walker

# TOONDAH HARBOUR

**APPENDIX 2 - I**

AIR QUALITY TECHNICAL REPORT

saunders havill group

Report

# Toondah Harbour Environmental Impact Statement – Air Quality Assessment

Walker Corporation

Astute Environmental Consulting

**Job: 19-118**

**Date: 4 March 2022**

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# GLOSSARY

| Term | Definition |
|---|---|
| TSP | Total suspended particles - Particles in the air environment with an equivalent aerodynamic diameter of less than 100 microns |
| $PM_{10}$ | Particles in the air environment with an equivalent aerodynamic diameter of not more than 10 microns. |
| $PM_{2.5}$ | Particles in the air environment with an equivalent aerodynamic diameter of not more than 2.5 microns. |
| $H_2S$ | Hydrogen sulfide |
| $NO_2$ | Nitrogen dioxide |
| NOx | Oxides of Nitrogen |
| CO | Carbon monoxide |
| $SO_2$ | Sulfur dioxide |
| TVOC | Group of carbon-based chemicals that have a high vapour pressure at room temperature |
| $\mu g/m^3$ | Microgram per cubic metre at 0 degrees Celsius and an atmospheric pressure of 1 |
| $g/m^2$/month | Grams per square meter per month |
| $m^3$ | Cubic meter of air |
| g/s | Grams per second |
| ° | Degree Celsius |
| EPP (Air) | Environmental Protection (Air) Policy 2019 |
| OQPC | Office of the Queensland Parliamentary Counsel, State of Queensland |
| AS/NZS | Standard Australia – Australia and New Zealand |
| NPI | National Pollutant Inventory |
| US EPA | United States Environmental Protection Agency |
| WGS84 | World Geodetic System 1984 |

# EXECUTIVE SUMMARY

Astute Environmental Consulting (Astute) was engaged by Walker Group Holdings (the Proponent) to prepare an air quality assessment for the Toondah Harbour Development. The assessment was performed to address the Guidelines for the preparation of a Draft Environmental Impact Statement for the Toondah Harbour Development, Queensland as well as other relevant State and Federal requirements. This included describing the potential emission sources, estimating emissions to air and predicting the impacts of the emissions having regard to State and Federal policies and legislation. Background air quality concentrations were considered to cumulatively assess the impact. Recommended mitigation measures and how these would be monitored, audited and managed have also been suggested.

The assessment has been performed in line with Application Requirements For Activities With Impacts To Air (DES, 2019) and has involved modelling using recognised meteorological and dispersion models, estimating both particulate emissions from earthworks and other related activities, and combustion emissions from earthmoving equipment.

Air quality impacts due to the Development in isolation, and with the inclusion of background concentrations of relevant pollutants, were determined at identified sensitive receptors and within the model domain. The results were then compared to the identified air quality criteria considering both human health agriculture, forest, natural vegetation and ecosystem standards within the EPP Air as required by the Draft Environmental Impact Statement for the Toondah Harbour Development, Queensland.

The air quality assessment found the following:

- TSP – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- $PM_{10}$ – Predicted compliance at all sensitive receptors in isolation and cumulatively.
- $PM_{2.5}$ - Predicted:
    - Compliance for annual average concentrations at all receptors except receptor 41 for Stage 1.
        - Concentrations dominated by background concentration which makes up 85% of the allowable criteria.
        - Maximum site contribution at these receptors was 1.2 µg/m$^3$.
    - Compliance for all receptors for 24 hour concentrations.
- Compliance for annual average concentrations at all receptors except receptors 40 to 49 for Stage 1
- Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Carbon monoxide – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Nitrogen Dioxide – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Sulfur dioxide – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Benzene – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Toluene – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Xylene – Predicted compliance at all sensitive receptors in isolation and cumulatively;

Even though compliance was generally predicted, and the exceedance occurred due to a high background concentration (annual $PM_{2.5}$), the proposed management measures in this report are based on the high-risk requirements in IAQM (2014) which includes the use of real-time particulate measurement which is used to optimise site mitigation and ensure that actions on the site are performed in a way to minimise the risk of adverse impacts on the site and surrounds.

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# 1 INTRODUCTION

Astute Environmental (Astute) was engaged by Walker Group Holdings (the Proponent) to conduct an air quality assessment of the Toondah Harbour Project (the Development).

## 1.1 Project Description

Toondah Harbour is an existing marine facility located in the suburb of Cleveland in Redland City, approximately 30 kilometres south of Brisbane. The harbour serves as the base for water taxi, passenger and vehicular ferry services between the mainland and North Stradbroke Island, as well as a public boat ramp for recreational vessels. The overwater areas are made up of a mix of tidal and intertidal habitats with the majority being intertidal mudflat but also include existing wet berths, swing basin and the public navigation channel known as Fison Channel.

The harbour was constructed on reclaimed land on the Cleveland Coast and has been operational since 1972 when it was used as barge terminal to support sand mining operations on North Stradbroke Island with vehicular ferries commencing in 1974. The most recent upgrades occurred in the early 2000s when additional hardstand car parking and the boat ramp were added.

In June 2013, the Queensland Government declared Toondah Harbour a Priority Development Area (PDA) under the Economic Development Act 2012 (ED Act) at the request of Redland City Council (RCC). The intent of the PDA is to revitalise the harbour and establish Toondah Harbour as a high-quality urban environment that capitalises on the high amenity of Moreton Bay and provides opportunities for a range of activities including outdoor dining, tourism facilities, residential, commercial development, marina and a public beach.

- After an open tender process run by the State and Local Government Walker Group Holdings Pty Limited were announced as preferred partner for development of the PDA and proposes to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina. Key components of the project include:
- Maintenance and Capital dredging of approximately 500,000m3 marine sediment to widen and lengthen Fison Channel to meet the minimum requirements for safe navigation set out in the PIANC (2014) Harbour Approach Channels Design Guidelines and Australian Standard 3962 – 2001 Guidelines for the Design of Marinas;
- An upgraded harbour precinct including improved vehicle and people loading facilities, increased parking, berthing for tourism operations, transport hub and improved marine service facilities;
- Beneficial re-use of the dredged material to create a reclamation on the tidal flats north of the harbour area to create a landform for the recreational, tourism, residential and marina uses;
- An approximately 200 berth marina and associated facilities; and
- A network of opens space and recreational areas including a 3.5 hectare (ha) foreshore park, a wetland and cultural education centre and range of boardwalks, plazas, nature trails, pocket parks.

An integral part of the development is capital dredging to widen and deepen the Fison Channel and extend the swing basin. This existing public navigation channel is 2.55km long and typically 45m wide (excluding batters) with a target depth of -2.5m LAT. It extends from the swing basin immediately in front of the existing barge berths, via three significant bends to exit into deeper water approximately 1.5km past Cassim Island. The swing basin's existing diameter is significantly below the accepted minimum of 1.5 times the maximum length of vessels currently utilising the harbour. Fison channel itself is too narrow for larger vessels such as the frequent passenger and vehicle ferries to safety pass each other therefore is operating as a one-way access with vessels forced to wait at either end for the channel to clear prior to commencing navigation. Channel use is constantly monitored by Stradbroke Ferries operator to safeguard against navigational issues. Barges travelling to and from North Stradbroke Island are also regularly observed 'bottoming out' in the channel, generating turbidity plumes and risking damage to the vessels.

Capital dredging of Fison Channel has been designed to provide safe, two-way navigation for all vessels including vehicle ferries. The swing basin diameter will be increased to improve manoeuvrability and Fison Channel widened to 75m (excluding batters) with a target depth of -3m LAT. The increased target depth results in dredging to the end of the channel (approximately 2.55km) to meet the natural sea floor depth. Dredging will result in approximately 530,000m3 of material including an allowance for over dredging.

Dredging will be carried out mechanically using a barge mounted backhoe dredge or similar, transported to the reclamation area via hopper or flat top barges and unloaded at a temporary dock constructed specifically for the purpose of unloading the dredged material. A perimeter bund will be established around the northern and southern reclamation areas to contain the dredged material and limit indirect impacts outside of the development footprint. The bund will comprise an inter-locking sheet piling cut-off wall, vibrated into place, within a rock revetment bund capped by a trafficable gravel vehicle and machinery access at a level above HAT.

Beneficial reuse of dredge materials is proposed to reclaim land for development areas. The formation of land through reclamation works will be split into two broad stages, stage one (referred to as the northern precinct) will incorporate the northern residential and central marina precincts and stage two is the southern residential precinct. A third on land stage including upgrading of the port facilities and development of the commercial area will occur concurrently with the landform stages over the life of the project. Works to upgrade to port will be carried out early in the project staging and will commence in the first year of construction. The stages are broadly described below.

### 1.1.1 Stage 1 Reclamation - Northern Residential and Central Marina Precinct

The initial development sequencing will produce the Northern Precinct, which includes the northern residential area and park as well as central marina precinct including commercial space. The delivery of the northern precinct will comprise enclosing the entire area by sheet piling and creation of a bund using imported rock armouring, stabilised landform earthworks and marina earthworks, subdivisional roadworks, and utility servicing ready for allotment building works to commence.

The northern residential precinct and open space areas will be formed using stabilised material from within the bunded area and material excavated to create the internal waterways and marina. Once material has been removed from this area a receiving dock and dredge material transfer area will be constructed and the first dredging campaign will commence to create the port swing basin and deepening and widening of the inner navigation channel. The dredge material will be used to create the landform around the marina with temporary earthen bunds used to separate internal works areas.

### 1.1.2 Stage 2 Reclamation - Southern Residential Precinct

The southern residential precinct is anticipated to commence approximately six years after the start of works; however, the timing may change as a result of several factors such as commercial requirements and ongoing review of the environmental management framework. This precinct encompasses close to half of the residential yield for the project as well as a boat ramp, rockwall breakwater, conservation area and will provide open water access to the marina.

Construction staging will be similar to Stage one with the entire precinct enclosed by sheet piling and rock bund, and material within the reclamation area and internal access channel stabilised and utilised for land formation before the second dredging campaign commences and material used to create the landform. Water access to the marina will be provided early in this stage creating improved water flow for the marina.

### 1.1.3 Ferry Terminal and Land-side Residential Development Area

The delivery of carpark works will comprise the stabilisation of the existing dredge spoil disposal area and the clearing of mangroves and construction of earthworks to provide a significant extension to the existing carparking facility servicing the island ferry operation. Additional fill material requirements will be supplied from nearby quarries or using stabilised material from the main reclamation area works.

The construction of the carparking facility will include upgrading of the waterline revetment works, as required.

The project has been designed to balance cut and fill with all dredged and excavated sediments to be dried on site and used within the reclamation, minimising the requirement for imported material. The only materials expected to be sourced externally for construction of the landform is rock armouring for the creation of the external bunds, agricultural lime to treat potential acid sulfate soils and a small amount of quarry material to assist in stabilising the dredge material.

## 1.2 Scope of Study

The objectives of this assessment were to prepare an assessment to ensure that the development is planned, designed, constructed and operated to protect air quality.

Specific requirements to address potential air quality concerns relating to the EPBC Act EIS Guidelines for the preparation of a draft Environmental Impact Statement include:

1. Describe the characteristics of any contaminants or material released during each stage of the construction, commissioning or operation of the project, including point source and fugitive emission with reference to:
    a. Sensitive receptors in the neighbouring community; and
    b. Marine and migratory fauna.
2. Predict impacts of the releases from the project on the values of the receiving air environment using recognised quality assured methods. The description of impacts should take into consideration the assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts. The impact prediction must:
    a. Address residual impacts on the environmental values (including appropriate indicators and air quality objectives of the air receiving environment, with reference to sensitive receptors. This should include all relevant values potentially impacted by the activity, under the EP Act, Environmental Protection Regulation 2008 and Environmental Protection (air) Policy 2008 (EPP AIR).
    b. Address the cumulative impact of the release with other known releases of contaminants, materials or wastes associated with existing development and possible future development (as described by approved plans and existing project approvals)
    c. Quantify the human health risk and amenity impacts associated with emissions from the project for all contaminants, including those covered by the National Environment Protection (Ambient Air Quality) Measure or EPP (Air)

3. Describe the proposed mitigation measures for air quality and how the proposed activity will be consistent with best practice environmental management. Where a government plan is relevant to the activity or site where the activity is proposed, describe the activities consistency with that plan
4. Describe how the achievement of the objective would be monitored, audited and reported, and how corrective actions would be managed.

The methodology used to meet the scope of work is provided below in Sections 2 and 3.

# 2 LEGISLATION, POLICY AND PLANNING INSTRUMENTS

The policies and acts relevant to the site are discussed below.

## 2.1 Queensland Legislation

The *Environmental Protection Act 1994* (OQPC, 2020) ("the EP act") is the primary environmental regulation in Queensland. It lists obligations and duties to present environmental nuisance and harm. The EP act sets out enforcement tools that can be used when offences or acts of non-compliance are identified.

Under the EP act, there is the general environmental duty which applies to everyone. The general environmental duty means that a person must not perform any activity that causes or could cause environmental harm unless management methods are in place to prevent or minimise the harm. The management methods include all reasonable and practicable measures to prevent minimise the potential harm.

Under the EP act there are a number of subordinate legislations that support the act, relevant to air quality are:

- the Environmental Protection Regulation 2019 (OQPC, 2019b); and
- the Environmental Protection (Air) Policy 2019 (OQPC, 2019a).

The Environmental Protection Regulation 2019 prescribes processes contained with the EP Act, including Environmentally Relevant Activities regulated under the EP Act. The Environmental Protection (Air) Policy[a] 2019 identifies values to be enhanced or protected, sets objectives (limits) for impact, and provides a framework for informed decisions concerning air quality.

The limits (criteria) with the EPP (Air) are used within modelling assessments to determine the relative risk of a project. The methodology for this project is detailed in Section 3 and follows the document *Application requirements for activities with impacts to air* (DES, 2019).

The criteria relevant to this project are summarised in Table 2-1 below.

## 2.2 National Environment Protection (Ambient Air Quality) Measure

The National Environment Protection (Ambient Air Quality) Measure (Australian Government, 2003) (often referred to as the NEPM) is a standard (or set of standard) air quality limits that set quantifiable characteristics of the environment against which environmental quality can be assessed. Across Australia, monitoring is performed by each state each year to determine current air quality trends with regard to the NEPM criteria. The overarching aim is for air quality across Australia to meet these limits.

