activities to enable avoidance of the habitat during those periods. Future projects will need to consider the impacts of underwater noise on sensitive marine fauna should they occur concurrently or immediately following the TMPP.

Operational noise will largely be dependent on the types of business and industry that will locate within the TMPP. It is expected that these will include industrial activities such as boat building, abrasive blasting, surface coating, workshops, storage of goods, and packaging, all of which are likely to operate within sheds. Other noise generating activities associated with this will include trucks and forklifts, trawlers and boats. Modelling of worst-case scenarios predicts that noise generated from the Precinct during operation will be similar to existing noise levels in the area. This level of impact is expected to be attenuated given that many activities will likely be located inside buildings. This will block noise sources from site receivers due to adjacent buildings, walls and barriers. In addition, the location of the Precinct, being at a distance of more than 350 m from the nearest sensitive receivers, further mitigates the potential for impact from the Precinct alone. The presence of a compacted dirt ramp (supporting the TPAR) between the TMPP and the nearby receivers may further mitigate operational noise from the Precinct. Hence there are not predicted to be compounding noise and vibration impacts from the operation of the Precinct but the combined development of the Precinct and the TPAR may act to decrease noise and vibration impacts experienced at sensitive receptors originating from the TMPP.

3.17.13 Waste management

Given the environmental values of the surrounding area of the project site, effective waste management will be an important aspect of any development in the area. The waste streams expected to be generated by each component of the TMPP have been detailed in Section 3.14 with an assessment of the potential environmental impacts of the wastes and options for waste management aimed at protecting environmental values are also provided. Identified impacts could be expected to be compounded by uncontrolled parallel developments, however, these other developments will have in place similar waste management requirements and mitigation measures. The predicted impacts and mitigation / management measures identified for this project are considered directly applicable to management of any cumulative impacts.

3.17.14 Cultural heritage

There are no predicted impacts on European or Indigenous cultural heritage resulting from this project and assessment based on known information regarding potential future projects indicates there are no expected cumulative impacts on historical heritage from the proposed future projects. All proposed projects should, however, liaise with the traditional owners and Native Title claimants of the area to determine whether any of the projects are likely to impact on any aspects of indigenous cultural heritage.

3.17.15 Health and Safety, Hazard and Risk

Only transient impacts on health and safety are expected during the construction phase of the project. Some of these impacts may be increased should other dredging and marine construction projects occur concurrently with the TMPP. For instance traffic related risks with mobilisation of construction workforce to the port precinct may increase with an increased volume of workforce attendance. Mitigation measures provided for impacts related to this project in Section 3.16 are relevant to these potential compounded impacts. These should, however, be reviewed if projects are to occur concurrently to determine whether additional or modified management measures are required to achieve the required health and safety outcomes.

Similarly, many of the hazards and risks identified for the TMPP will occur during the construction phase and have the potential to be cumulative if a number of the proposed future projects occur concurrently. If projects are to occur concurrently, the mitigation measures proposed against the risks identified in this project (refer Section 6) will need to be reviewed to determine whether any additional mitigation measures are required. For instance, in the case of multiple dredging programs occurring at the same time, communication strategies to inform other vessels of dredging movements may need to be considered to adequately manage the risk of congested waterways and access to vessel facilities, including boat ramps, in Ross River. Any such approach would be determined in discussions with Maritime Safety Queensland.

3.17.16 Social values

Potential cumulative social impacts that may result if the TMPP and other proposed future projects proceed are primarily related to reduced access to the coast and impacts on recreational opportunities. This primarily relates, however, to the TMPP and in a small way to the TPAR as other projects are on lands that do not provide public access or provide only restricted access. Additional comment regarding this was provided above under Section 3.17.9.2. Many of the potential impacts are expected to be short lived during construction activities. Some long term impacts, such as loss of a dog walking area as a result of construction, may be offset through redevelopment of lands upriver currently occupied by industries that are likely to relocate to the Precinct.

While the TMPP will not place significant pressure on the local labour force or housing market, if other projects occur concurrently with this project, it will contribute slightly to the overall pressures on the Townsville region in terms of labour force, accommodation and community and social support services. Consideration should be given to this potential for future project planning.

3.17.17 Impacts on local economies

In general, developments such as the TMPP and others proposed within the Townsville region result in net economic benefits to the local, regional, state and sometimes national economy. However, while there may be a net economic benefit from each project individually, if a number of projects proceed concurrently, there may be impacts on some aspects of the economy such as increases in house prices, rental prices and the ability of labour market and support services

to provide adequate levels of service to all projects. This may result in the import of some labour and services from outside the local area.

3.17.18 Summary

The TMPP is not considered to make a significant contribution to cumulative impacts associated with wider strategic policy such as greenhouse as emissions, regional resource consumption and waste disposal. The ability to upgrade some operational industrial facilities through relocation to the new Precinct in fact provides opportunity to realize some reductions in existing cumulative impacts, such as to GHG emission or water quality impacts. Although a number of potential cumulative impacts have been identified, the most significant area where cumulative impacts are likely from concurrent or successive project development within the port precinct in Townsville relate to the marine systems of the area. The TPAR construction is expected to commence prior to the Precinct construction and there may be overlap in construction activities. These projects, and others that may undertake dredging and disposal activities and in water construction need to consider the potential cumulative impacts identified here and adopt appropriate mitigation strategies.