[a] EPP (Air)

The current version was published in 2003 however a number of variations (including proposed variations) have occurred in the years since. In 2005 the following amendment was proposed for particulate matter (PM):

- Amending the status of the annual average and 24-hour average $PM_{2.5}$ 'advisory reporting standards' to 'standards';
- Including an annual average $PM_{10}$ standard of 25 µg/m$^3$;
- Including an aim to move to annual average and 24-hour $PM_{2.5}$ standards of 7 µg/m$^3$ and 20 µg/m$^3$ by 2025;
- Initiating a nationally consistent approach to reporting population exposure to $PM_{2.5}$; and
- Replacing the five-day exceedance form of the 24-hour $PM_{2.5}$ and $PM_{10}$ standards with an exceptional event rule[b].

It was most recently proposed in 2019 that the NEPM be updated to strengthen its ozone, nitrogen dioxide and sulfur dioxide standards. The proposed Sulfur Dioxide and Nitrogen dioxide standards were[c]:

- 1 hour Nitrogen dioxide – 0.09 ppm;
- 1 year Nitrogen dioxide – 0.19 ppm;
- 1 hour Sulfur dioxide – 0.10 ppm; and
- 1 day Sulfur dioxide – 0.02 ppm.

However, it is important to note that some of these changes are goals for the future, i.e. $PM_{2.5}$ has a goal set at 2025.

The criteria relevant to this project are summarised in Table 2-1.

## 2.3 National Environmental Protection (Air Toxics) Measure

The National Environment Protection (Air Toxics) Measure (Australian Government, 2011) (often referred to as the Air Toxics NEPM) is a standard (or set of standards) that set quantifiable characteristics of the environment against which environmental quality can be assessed.

The Air Toxics NEPM covers:

- Benzene
- Formaldehyde
- Benzo(a)pyrene as a marker for
- Polycyclic Aromatic Hydrocarbons
- Toluene
- Xylenes (as total of ortho, meta and para isomers)

Relevant to this study are Benzene, Toluene and Xylenes. The criteria relevant to this project are summarised in Table 2-1.

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[b] Allows data to be assessed having regard to extreme events including dust storms and bushfires.
[c] These are reproduced below in the units of µg/m$^3$

## 2.4 Dust Deposition

Dust deposition is important as it is used to determine the risk of nuisance dust impacts.

OQPC (2019a) does not have a Total Suspended Particulate objective for assessing impact. Nuisance impacts associated with dust can occur before health limits are exceeded.

Dust deposition in Queensland is frequently assessed against the criteria detailed in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA, 2016) which details a 2 g/m$^2$/month maximum increase or 4 g/m$^2$/month total.

In addition to this, the nuisance criterion in the Good Practice Guide for Assessing and Managing Dust (NZMFE, 2016) is relevant. It sets a criterion of 60 µg/m$^3$ as a rolling 24-hour average for a sensitive receiving environment. Concerning the criterion, NZMFE notes “These triggers are intended to be used for the proactive management of dust on-site” and “The TSP trigger levels have been successfully used to control dust on New Zealand Transport Agency road construction projects and have also been found effective by regional councils and independent consultants at reducing dust complaints on other sites (e.g. quarries)”. This criterion has not been modelled, however, it has been included in this report as part of the proposed management measures in Section 6.

## 2.5 Odour Guideline

The *Guideline: Odour Impact Assessment from Developments* (DEHP, 2013) (“the odour guideline”) is the principal guidance document used in Queensland for assessing odour impacts.

The odour guideline notes perception of odours can be characterised by four major attributes or dimensions:

- Detectability (or odour threshold) refers to the minimum concentration of odorant stimulus necessary for detection in some specified percentage of the test population. The odour concentration of a sample can be characterised by the number of dilutions to reach this detection threshold;
- Intensity refers to the perceived strength or magnitude of the odour sensation which increases linearly with the logarithm of the odour concentration;
- Hedonic tone is a judgement of the relative pleasantness or unpleasantness of an odour; and
- Odour quality is simply a qualitative description of what the odour smells like.

The term nuisance is used to describe the cumulative effect on people caused by repeated events of annoyance over an extended period. Nuisance results when people are affected by an odour they can perceive in their living environment, at home, at work, or during recreational activities, and:

- the appraisal of the odour is negative;
- the perception occurs repeatedly;
- it is difficult to avoid perception of the odour; and
- people believe that the odour has a negative effect on their well-being.

Odour impact assessment criteria are set out in the odour guideline for use in dispersion modelling studies. However, in the context of the dredge material, which contains a range of organic and inorganic materials in very low concentrations, the potential strength and extent of odour emissions from the Development cannot be accurately quantified. Therefore an odour dispersion modelling study and odour impact assessment criteria are not useful in assessing or managing odour impacts.

Further information is provided in Section 5.1.3 below however odours are expected to be minor and easily managed through a range of standard measures.

## 2.6 Summary of Criteria

The various State and Federal air quality criteria are summarised in Table 2-1.

**Table 2-1: Summary of State and Federal Criteria**

| Pollutant | EPP Air 2019 (or as noted) | NEPM 2003 | Proposed Variation NEPM 2015 or 2019 | Air Toxics NEPM Monitoring Investigation Level |
|---|---|---|---|---|
| Total Suspended Particles | 90 µg/m$^3$ 1 year (health and wellbeing) (OQPC, 2019a)<br>60 µg/m$^3$ 24 hour average (NZMFE, 2016) | N/A | N/A | N/A |
| $PM_{10}$ | 50 µg/m$^3$ 1 day<br>25 µg/m$^3$ 1 year<br>no exceedances allowable | 50 µg/m$^3$ 1 day<br>(5 exceedances a year) | 50 µg/m$^3$ 1 day<br>25 µg/m$^3$ 1 year<br>exceptional event rule | N/A |
| $PM_{2.5}$ | 25 µg/m$^3$ 1 day<br>8 µg/m$^3$ 1 year | Advisory<br>25 µg/m$^3$ 1 day<br>8 µg/m$^3$ 1 year | 25 µg/m$^3$ 1 day<br>8 µg/m$^3$ 1 year<br>exceptional event rule[d] | N/A |
| Nitrogen Dioxide | 250 µg/m$^3$ 1 hour 1 day exceedance a year (health and wellbeing)<br>62 µg/m$^3$ 1 year (health and wellbeing)<br>33 µg/m$^3$ 1 year (health and biodiversity of ecosystems) | Same as health and wellbeing EPP Air 2019 | 188 µg/m$^3$ 1 hour<br>39 µg/m$^3$ 1 year<br>(for consultation only) | N/A |
| Sulfur Dioxide | 570 µg/m$^3$ 1 hour (health and wellbeing)<br>229 µg/m$^3$ 1 day (health and wellbeing)<br>57 µg/m$^3$ 1 year (health and wellbeing)<br>31 µg/m$^3$ 1 year (protecting agriculture)<br>21 µg/m$^3$ 1 year (forests and natural vegetation | Same as EPP Air 2019 for health and wellbeing | 285 µg/m$^3$ 1 hour<br>57 µg/m$^3$ 1 day<br>(for consultation only) | N/A |
| Carbon Monoxide | 11 mg/m$^3$ 8 hours (1 day a year exceedance) | Same as EPP Air | Same as EPP Air | N/A |
| Deposition | N/A<br>2 g/m$^2$/month maximum increase or<br>4 g/m$^2$/month total<br>(NSW EPA, 2016) | N/A | N/A | N/A |
| Benzene | 5.4 µg/m$^3$ 1 year (health and wellbeing) | N/A | N/A | 8.1 µg/m$^3$ |

[d] Proposed new standard from 2025 onwards, not relevant to this project at this point in time.

| Pollutant | EPP Air 2019 (or as noted) | NEPM 2003 | Proposed Variation NEPM 2015 or 2019 | Air Toxics NEPM Monitoring Investigation Level |
|---|---|---|---|---|
| Toluene | 4.1 µg/$m^3$ 24 hours (health and wellbeing)<br>0.1 µg/$m^3$ 1 year (health and wellbeing)<br>1,100 µg/$m^3$ 30 minute (protecting aesthetic environment) | N/A | N/A | Same as EPP Air |
| Xylene | 1.2 mg/$m^3$ 1 day (health and wellbeing)<br>950 µg/$m^3$ 1 year (health and wellbeing) | N/A | N/A | Same as EPP Air |

# 3 ASSESSMENT METHODOLOGY

The methodology followed in assessing and evaluating potential air quality impacts is outlined below:

- **Define project scope:** This was discussed in Section 1.
- **Identify sensitive receptors**: A site visit was conducted by Astute to inspect nearby dwellings and commercial sites with confirmation of their locations having regard to recent aerial imagery. This is discussed in Section 4.1.
- **Determine assessment criteria**: State and federal legislation and policies that define air quality criteria were discussed and analysed. This is described in Section 2.
- **Examine the existing environment and meteorology**: Meteorological data was obtained and examined from the nearest weather stations (Bureau of Meteorology at Redlands and the old Redlands HRS station) and pollutant concentration data from the Department of Environment and Science stations in the area. The data were analysed to define the existing environment. This is described in Section 4.
- **Monitor for Hydrogen Sulphide**: Hydrogen sulphide is an odorant that is known to commonly occur around sites near mangroves. A real-time monitoring method was selected a real-time $H_2S$ monitor was installed at two locations. The aim was to define whether the gas was present naturally. This is described in Section 3.2.
- **Identifying activities which could emit to air**: The proposed activities were examined and identified that had the potential to emit to air. Emission sources included exhaust emissions, wind erosion, and earthmoving activities including vehicle movements, loading, unloading and placement of materials. This is described in Section 3.1.
- **Modelling methodology adopted**: A standard assessment method was adopted that is consistent with Application Requirements For Activities With Impacts To Air (DES, 2019). A combination of TAPM/CALMET/CALPUFF which is considered best practice was used for the modelling assessment. This is described in Section 3.3.
- **Estimate emissions:** Emissions to air from each of the activities were made using standard methods which included National Pollutant Inventory (NPI) Handbooks and US EPA AP42 methods. The methods were supplemented by other recognised publications.  This included assuming that mitigation was employed on the site to reduce dust emissions.  This is described in Section 3.4 and the Appendix.
- **Assessment of Predicted Impacts:** The outputs from the dispersion model CALPUFF were examined with and without background concentrations and the results compared to the legislation previously identified. The results were then examined having regard to the proposed mitigation measures. This is described in Section 5.
- **Detail management and mitigation measures**: Recommended ongoing management and mitigation measures for the phases of the project are detailed in Section 6.
- **Analyse the risk**: Commentary is provided with regard to the assessment performed, the predicted impacts, the criteria adopted and the proposed mitigation measures. Recommendations are provided concerning ongoing monitoring that would be used in the context of a dust management plan for the sites. This is described in Section 7.

## 3.1 Air Quality Risks

Concerning air quality, due to the proximity of the site to the existing sensitive locations, three main components have the potential to lead to impacts if not managed correctly:

- Dredging and reclamation;
- Civil Construction; and
- Ongoing use of the development site.

Of these three activities, the dredging and reclamation work would have the highest potential risk due to the extent of the area covered and the number of vehicles in operation. The civil construction and the ongoing use represent a negligible risk from an air quality perspective. This is addressed in more detail in section 3.1.3.

The main pollutants are particulate matter from earthmoving and non-road vehicle exhausts (i.e. earthmoving equipment), and combustion gases from the operation of vehicles or equipment with internal combustion engines.

### 3.1.1 Dredging and Reclamation

Emissions from the dredging and reclamation will include:

- Exhaust emissions from construction equipment (fine particulate matter, Oxides of Nitrogen, Sulfur Dioxide, Carbon Monoxide and volatile organic compounds);
- Exhaust emissions from the two tugboats, and excavator on dredge barge (particulate matter, Oxides of Nitrogen, Sulfur Dioxide, Carbon Monoxide and volatile organic compounds);
- Particulate emissions from the handling of materials, wind erosion and vehicle movements (particulate matter); and
- Potential short-term odour from organic matter in the dredged material.

Potential impacts from these activities would be localised and limited to the period when the activities are occurring. Emission estimation for these activities is described in Section 3.4.

Particulate matter can take the form of the total size fraction (total suspended solids (TSP)) or particulate matter less than 10 micrometres in diameter ($PM_{10}$) or less than 2.5 micrometres in diameter ($PM_{2.5}$). Estimates have been made for all size fractions.

### 3.1.2 Civil Construction

Civil construction refers to the design and construction of roads and infrastructure, including sewers on site. The civil construction activities would occur once the reclamation work is finalised and the site is prepared for the ability to construct buildings on the site. Civil construction occurs at all new developments which require similar infrastructure.

The civil construction elements would not occur at the same time in the same area as the reclamation work which involves a much larger area and more equipment. The primary risk from the civil works is particulate emissions from earthworks.

Due to the proximity of the site to nearby sensitive locations, and its proximity to Moreton Bay, conservative management measures are recommended reflecting the sensitivity of the area and to ensure that the development is planned, designed, constructed and operated to protect air quality.

The management methods to manage the risk of particulate impacts from civil construction are described in Sections 6 and 7 below.

### 3.1.3 Ongoing Use and Operations

Compared to the other two elements, ongoing use and operations are expected to have a low risk and not be significantly different from what is occurring now.

Once the civil works are complete, development will occur on site which primarily consist of the construction of buildings. The primary risk concerning these activities will be particulate impacts. These can be managed via industry good practice. Whilst Redland City Council does not provide guidance, other Councils including Gold Coast City Council has publications concerning this[5].

Other uses including food outlets may generate odour from cooking which could lead to localised impacts. These should be assessed in line with Redland City Council's requirements for similar operations.

The management methods to manage the risk of particulate impacts are described in Sections 6 and 7 below.

Other ongoing uses relevant to air quality will include harbour operations, the boat ramp and marina and maintenance dredging. Based on the masterplan, the capacity of the harbour in unlikely to significantly change from the current use although larger vessels will be used with a small number of additional boat movements. By adopting the best practice management methods detailed in Section 6 the risks associated with the dredging and reclamation work and civil construction work will be minimal.

## 3.2 Baseline $H_2S$ Monitoring

Mangroves are common through Moreton Bay, particularly in the Redlands area. During May to November, a "rotten egg" type odour (Hydrogen Sulphide[6]) is often detected near mangroves (Redland City Council, 2016), which is a result of the breakdown of mangrove seeds by bacteria living in the soil in which the mangroves grow.

It is possible that during dredging, short term $H_2S$ generation can occur as a result of the dredged material being exposed to the air, and oxidising. Project specific sediment analysis indicated there may be potential acid sulphate soils in the dredge material however this will be treated so that acid sulphate soils do not form to reduce the risk of adverse impacts. Considering the above, it was considered prudent to collect $H_2S$ concentration data to demonstrate if $H_2S$ was present in the area.

As a result of this, real-time monitoring was performed in two locations.

### 3.2.1 Sample Location Selection

When selecting sampling locations consideration is given to *AS/NZS 3580.1.1:2016 Methods for sampling and analysis of ambient air Guide to siting air monitoring equipment* (Standards Australia,

[5] https://www.goldcoast.qld.gov.au/documents/bf/dirt-dust-from-construction.PDF
[6] $H_2S$

2016). The standard includes $H_2S$ monitoring, however only for AS/NZS 3580.8.1 which is gas Chromatographic Method for airports.

Therefore, the generic requirements for monitoring locations can be considered. The electrochemical cell method used here (Acrulog[7] low level units) is commonly used to monitoring $H_2S$ in real-time, for example, Sydney Water (2018) allows the use of electrochemical cells for monitoring odour control units. The units have a small pump, and draw air in and pass it over the electrochemical cell which results in a concentration being recorded due to the reaction between the cell and the $H_2S$ concentration (the chemical reacts with the $H_2S$). A stock photograph showing a PPB unit is shown below in Figure 3-1.


**Figure 3-1: Acrulog PPB Unit (without housing that includes modem or power system)[8]**

[7] Acrulog is a modernised version of the Odalog systems.
[8] Stock photo

As the units here are small compared to the larger equipment typically mounted in trailers such as the methods referred to in *AS/NZS 3580.1.1:2016*, the primary siting considerations were:

- To locate the units in locations which reflected both existing receptor locations and prevailing winds; and
- To locate the units in locations where access was able to be obtained to mount the units on a telephone pole or similar, at a height to reduce the risk of vandalism (the sample unit was out of reach for a person with a stick or throwing objects).

The sample locations selected were:

- The corner of Erobin and Russell Street – located west of the development, good site access including access to pole, downwind of proposed dredging locations and near to mangroves; and
- The Sealink Carpark on Emmett Drive – located west of the proposed dredging and reclamation areas as well as the ferry loading and unloading area.

The location criteria from AS3580.1.1 are described in Table 3-1 and commentary is provided concerning the requirements of the standard and any variations from it. The sample locations are shown in Figure 3-2, Figure 3-3 and Figure 3-4. The units were installed on 4 March 2020 and set to log every 10 minutes.

**Table 3-1: Locating Criteria – $H_2S$ AS/NZS 3580.1.1**

| Requirement | Complies | Comment |
|---|---|---|
| Clear sky angle 120° | No | Units do not have sample inlets at top. Not significant as primary sampling area is to the east, unobstructed in that direction. |
| Unrestricted airflow of 270° around sample inlet or 180° if the inlet is on side of a building | Yes | Yes – unobstructed on the eastern side. |
| 10 m from any object with a height exceeding 2 m below the height of the sample inlet. | No | Foreshore has many buildings and trees. Unable to find a secure location that was unobstructed. |

Note: Requirements are for an airport where obstructions are limited.

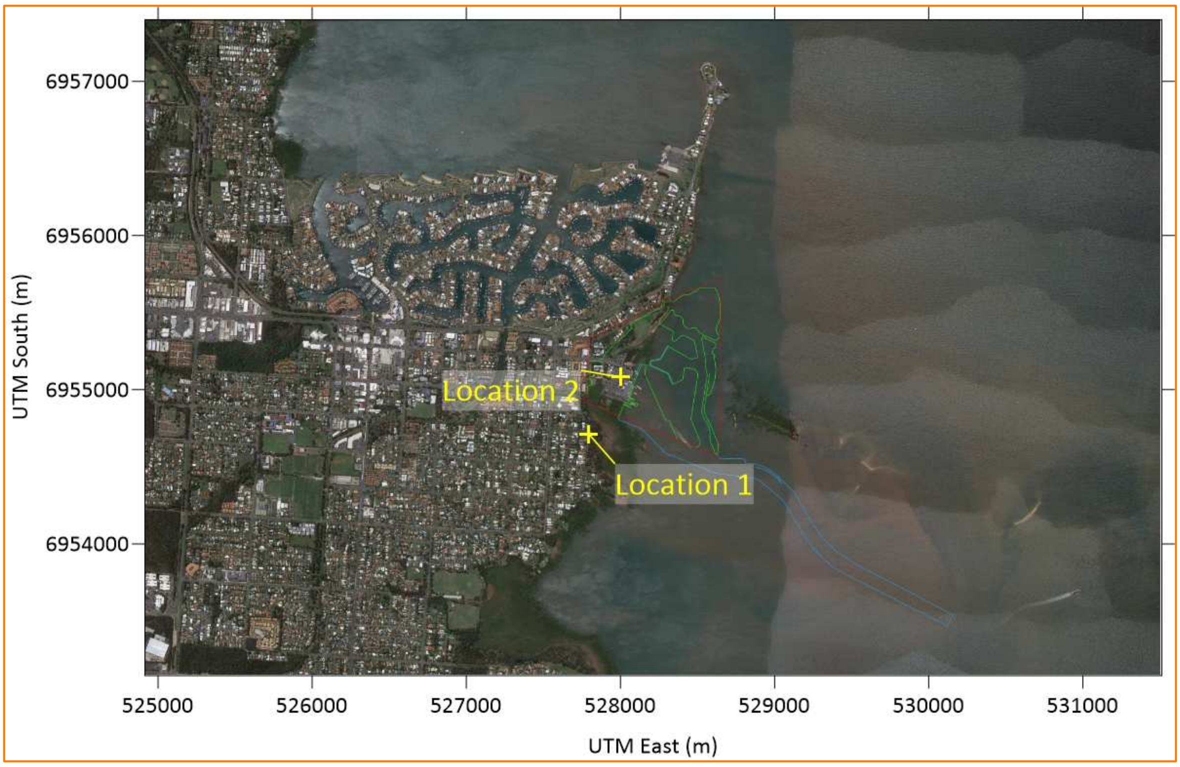



**Figure 3-2: Sample Locations**


**Figure 3-3: Location 1 – Acrulog Serial Number 191202312**


**Figure 3-4: Location 2 – Acrulog Serial Number 191202311**

### 3.2.2 Calibration

The units came with an initial calibration dated 30 January 2020 for 500 ppb (0.5 ppm). On 24 July 2020, both units were calibrated onsite by Acrulog staff based on a gas standard of 420 ppb. Unit

191202311 reported a concentration +5.7% higher than the standard, and unit 191202312 reported a concentration of +1.9%. Both units were subsequently recalibrated to the gas standard and certificates issued by Arculog.

The results from the loggers are summarised in Section 4.

## 3.3 Modelling Methodology

The assessment and modelling methodology described in Section 3 is shown graphically in Figure 3-5.

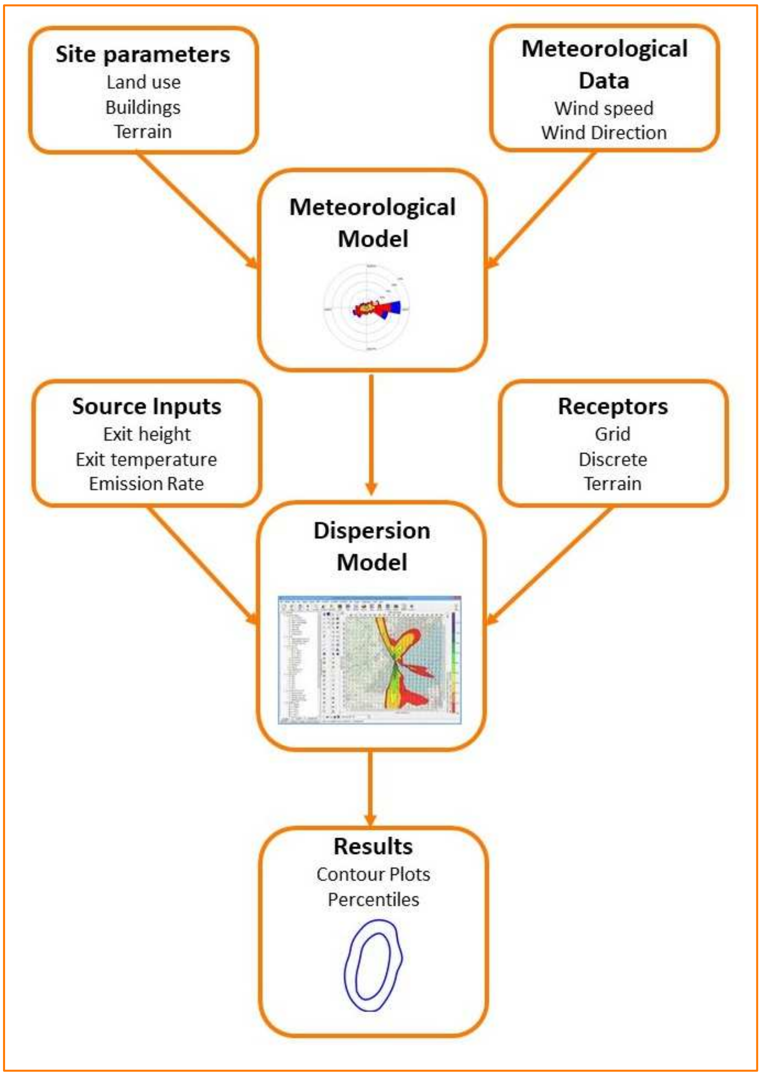



**Figure 3-5: Modelling Methodology**

### 3.3.1 Meteorological Methodology

For this project, a combination of the hybrid approach (Outer Calmet Grid) and the no-observation approach (Inner Calmet Grid) as detailed in the *Generic Guidance and Optimum Model Settings for* *the CALPUFF modelling system for inclusion into the Approved Methods* (NSW EPA, 2016) was used The use of this methodology is consistent with DES (2019).

In simple terms, an outer domain was modelled with observed data from various weather stations, and then an inner domain based on the outer domain outputs. This is described further below.

### 3.3.2 TAPM

TAPM v4 predicts meteorological data including wind speed and direction in an area using a series of fluid dynamics and scalar transport equations (Hurley, 2008a; Hurley, 2008b; Hurley, et al., 2008c) and it has both prognostic meteorological and air pollution (dispersion) components. The benefit of using TAPM is that key meteorological aspects including the influence of terrain induced flows are predicted both locally and regionally.

Data from TAPM was used to be the initial guess field (coarse starting grid of 1,000 metres) for CALMET.

### 3.3.3 CALMET

CALMET is the meteorological pre-processor to CALPUFF and generates wind fields which include slope flows, terrain effects, and can incorporate factors including terrain blocking. CALMET uses meteorological inputs in combination with land use and terrain information for the modelling domain to predict a three-dimensional meteorological grid (which includes wind speed, direction, air temperature, relative humidity, mixing height, and other variables) for the area (domain) modelled in CALPUFF.

CALMET was modelling using the nested approach, where the final results from a coarse-grid run were used as the initial guess to the fine inner grid. With this methodology terrain features including slope flows, blocking effect can be allowed to take effect and the larger–scale wind flow provides a better start in the fine-grid run.

The outer domain (40 km × 40 km) was modelled with a resolution of 0.4 km. TAPM-generated three-dimensional meteorological data was used as the initial guess wind field and the local topography and available surface weather observations in the area were used to refine the wind field defined by the TAPM data.

Hourly surface meteorological data from Bureau of Meteorology (BOM) station located at Brisbane Airport, Archerfield Airport, Banana Bank North Beacon, Redland (Alexandra Hills) along with Department of Environment and Science Air Quality Monitoring Stations at Springwood were incorporated in the outer domain modelling. The output from the outer domain CALMET modelling was then used as the initial guess field for the inner domain CALMET modelling. The inner domain encompasses an area of 10 km × 10 km.

The 10 km x 10 km inner domain was centred near the project site. A terrain and land use resolution of 30 m was initially used throughout the domain. The terrain data was derived based on the SRTM dataset and the Land use was initially based on the Australia Pacific Global Land Cover Characterization (GLCC) dataset at 1km resolution. The land use was then manually edited at 100 m resolution based on a recent aerial photograph of the area. Elements of the terrain for the site was manually adjusted to height of 3m to account for the project landform over water.

Table 3-2: TAPM and CALMET Setup

| Model | Parameter | Value |
|---|---|---|
| TAPM (v 4.0.5) | Number of grids (spacing) | 30km, 10km, 3km, 1km |
| | Number of grid points | 45 x 45 x 25 (vertical) |
| | Year of analysis | 2017 |
| | Centre of analysis | 27° 32' South (latitude), 153° 16' East (longitude) |
| | Meteorological data assimilation | N/A |
| | Radius of influence | N/A |
| CALMET (v 6.334) – outer grid | Meteorological grid domain | 40km x 40km |
| | Meteorological grid resolution | 0.4km |
| | South-west corner of domain | X = 506.000 km, Y = 6934.500 km |
| | Surface meteorological stations | Brisbane Airport AWS<br>Archerfield Airport AWS<br>Banana Bank North Beacon<br>Redlands (Alexandra Hills)<br>DSITIA/DES Springwood |
| | Upper air meteorological data | Model generated. |
| | 3D Windfield | m3D from TAPM (1.0km) input as in initial guess in CALMET |
| | Year of analysis | 2017 |
| | Terrad | 6.5 km |
| | R1/R2 | 2.5/5 |
| | Rmax1/Rmax2/Rmax3 | 5/10/5 |
| CALMET (v 6.334) – inner grid | Meteorological grid domain | 10km x 10km |
| | Meteorological grid resolution | 0.10km |
| | South-west corner of domain | X = 522.000 km, Y = 6949.500 km |
| | Surface meteorological stations | N/A |
| | 3D Windfield | 3D output from outer domain model run |
| | Year of analysis | 2017 |
| | Terrad | 1.2 km |

### 3.3.4 Dispersion Modelling

CALPUFF simulates complex effects including vertical wind shear, coastal winds including recirculation and katabatic drift. The model employs dispersion equations based on a Gaussian distribution of puffs released within the model run, and it takes into account variable effects between emission sources.

Key inputs used in CALPUFF for the project are summarised below in Table 3-3.

**Table 3-3: CALPUFF Setup**

| Model | Parameter | Value |
|---|---|---|
| CALPUFF (v 6.40) | Meteorological grid domain | 10km x 10km |
| | Meteorological grid resolution | 0.10km |
| | South-west corner of domain | X = 522.000 km, Y = 6949.500 km |
| | Method used to compute dispersion coefficients | 2 - dispersion coefficients using micrometeorological variables |
| | Minimum turbulence velocity (Svmin) | 0.2 m/s, 0.37 m/s over water |
| | Coastline.dat | Yes – manually digitised |
| | Default settings | All other CALPUFF defaults have been used in line with OEH (2011). |

### 3.3.5 Modelling Scenarios

The dispersion modelling has been presented based on two scenarios for the dredging and reclamation phase of the development as follows:

- Stage 1 of the development encompasses the creation of the northern residential and central marina precincts as well as dredging of the port turning basin and inner entrance channel. The upgrade of on-land facilities at the ferry terminal will occur in the early phases of Stage 1; and
- Stage 2 of the development encompasses the creation of the southern residential peninsula and dredging of the outer port entrance channel.

Both stages modelled represent worst case emissions scenarios both in the extent of the earthworks and proximity to the sensitive receptors and have been modelled separately. The stages are presented below in Figure 3-6 and Figure 3-7.

Potential air quality impacts from the civil construction and ongoing use and operations of the development have not been estimated and modelled due to their smaller and or negligible emission rates as well as the proposed Management Measures detailed in Section 6.

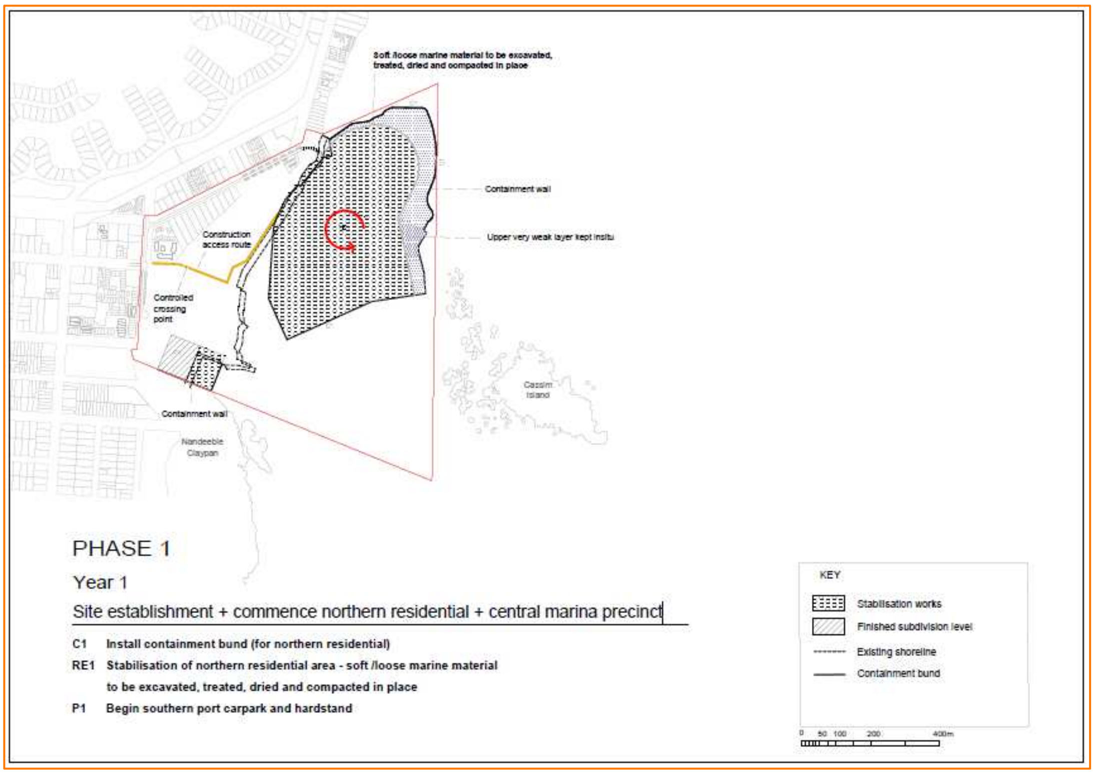



**Figure 3-6 Stage 1 – Project Phase 1; Year 1**

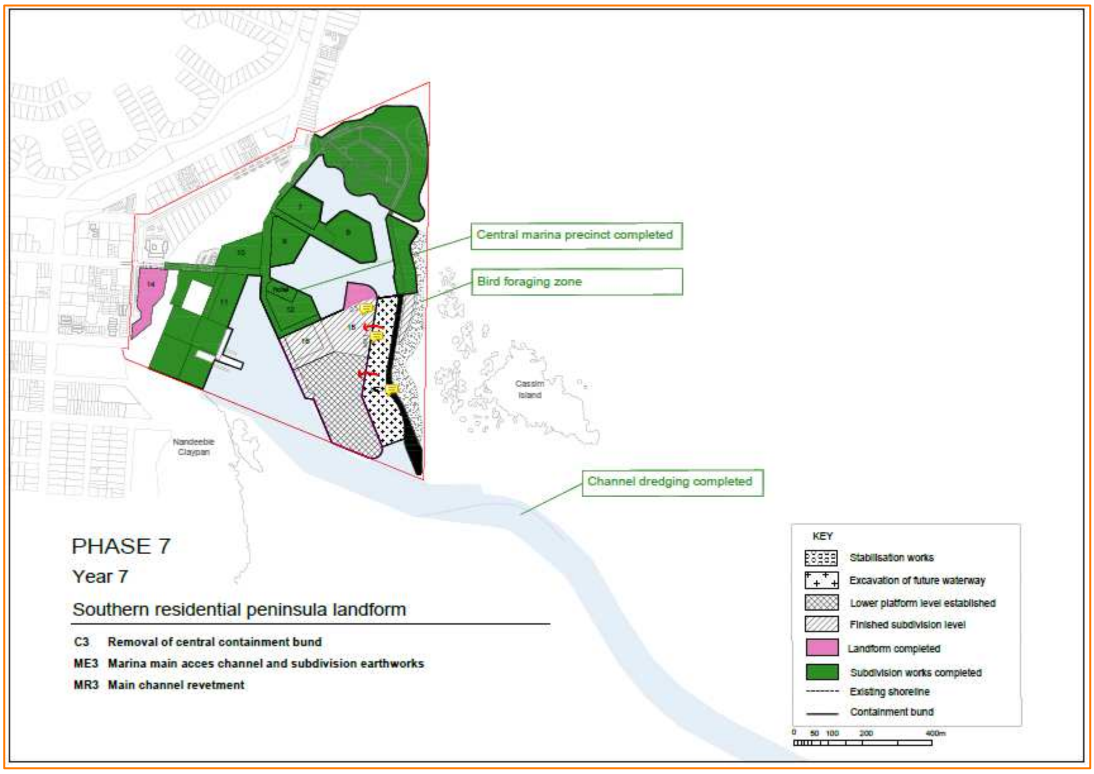



**Figure 3-7 Stage 2 – Project Phase 7**

### 3.3.6 Representative Year

The selection of a representative meteorological year for dispersion modelling is important as typically, one single year of data is included in an assessment. Critical meteorological factors for air quality assessments include wind speed and temperature. These need to be assessed against long term data to determine which year is most similar to the average conditions rather than simply selecting a modelling year at random.

The Redland site has only been operating since August 2015, which isn't sufficient enough time to evaluate long term trends. Therefore, an analysis of the data and site station information collected at the Brisbane Airport Bureau of Meteorology site (BoM; Number: 040842) was performed.

1-minute data from the Brisbane Airport station was obtained and then averaged using standard methods (scalar wind speed and vector wind direction averaging). This data was then averaged by hour of day for the years 2010 to 2019 for wind speed, temperature and humidity, and compared these data to the long term averages (i.e. all hours from 2012 to 2010).

The data are summarised below as box and whisker plots. A box and whisker plot is a figure that presents information based on factors such as minimum and maximum values, the 25$^{th}$ and 75$^{th}$ quartile values and averages. They are useful for indicating whether a distribution is skewed and whether there are potential unusual observations (outliers) in the data set. They are particularly useful when large numbers of observations are involved and when two or more data sets are being compared (Statistics Canada, 2013).

Figure 3-8 below shows how a box plot is structured. In the case of the figure, the maximum, minimum, quartile, median and average values are shown. The Inter Quartile Range (IQR) in the figure shows the middle 50% of values (the difference between the 75$^{th}$ and 25$^{th}$ percentiles). The data was also compared by determining a correlation coefficient for each dataset against the long term average.

The data in box and whisker plots can easily be used to see if two datasets are different. For example, if the boxes showing the IQR overlap they are not considered different, but if they do not overlap the two datasets can be considered different. The median lines are also critical in that even if the boxes overlap if the median of one dataset is above or below the IQR (box) of another dataset, they are also considered different.

The representative year and dataset modelled here is 2017 as the data for 2017 was similar to the long-term averages. Using this year also allowed the incorporation of data from the Redlands BoM station into the meteorological model.

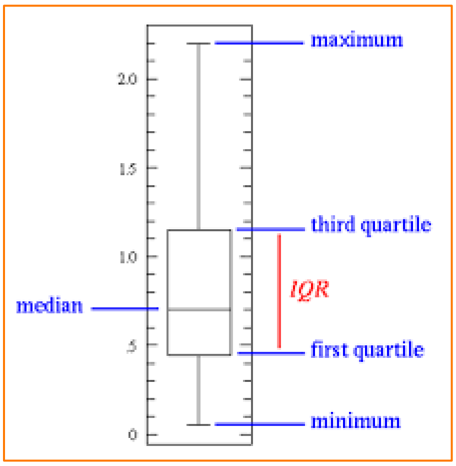



**Figure 3-8: Boxplot Structure**

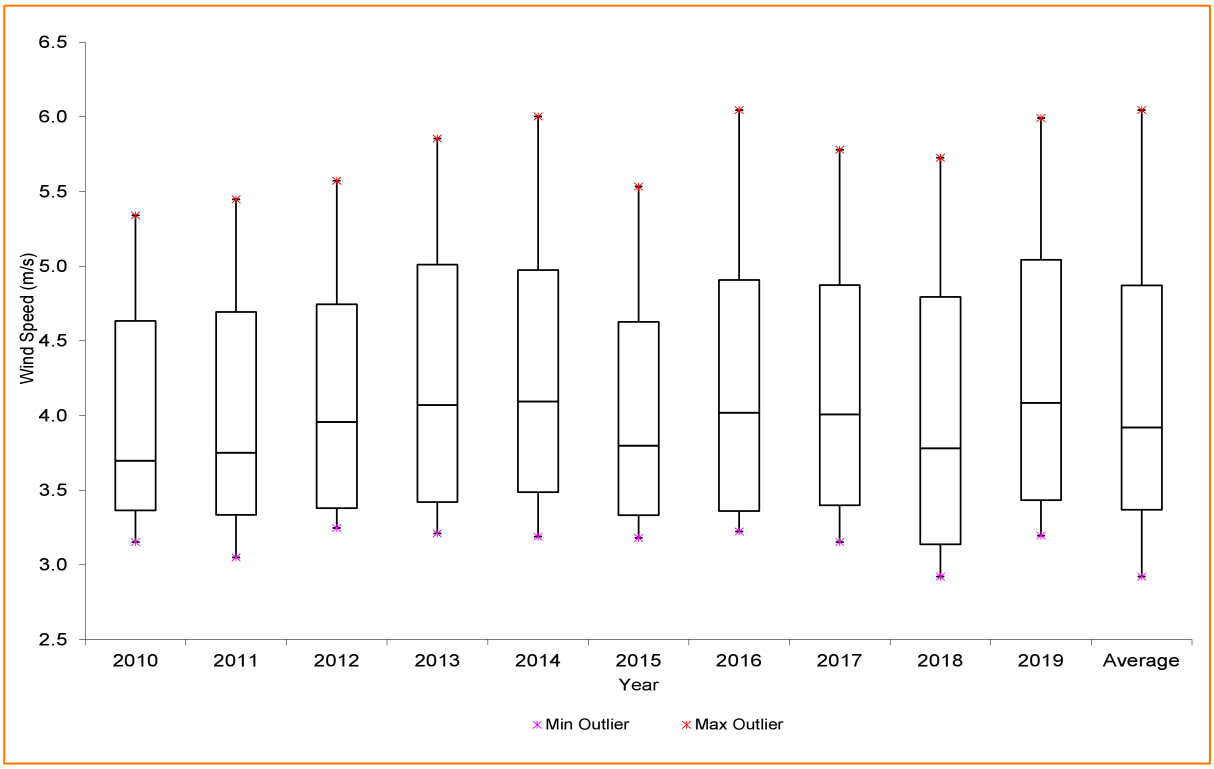



**Figure 3-9 Box and Whisker Plot – Wind Speed**

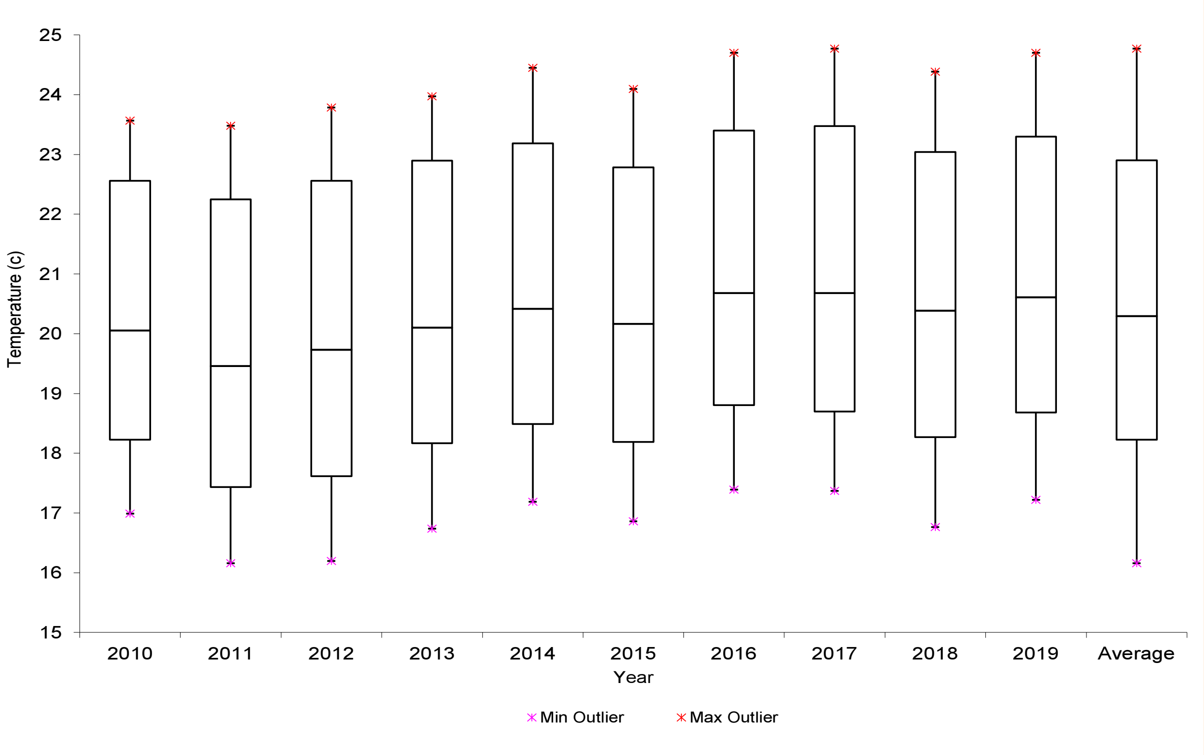



**Figure 3-10 Box and Whisker Plot – Temperature**

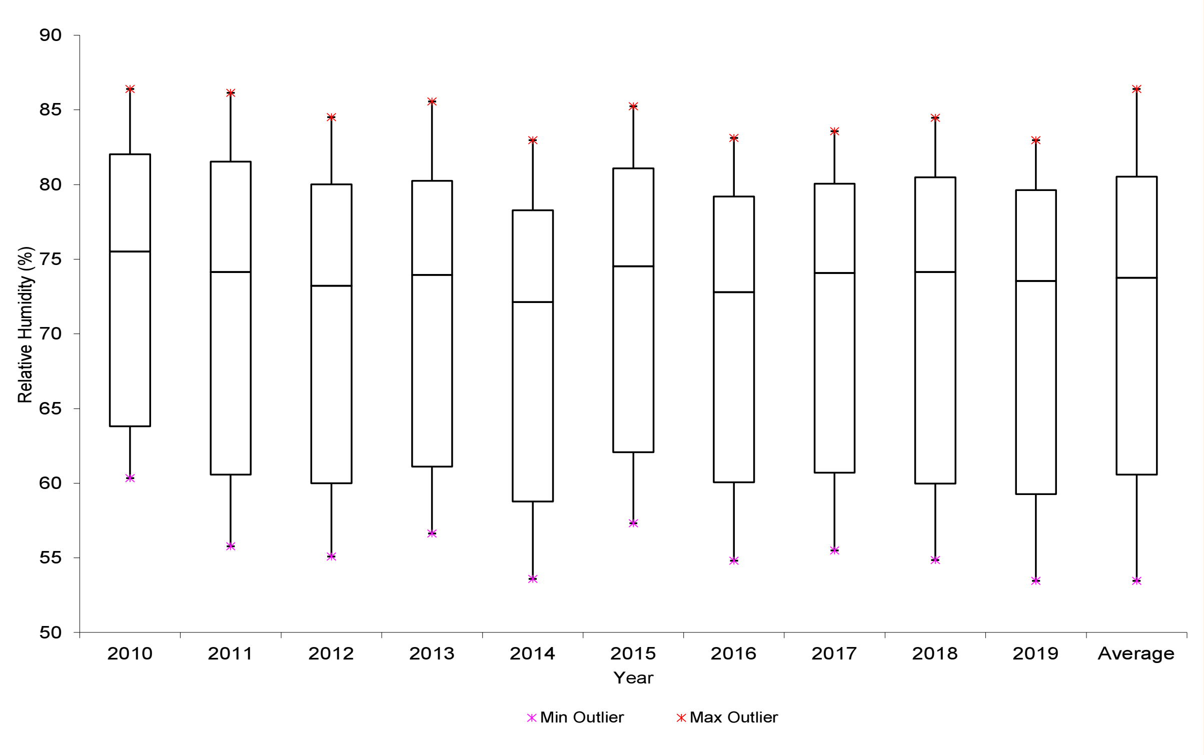



**Figure 3-11 Box and Whisker Plot – Relative Humidity**

## 3.4 Emissions Estimation

To assess the potential for air quality impacts from the development, particulate and combustion gas emissions have been estimated and modelled. Information about the construction fleet, hours of operation and activity data have been provided with assumptions made as required.

The majority of air emissions will occur from the dredging and reclamation phase of the development which has been the focus of this air quality assessment. There are no specific dust estimation techniques for the earthworks involved with dredged material. Therefore, the methodology is consistent with mining assessments as the equipment and processes are similar with adjustments made to site-specific conditions.

The emissions estimation techniques used were as follows;

- National Pollutant Inventory Emission Estimation Technique Manuals (www.npi.gov.au);
- USEPA AP42 Emission Factors and Equations (USEPA, 2016); and
- Technical datasheet for various diesel engines including European Stage III A/B standards for nonroad diesel engines.

The use of emissions factors from mining activities routinely used in the coal and mineral sector will lead to conservative estimates of particulate emissions. Furthermore, it is likely that the heavy machinery used on site will have engines that exceed the emissions standards in the European Stage III A/B standards and will emit less combustion emissions than modelled in this assessment.

The equations and activity details are presented in APPENDIX A.

The control factors adopted for this assessment are summarised below in Table 3-4 Modelled particulate and combustion emissions are summarised in Table 3-5 to Table 3-8.

**Table 3-4: Adopted Control Factors**

| Source Name | Description | Comment | Control Factor | Source |
|---|---|---|---|---|
| Site access roads | Compacted and high moisture content from dredged material | Two water trucks in use | 75% | NPI Mining Manual |
| Wind erosion | Compacted and high moisture content from dredged material | Two water trucks in use | 75% | |
| Graders and all general earthworks | Compacted and high moisture content from dredged material | Increase watering as necessary | 50% | |

**Table 3-5: Total Modelled Particulate Emissions by Hour – Scenario 1 (No Control Factors)**

| Source | TSP (g/s) | $PM_{10}$ (g/s) | $PM_{2.5}$ (g/s) |
|---|---|---|---|
| Wheel generated dust | 3.54 | 0.40 | 0.06 |
| Wind erosion | 1.77 | 0.88 | 0.13 |
| Swamp Dozer | 0.20 | 0.032 | 0.005 |
| Grader | 0.23 | 0.10 | 0.016 |

| Source | TSP (g/s) | $PM_{10}$ (g/s) | $PM_{2.5}$ (g/s) |
|---|---|---|---|
| Trumps dumping | 0.012 | 0.006 | 0.0009 |
| Compactor | 0.20 | 0.032 | 0.005 |
| Excavation | 0.012 | 0.006 | 0.0009 |

**Table 3-6: Total Modelled Combustion Emissions by Hour – Scenario 1 (No Control Factors)**

| | $PM_{10}$ | $PM_{2.5}$ | NOx (g/s) | CO (g/s) | $SO_2$ (g/s) | TVOCs |
|---|---|---|---|---|---|---|
| Tugboat | 0.089 | 0.18 | 5.9 | 1.56 | 0.0094 | 0.11 |
| Dredging Excavator | 0.028 | 0.028 | 0.28 | 0.49 | 0.0034 | 0.027 |
| Swamp Dozer | 0.017 | 0.017 | 0.17 | 0.31 | 0.00060 | 0.017 |
| Grader | 0.015 | 0.015 | 0.15 | 0.26 | 0.00060 | 0.014 |
| Dump trucks | 0.17 | 0.17 | 1.74 | 3.0 | 0.0072 | 0.17 |
| Compactor | 0.021 | 0.021 | 0.21 | 0.36 | 0.00080 | 0.020 |
| Excavation | 0.034 | 0.034 | 0.34 | 0.60 | 0.0012 | 0.032 |

Note: Includes consideration of Stage III A/B emissions standards for nonroad engines.

**Table 3-7: Total Modelled Particulate Emissions by Hour – Scenario 2 (No Control Factors)**

| | TSP (g/s) | $PM_{10}$ (g/s) | $PM_{2.5}$ (g/s) |
|---|---|---|---|
| Wheel generated dust | 1.31 | 0.15 | 0.023 |
| Wind erosion | 1.20 | 0.60 | 0.090 |
| Swamp Dozer | 0.20 | 0.032 | 0.0048 |
| Grader | 0.23 | 0.10 | 0.016 |
| Trumps dumping | 0.0093 | 0.0044 | 0.00066 |
| Compactor | 0.20 | 0.032 | 0.0048 |
| Excavation | 0.0093 | 0.0044 | 0.00066 |

**Table 3-8: Total Modelled Combustion Emissions by Hour – Scenario 2 (No Control Factors)**

| | $PM_{10}$ | $PM_{2.5}$ | NOx (g/s) | CO (g/s) | $SO_2$ (g/s) | TVOCs |
|---|---|---|---|---|---|---|
| Tugboat | 0.089 | 0.18 | 5.89 | 1.56 | 0.0094 | 0.11 |
| Dredging Excavator | 0.028 | 0.028 | 0.28 | 0.49 | 0.0034 | 0.027 |
| Swamp Dozer | 0.017 | 0.017 | 0.17 | 0.31 | 0.00060 | 0.017 |
| Grader | 0.015 | 0.015 | 0.15 | 0.26 | 0.00060 | 0.014 |
| Dump trucks | 0.17 | 0.17 | 1.74 | 3.05 | 0.0072 | 0.17 |
| Compactor | 0.021 | 0.021 | 0.21 | 0.360 | 0.00080 | 0.020 |
| Excavation | 0.028 | 0.028 | 0.28 | 0.488 | 0.0034 | 0.027 |

Note: Includes consideration of Stage III A/B emissions standards for nonroad engines.

### 3.4.1 Modelling of NOx Chemistry

Oxides of nitrogen (NOx) emitted from combustion sources are primarily composed of nitric oxide (NO) and nitrogen dioxide ($NO_2$).

Eventually, all NO emitted is oxidized to $NO_2$ in the atmosphere in the presence of ozone and sunlight. This formation of $NO_2$ from NO is a complex photochemical process depending on factors that include the total amount of available NOx and ozone. The reaction takes place over several hours and can result in increased ground-level $NO_2$ concentrations further down-plume (far-field) and decreased closer to the source (near field).

For this assessment, a ratio of 30% (conversion from NOx to $NO_2$) has been used as detailed in Katestone Environmental (2011; 2018).

### 3.4.2 Total Volatile Organic Compound Speciation

The emission estimation methods detailed above estimate total volatile organic compounds. Where required, speciation of compounds was based on the report *Speciation Profiles and Toxic Emission Factors for Non-road Emissions* (USEPA, 2015).

# 4 EXISTING ENVIRONMENT

This section of the report describes the existing environment around the Development location as relevant to air quality including surrounding receivers; land use; terrain; prevailing climate and meteorology; and, regional ambient air quality conditions

## 4.1 Sensitive Receptors

Sensitive receptors are locations which may be impacted by emissions to air. The definition of sensitive receptors can be found in Application requirements for activities with impacts to air (DES, 2019). DES (2019) states that a sensitive place could include but is not limited to:

- a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises;
- a motel, hotel or hostel;
- a kindergarten, school, university or other educational institution;
- a medical centre or hospital;
- a protected area under the Nature Conservation Act 1992, the Marine Parks Act 2004 or a World Heritage Area[9];
- a public park or garden; and
- a place used as a workplace including an office for business or commercial purposes.

Based on the definitions, sensitive locations for the community for this project include nearby dwellings, educations facilities (child care centre and school) and parkland (i.e. GJ Walter Park). These locations were selected based on recent aerial imagery and are shown in Figure 4-1 with the description given in Table 4-1. Based on the definition above, Cassim Island and the Nandeebie Claypan roost sites could also be considered sensitive locations. Four locations have been added to the modelling predictions to further assess this.

Commentary concerning the risk at the receptors and the development activities is provided in Section 5.

[9] This definition includes Cassim Island and the Nandeebie Claypan roost sites


**Figure 4-1: Modelled Receptors**

**Table 4-1: Description of Sensitive Receptors**

| Number | Description | Easting (UTM; m) | Northing (UTM; m) |
|---|---|---|---|
| SR1 | Oyster Point Park | 527,996 | 6,954,364 |
| SR2 | Oyster Point Park | 527,941 | 6,954,401 |
| SR3 | Residential property | 527,876 | 6,954,408 |
| SR4 | Residential property | 527,854 | 6,954,449 |
| SR5 | Residential property | 527,836 | 6,954,474 |
| SR6 | Residential property | 527,789 | 6,954,491 |
| SR7 | Residential property | 527,764 | 6,954,522 |
| SR8 | Residential property | 527,765 | 6,954,531 |
| SR9 | Residential property | 527,763 | 6,954,547 |
| SR10 | Residential property | 527,764 | 6,954,568 |
| SR11 | Residential property | 527,765 | 6,954,589 |
| SR12 | Residential property | 527,766 | 6,954,606 |
| SR13 | Residential property | 527,768 | 6,954,626 |
| SR14 | Residential property | 527,768 | 6,954,647 |
| SR15 | Residential property | 527,770 | 6,954,668 |
| SR16 | Residential property | 527,770 | 6,954,690 |
| SR17 | Residential property | 527,793 | 6,954,769 |
| SR18 | Residential property | 527,780 | 6,954,812 |
| SR19 | Star of the Sea Catholic Primary School | 527,728 | 6,954,878 |
| SR20 | Star of the Sea Catholic Primary School | 527,722 | 6,954,932 |
| SR21 | Residential property | 527,772 | 6,954,991 |
| SR22 | Residential property | 527,776 | 6,955,026 |
| SR23 | Residential property | 527,776 | 6,955,061 |
| SR24 | Residential property | 527,777 | 6,955,093 |
| SR25 | Residential property | 527,780 | 6,955,122 |
| SR26 | Residential property | 527,780 | 6,955,144 |
| SR27 | Residential property | 527,782 | 6,955,167 |
| SR28 | Residential property | 527,789 | 6,955,216 |
| SR29 | Residential property | 527,885 | 6,955,215 |
| SR30 | Residential property | 527,893 | 6,955,232 |
| SR31 | Residential property | 527,911 | 6,955,271 |
| SR32 | Residential property | 527,923 | 6,955,290 |
| SR33 | Residential property | 527,943 | 6,955,309 |
| SR34 | Residential property | 527,974 | 6,955,317 |
| SR35 | Residential property | 527,990 | 6,955,333 |
| SR36 | Residential property | 528,001 | 6,955,353 |
| SR37 | Residential property | 528,017 | 6,955,367 |
| SR38 | Residential property | 528,027 | 6,955,384 |
| SR39 | Residential property | 528,051 | 6,955,385 |
| SR40 | GJ Walker Park | 528,140 | 6,955,403 |
| SR41 | GJ Walker Park | 528,236 | 6,955,437 |
| SR42 | GJ Walker Park | 528,288 | 6,955,502 |
| SR43 | Residential property | 528,310 | 6,955,604 |
| SR44 | Residential property | 528,314 | 6,955,632 |
| SR45 | Residential property | 528,324 | 6,955,653 |
| SR46 | Residential property | 528,326 | 6,955,664 |
| SR47 | Residential property | 528,329 | 6,955,680 |
| SR48 | Residential property | 528,337 | 6,955,696 |
| SR49 | Residential property | 528,345 | 6,955,710 |
| SR50 | Residential property | 528,353 | 6,955,724 |

| Number | Description | Easting (UTM; m) | Northing (UTM; m) |
|---|---|---|---|
| SR51 | Residential property | 528,363 | 6,955,744 |
| SR52 | Residential property | 528,369 | 6,955,758 |
| SR53 | Residential property | 528,386 | 6,955,792 |
| SR54 | Residential property | 528,403 | 6,955,827 |
| SR55 | Residential property | 528,418 | 6,955,861 |
| SR56 | Residential property | 528,417 | 6,955,884 |
| SR57 | Residential property | 528,420 | 6,955,917 |
| SR58 | Mudflats | 528,711 | 6,955,018 |
| SR59 | Cassim Island | 528,821 | 6,954,847 |
| SR60 | Nandeebie Claypan | 527,888 | 6,954,787 |
| SR61 | Nandeebie Claypan | 527,973 | 6,954,695 |

## 4.2 Climate and Meteorology

The nearest Bureau of Meteorology (BoM) weather monitoring stations include:

- Redlands HRS (Station number 040265) that has been collecting climate statistics data since 1953 but is now closed;
- Redland (Alexandra Hills; Station number 140007) opened in 2015 after the closure of Redlands HRS and has been collecting climate statistics on a one-minute timestep; and
- The Banana Bank North Beacon (Station number 040925) located in Moreton Bay opened in 2002 and collects wind speed and direction data only.

The climate in the Redland Bay area is characterised by warm humid summers and mild winters. It has summer dominant rainfall with the majority falling between December to March. A summary of the data from the Redlands HRS weather station is presented below in Table 4-2 and wind roses for 9 am and 3 pm are presented in Figure 4-2. The wind roses show that the winds are typical of those along the coast of south-east Queensland, westerly and easterly winds occur in the morning, reflecting the land breeze and sea breeze effects (subject to time of year and time of day) and easterly winds in the afternoon, reflecting the developed sea breezes.

**Table 4-2: Climate summary for Redlands (Redlands HRS 1953-2013)**

| Statistic | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean maximum temperature (°C) | 29 | 28.6 | 27.7 | 25.9 | 23.2 | 21 | 20.5 | 21.6 | 23.6 | 25.3 | 26.9 | 28.2 | 25.1 |
| Mean minimum temperature (°C) | 19.9 | 19.9 | 18.6 | 15.7 | 12.5 | 9.7 | 8.2 | 8.3 | 11 | 14.1 | 16.7 | 18.7 | 14.4 |
| Mean Rainfall | 161 | 164 | 162 | 107 | 112 | 88 | 61 | 52 | 38 | 84 | 103 | 142 | 1252 |
| Rain Days | 12 | 13 | 13 | 11 | 10 | 8 | 7 | 6 | 7 | 9 | 10 | 11 | 118 |
| 9am relative humidity | 69 | 72 | 73 | 72 | 73 | 73 | 71 | 65 | 63 | 63 | 66 | 67 | 69 |
| 3pm relative humidity | 66 | 68 | 68 | 66 | 63 | 61 | 58 | 56 | 58 | 62 | 65 | 66 | 63 |

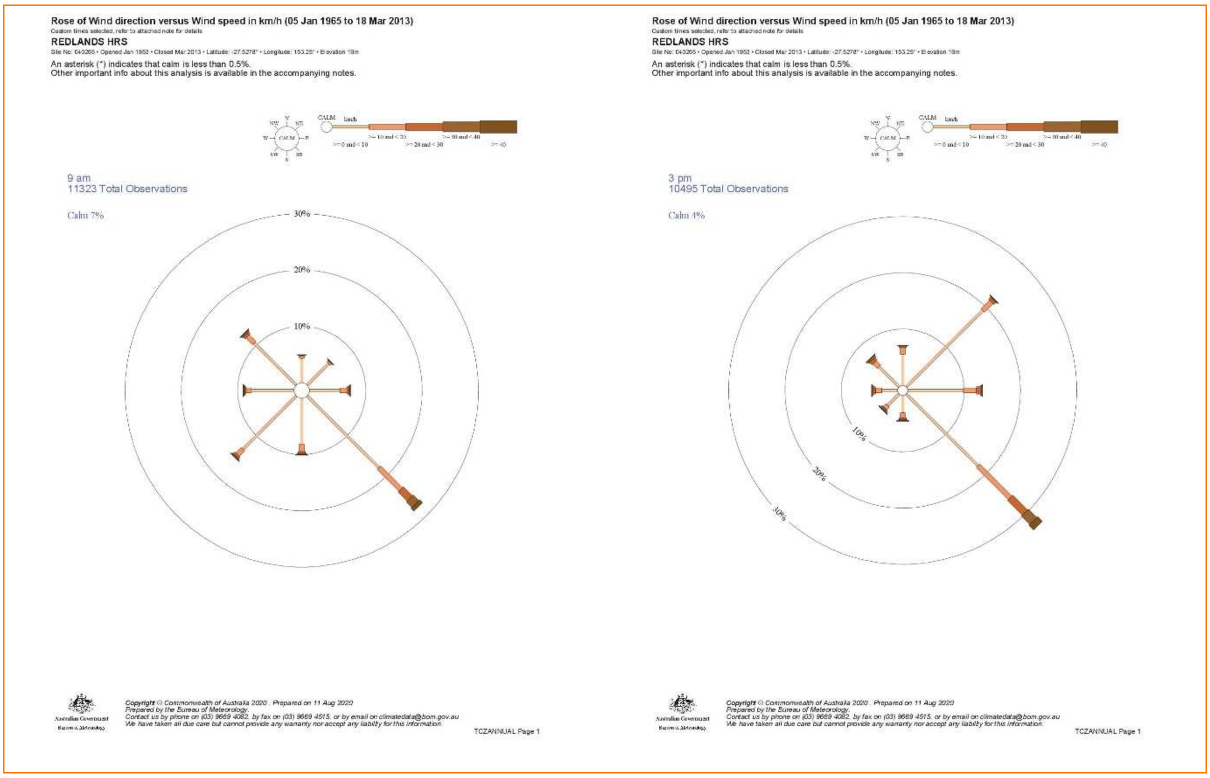



**Figure 4-2: Redlands HRS 9 am (left) and 3 pm (right) Wind Roses (1953-2013)**

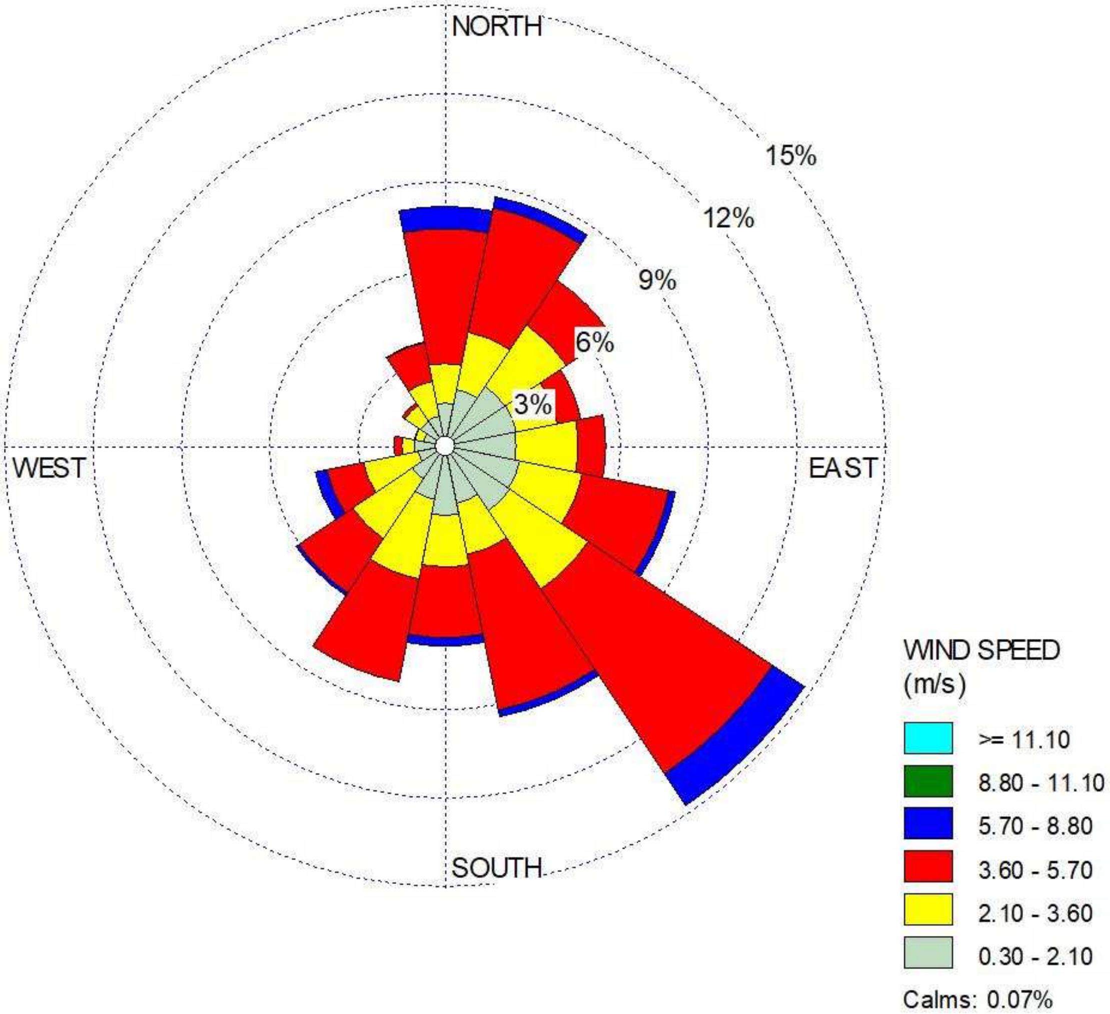
## 4.3 Modelled Meteorological Data

The principal meteorological parameters that influence plume dispersion are wind direction, wind speed, atmospheric stability (turbulence) and atmospheric mixing height (height of turbulent layer). This section presents a summary of the key meteorological features.

### 4.3.1 Wind Speed and Direction

Wind roses are used to show the frequency of winds by direction and strength. The bars show the compass points (north, north-north-east, north-east etc) from which wind could blow. The length of each bar shows the frequency of winds from that direction and the different coloured sections within each bar show the wind speed categories and frequency of winds in those categories. In summary, wind roses are used to visually show winds over a period of time.

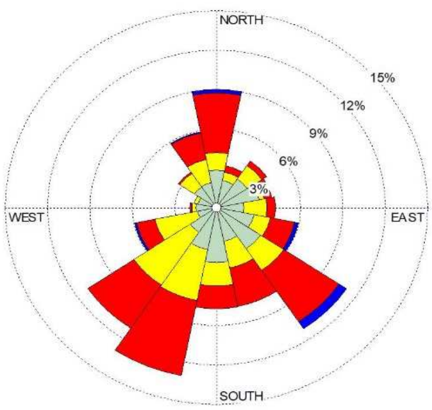
The wind roses below were created from data extracted from CALMET and are presented in Figure 4-3 (annual) and Figure 4-4 (time of day). The annual wind roses show that the prevailing wind directions are all directions except for the south-east which has a lower relative frequency of winds, which is a function of the terrain in the area and synoptic-scale effects. The wind roses show a relatively low proportion of calm winds (~0.1 %) with light winds (up to 3 m/s) occurring frequently (~54% of the time). The wind speed frequencies for 2007 are summarised graphically in Figure 4-5.



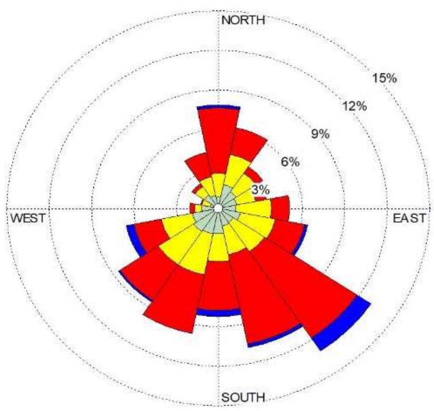

| *Location:*<br>X = 524,233 m East<br>Y = 6,953,692 m South | *Year:*<br>2017 | *Data Source:*<br>CALMET extract |
|---|---|---|
| *Calm winds:*<br>0.07 | *Average wind speed:*<br>3.22 m/s | *Creator:*<br>W. Shillito |

**Figure 4-3: Annual Wind Rose**

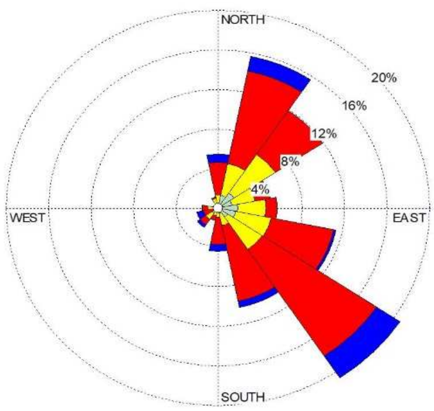
**1 AM to 6 AM**



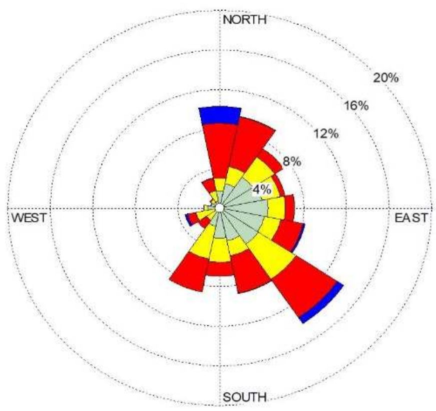

**7 AM to 12 PM**



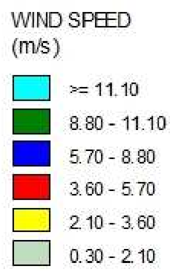

**1 PM to 6 PM**




**7 PM to 12 AM**




| *Period* | *Average wind speed (m/s)* | *Calm winds %* |
|---|---|---|
| 1 AM to 6 AM | 2.82 | 0.09 |
| 7 AM to 12 PM | 3.29 | 0.09 |
| 1 PM to 6 PM | 3.82 | 0.05 |
| 7 PM to 12 AM | 2.95 | 0.05 |




| *Location:* | *Year:* | *Data Source:* | *Creator:* |
|---|---|---|---|
| X = 524,233 m East<br>Y = 6,953,692 m South | 2017 | CALMET extract | W. Shillito |

**Figure 4-4: Time of Day Wind Rose**

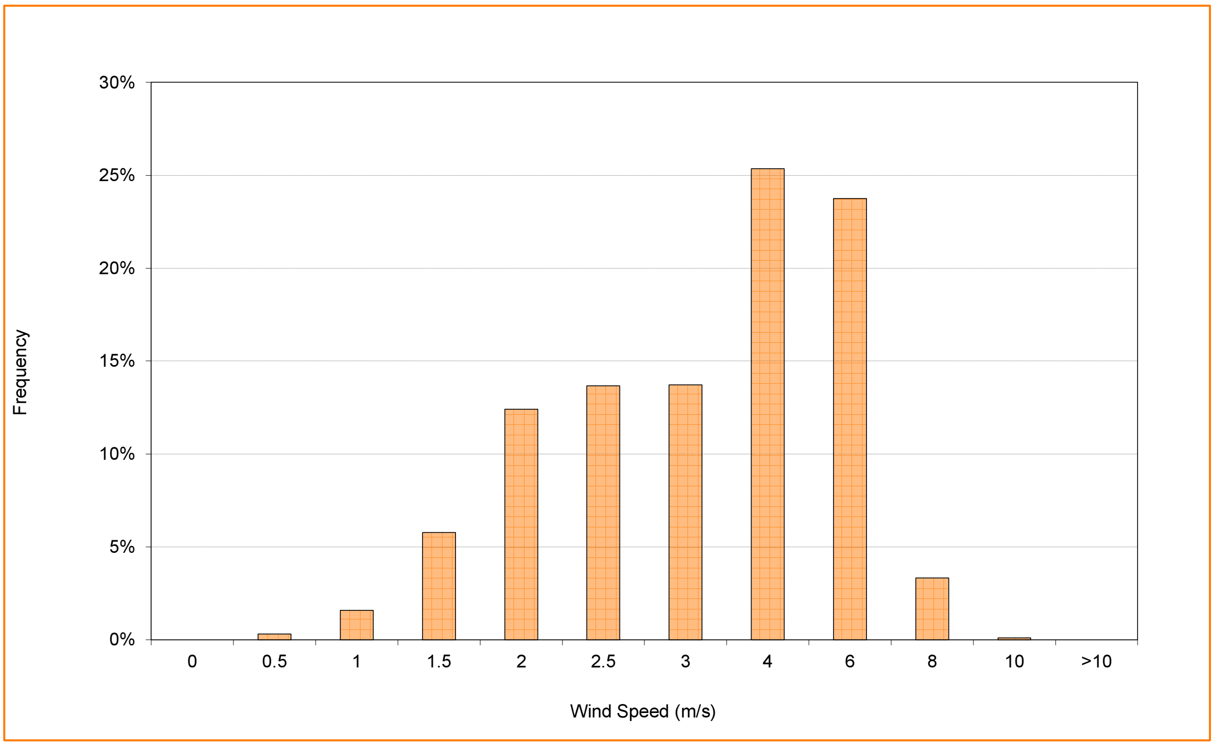



**Figure 4-5: Wind Speed Frequency**

### 4.3.2 Atmospheric Stability

Atmospheric stability is a key factor in dispersion modelling and is used to describe turbulence in the atmosphere. Turbulence is an important factor in plume dispersion. Turbulence increases the width of a plume due to random motion within the plume. This changes the plume cross-sectional area (width and height of the plume), thus diluting or spreading the plume. As turbulence increases, the rate at which this occurs also increases. Limited or weak turbulence, therefore, does not dilute or diffuse the plume as much as strong turbulence and therefore leads to high downwind concentrations. This is often associated with very low wind speeds (<0.3 m/s).

The Pasquill-Gifford stability scheme has been in use for many years to define turbulence in the atmosphere. The scheme uses stability classes from A to F[10]. Class A is highly unstable and at the other end of the scheme are class F conditions, which are very stable conditions that commonly occur at night and in the early morning. As noted above, under stable conditions, plumes do not disperse as well as during the day (unstable conditions) and can lead to impacts, especially for ground-level sources.

Between Class A and Class F are stability classes which range from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are most often associated with clear skies, class D is linked to sunset and sunrise, or cloudy and/or windy daytime conditions. Unstable conditions most often occur during the daytime and stable conditions are most common at night.

The stability classes predicted by CALMET are summarised in Figure 4-6. The data shows that E and F class stability which can only occur at night (along with D class winds which can occur day or night)

[10] Note that CALPUFF uses a more accurate micrometeorological scheme for turbulence.

occurs ~31% of the time. It is noted that 54% of the time winds are neutral (D class), this is commonly associated with sites with high winds speeds (>2 m/s) at night or high wind speeds with moderate to low solar radiation during the day.

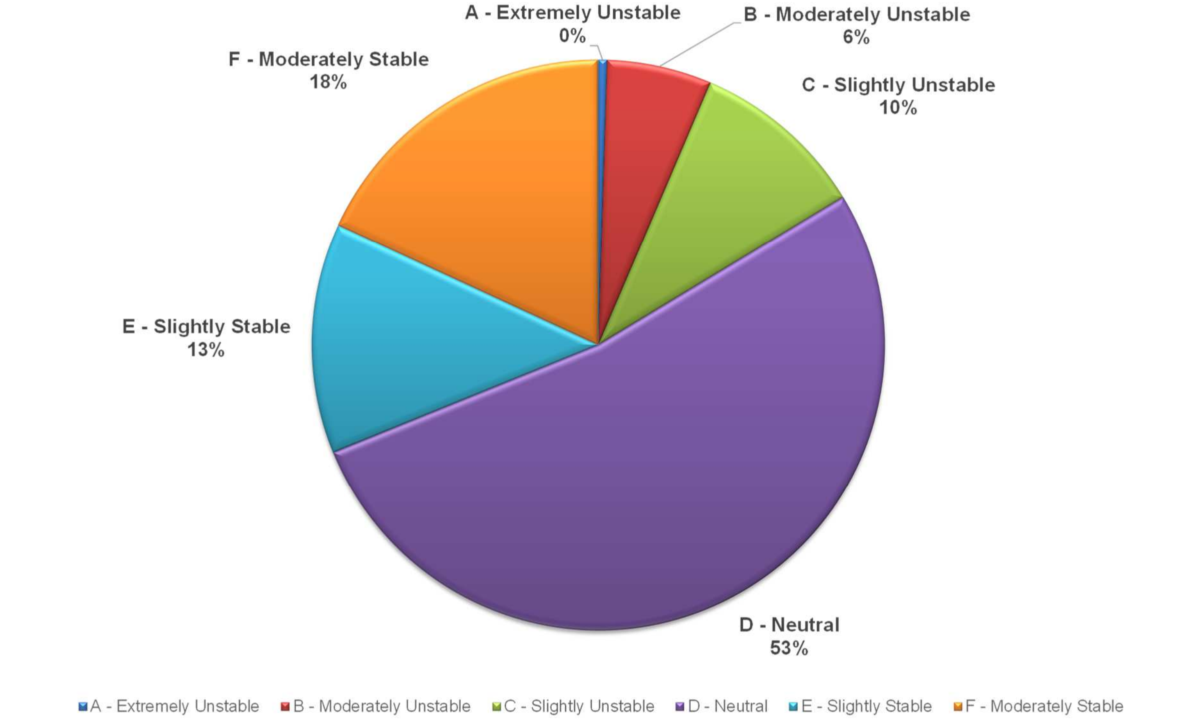



**Figure 4-6: Atmospheric Stability**

### 4.3.3 Atmospheric Mixing Height

The mixing height is the height of vertical mixing of air and suspended gases or particles above the ground. This height can be measured by the observation of the atmospheric temperature profile. A parcel of air rising from the surface of the Earth will rise at a given rate (called the dry adiabatic lapse rate). As long as the parcel of air is warmer than the ambient temperature, it will continue to rise. However, once it becomes colder than the temperature of the environment, it will slow down and eventually stop (University of Michigan , 2004).

The mixing height is commonly referred to as an inversion layer. It is an important parameter when assessing air emissions as it defines the vertical mixing of a plume. This is because the air below the layer has restricted dispersion vertically.

The estimated variation of mixing height over time predicted at the site by CALMET is shown in Figure 4-7. The diurnal cycle is clear in this figure whereby at night the mixing height is normally relatively low and after sunrise, it increases as a result of heat associated with the sun on the Earth's surface. Overall, the estimated mixing height shown below is as expected for a coastal location.

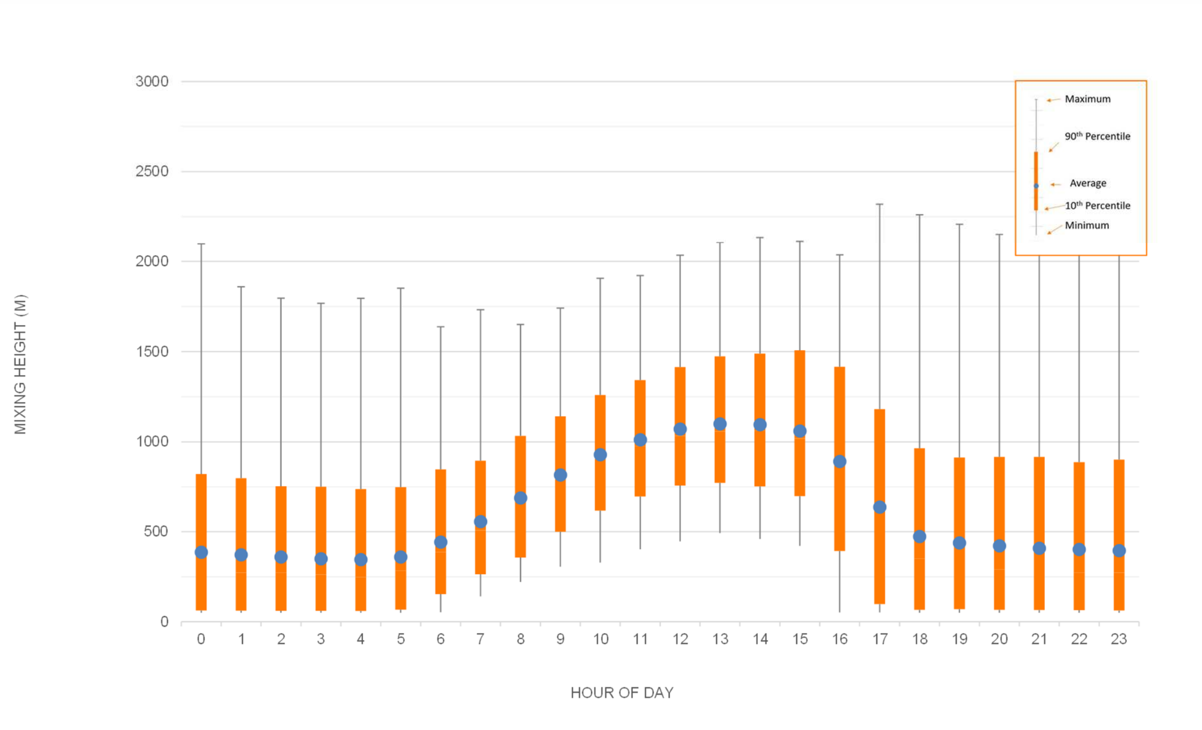



**Figure 4-7: Predicted Mixing Heights**

## 4.4 Background Air Quality Data

### 4.4.1 DES Data

Existing air quality in the region surrounding the site is influenced by, but not limited to the following sources:

- Exhaust emissions from the local road infrastructure and small marine craft;
- Emissions from industrial and manufacturing sources in the area;
- Natural features of the local environment, such as salt spray and wind erosion of exposed soil; and
- Dust emissions from nearby roads and minor construction sites.

The Department of Environment and Science (DES, formerly DEHP) operates several monitoring stations throughout Queensland with the closest being Cannon Hill located 20km to the northwest and Wynnum North 15kms to the north northwest. Data was also sourced from the Springwood and South Brisbane to account for air toxics and carbon monoxide as these compounds are not monitored at the Cannon Hill and Wynnum North stations. The use of data from these regional stations is consistent with DES (2019).

A summary of the average and 70$^{th}$ percentile ambient air pollutant measurements (based on the recognised methodology detailed in Brisbane City Council (2014)) from the monitoring sites for inclusion in the dispersion modelling predictions as background concentrations is presented in Table 4-3. The pollutants, their monitoring location and averaging periods and statistics can be seen in the table.

**Table 4-3 Ambient air monitoring data**

| Station | Pollutant | Averaging Period | Statistic | Value (µg/m$^3$) |
|---|---|---|---|---|
| Cannon Hill (2014 – 2018) | Total suspended particulates (TSP) | Annual | Average | 24.9 |
| | $PM_{10}$ | 24 – hours | 70$^{th}$ percentile | 17.4 |
| | | Annual | Average | 15.4 |
| | $PM_{2.5}$ | 24 – hours | 70$^{th}$ percentile | 8.6 |
| | | Annual | Average | 6.8 |
| Wynnum North (2013 – 2017) | $NO_2$ | 1 – hour | 70$^{th}$ percentile | 18.1 |
| | | Annual | Average | 17.7 |
| | $SO_2$ | 1 – hour | 70$^{th}$ percentile | 2.9 |
| | | 24 – hours | 70$^{th}$ percentile | 3.9 |
| | | Annual | Average | 3.9 |
| South Brisbane (2014 – 2018) | CO | 8 – hours | Average | 268 |
| Springwood (2013 – 2017) | Benzene | Annual | Average | 4.5 |
| | Toluene | 1 – hour | 70$^{th}$ percentile | 25.6 |
| | | 24-hour | 70$^{th}$ percentile | 17.9 |
| | | 1-year | Average | 17.9 |
| | Xylene | 24-hour | 70$^{th}$ percentile | 23.6 |
| | | 1-year | Average | 23.2 |

Note: Different sites used as not all sites measure all pollutants.

### 4.4.2 Hydrogen Sulphide

The $H_2S$ monitoring was performed to examine whether there were background concentrations of $H_2S$ at a detectable concentration.

The terms ‘detection’ and ‘recognition’ threshold refers to the point at which a person may detect there is a difference between clean air and air with a low concentration of $H_2S$. Recognition threshold is the point at which the $H_2S$ odour is recognisable as $H_2S$ (recognition threshold).

The most recent literature summarised in AIHA (2013) suggests that the detection threshold and recognition threshold can be in the order of a few ppb. Bay of Plenty Regional Council (2012) drew a similar conclusion but noted that the majority of people they tested could detect $H_2S$ at 7 µg/m$^3$ (5 ppb), which is the default threshold value on a 30 minute average in the EPP (Air).

Of the just over 220 days of monitoring, for the 10-minute observations, $H_2S$ at or above 1ppb was recorded on 97 occasions (0.3% of readings) at Location 1, and 7 occasions (<0.1% of readings) at Location 2. The results from Location 1 and Location 2 are shown graphically below in Figure 4-8 and Figure 4-9. The results show that detectable $H_2S$ may be present from time to time. Due to the height of the monitoring locations, the ground level concentrations would be marginally higher, and a more frequent monitoring period (e.g. 5 minutes) may have detected more occasions where $H_2S$ was present. However, this is not considered to be significant in the context of the results to date.

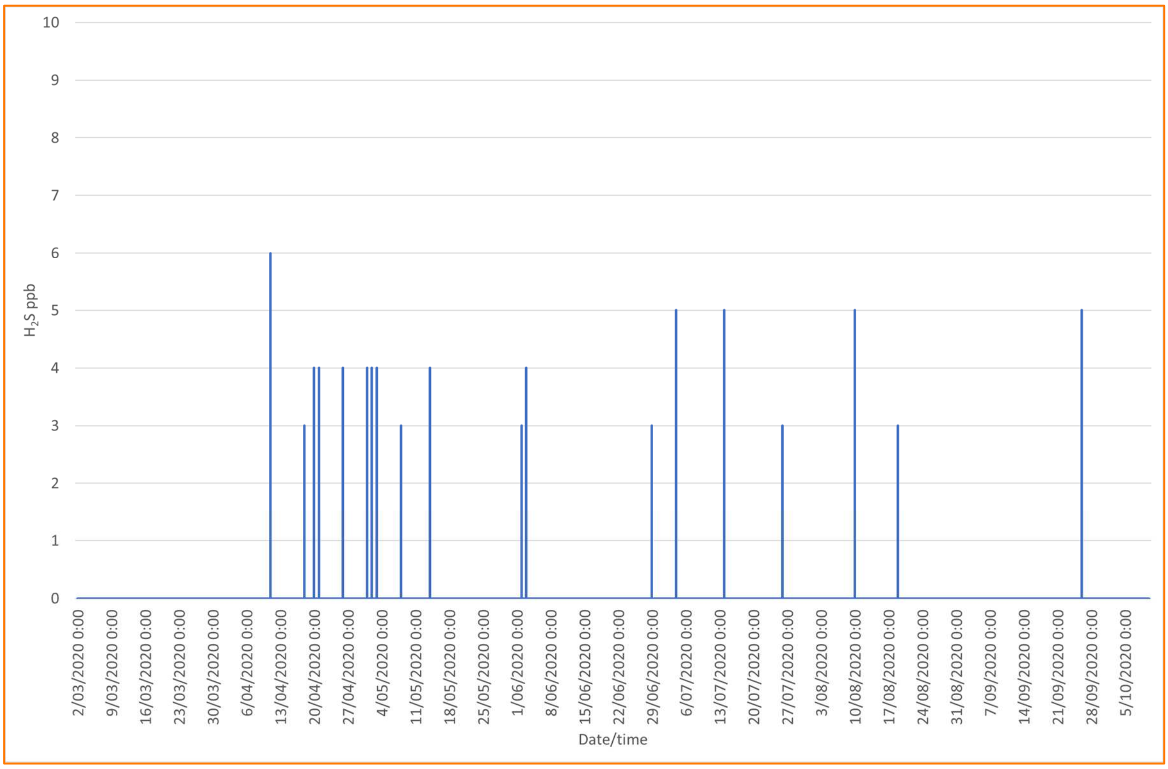



**Figure 4-8: Location 1 – March to October 2020**

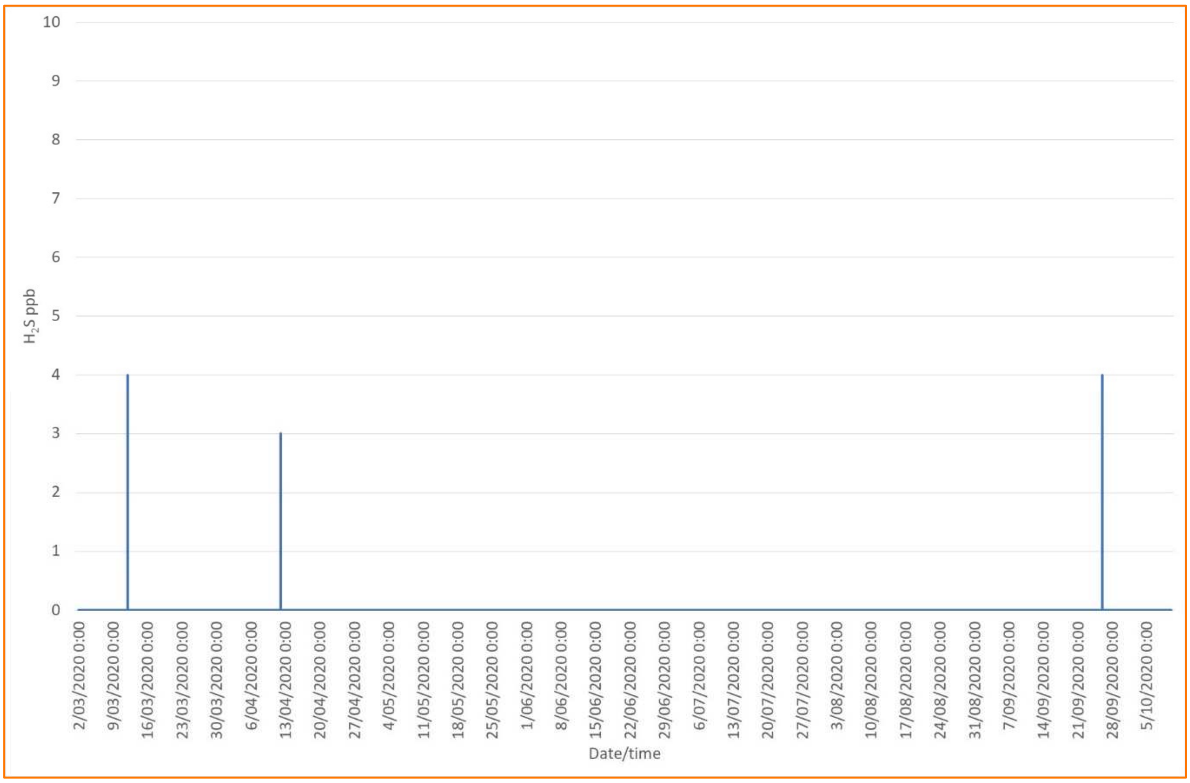



**Figure 4-9: Location 2 – March to October 2020**

# 5 POTENTIAL IMPACTS

## 5.1 Summary of Potential Impacts

This section provides an assessment of the potential air quality impacts of the Development, based on model predictions including the addition of background data to predicted concentrations and comparisons to air quality criteria.

The risk of potential air quality impacts occurring for this Development is greatest for the dredging and reclamation work, primarily due to the excavation, handling and wind erosion of the dried out dredged material. The emissions to air from the civil construction and the ongoing use and operation of the Development are considered to be negligible compared with the reclamation activity due to the reduced scope of those works compared to Stages 1 and 2. Therefore, their potential impacts can be adequately managed using the methodologies and techniques presented in Section 6 and have not been assessed further.

The tabulated results for all sensitive receptors for both Stage 1 and 2 are presented in APPENDIX B in isolation and cumulatively with background concentrations. Contour plots are for both Stage 1 and 2 for the cumulative assessment are presented in APPENDIX C.

### 5.1.1 Dredging and Reclamation – Stage 1

The predicted ground level concentrations of particulates, combustion gases and air toxics for Stage 1 are summarised below including background concentrations for a cumulative assessment.

Table 5-1 presents the sensitive receptor that had the highest predicted concentration including background data (detailed in Table 4-3) for a given pollutant. The results presented are the maximum model prediction for the averaging period stated, except for the annual average, which is an average.

The model results show that compliance was predicted for all pollutants modelled and assessed except for the annual average for $PM_{2.5}$ at sensitive receptor 41 located in GJ Walker Park.

As shown in Table 4-3, the background data included in the assessment of $PM_{2.5}$ was from the Cannon Hill monitoring station (Section 4.4), the closest available data with long term averages for $PM_{2.5}$. The annual average concentration is 6.8 µg/m$^3$, which is ~85% of the criterion. Background conditions at Toondah Harbour would be much lower than the Cannon Hill monitoring station, which is located adjacent to a rail line. The contribution from the Development in isolation is, compared to the background, low at a maximum of 1.2 µg/m$^3$.

The majority of $PM_{2.5}$ estimated for the modelling is emitted from the combustion of diesel in the reclamation equipment and to a lesser extent dust emission from the handling of the dried dredged material. The $PM_{2.5}$ emissions for engine emissions have been estimated and modelled based on emission factors from European Stage III (as discussed in Section 3.4) and the equipment used at the site will likely have lower emissions as it is expected that a modern earthmoving fleet will be used on site. Therefore, the risk is considered low.

**Table 5-1: Stage 1 Predicted concentrations – Cumulative**

| Pollutant | Averaging Period | Statistic | Units | Criteria | Maximum concentration (including background) | Sensitive Receptor |
|---|---|---|---|---|---|---|
| TSP | Annual | Average | µg/m³ | 90 | 36.2 | SR42 |
| $PM_{10}$ | 24 hour | Maximum | µg/m³ | 50 | 26.8 | SR43 |
| | Annual | Average | µg/m³ | 25 | 18.5 | SR42 |
| $PM_{2.5}$ | 24 hour | Maximum | µg/m³ | 25 | 12.8 | SR43 |
| | Annual | Average | µg/m³ | 8 | 8.0 | SR41 |
| Dust Deposition | Monthly | Maximum | g/m²/month | 4 | 3.1 | SR43 |
| $NO_2$ | 1 hour | Maximum | µg/m³ | 250 | 129 | SR61 |
| | Annual | Average | µg/m³ | 62 | 21.2 | SR61 |
| CO | 8 hour | Average | µg/m³ | 11,000 | 451 | SR49 |
| $SO_2$ | 1 hour | Maximum | µg/m³ | 570 | 3.8 | SR42 |
| | 24 hour | Average | µg/m³ | 229 | 4.06 | SR41 |
| | Annual | Average | µg/m³ | 57/31/21 | 4.03 | SR41 |
| Benzene | Annual | Average | µg/m³ | 5.4 | 4.5 | Multiple[11] |
| Toluene | 30 minute | Maximum | µg/m³ | 1,100 | 26.4 | SR42 |
| | 24 hour | Average | µg/m³ | 4,100 | 18.0 | Multiple |
| | Annual | Average | µg/m³ | 400 | 17.9 | Multiple |
| Xylene | 24 hour | Average | µg/m³ | 1,200 | 23.6 | Multiple |
| | Annual | Average | µg/m³ | 950 | 23.2 | Multiple |

Note exceedances are shown by grey highlighting.

Further analysis of the results presented in Table 5-1, show the sensitive receptors that have the potential for air quality impacts are SR41 to SR43, SR49 and also SR61 (Naddeebie Claypan). The predicted impacts at SR61 are half the air quality objective.

The locations shown below in Figure 5-1, SR41 and SR42 are located in GJ Walker park with SR43-SR51 being residential locations. The air quality risk is considered to be higher to the west of the Development here due to the prevailing winds (easterly through south easterly) and the location of the reclamation activity.

For the purpose of this assessment Cassim Island (to the east of the Development) and the Nandeebie Claypan (to the south of the Development) have been modelled as sensitive locations as discrete receptors. As shown in the contour plots in APPENDIX C, the most likely impacted receptors are to the west rather than to the east or south where these receptors are, which is a function of the prevailing winds. Therefore, it can be concluded that the receptors to the west are the most likely impacted for the development due to their proximity to the development and the prevailing winds. Based on the criteria in Section 2 compliance is predicated at Cassim Island and the Nandeebie Claypan roost site during Stage 1.

Although compliance is predicted for the criteria that applies to health and biodiversity of ecosystem and natural vegetation, the dust management plan for the site should include management measures

[11] Multiple sensitive receptors are similar in predicted concentrations (below the criteria) and are dominated by background data

which focus on operations during high risk winds for those areas, namely northerly through westerly winds.


**Figure 5-1 Sensitive Receptors for Stage 1**

As previously discussed, the modelling assessment presented here has used conservative emissions estimation methods based on techniques used for mining assessments. The potential for dust generation is from the material handling, wind erosion and vehicular movement on the dried out dredged material. Whilst the emission estimation has included control factors (Table 3-4), the dredging process is a wet process, and emissions are expected to be lower than the predicted emissions, and in any case, there will be ample water available for dust suppression should short term increases in dust emissions occur.

By adopting the management measures in Section 6, including using real-time dust measurements, the risk of potential exceedances can be managed.

### 5.1.2 Dredging and Reclamation – Stage 2

The predicted ground-level concentrations of particulates, combustion gases and air toxics for Stage 2 are summarised below including background concentrations for a cumulative assessment.

Table 5-2 presents the sensitive receptor that had the highest predicted concentration including background data (Table 4-3) for a given pollutant. The results presented are the maximum model prediction for the averaging period stated, except for the annual average which is an average. The results show that compliance was predicted for all pollutants modelled and assessed.

The predicted cumulative impacts are dominated by the background concentration data with a smaller contribution from the dredging and reclamation activities. The predicted concentrations at the sensitive receptors are less than for the Stage 1 assessment due to the greater distance the work is being performed from the coastline.

Cassim Island (to the east of the Development) and the Nandeebie Claypan roost sites (to the south of the Development) are sensitive locations. As shown in the contour plots in APPENDIX C, the most likely impacted receptors are to the west rather than to the east or south where these receptors are, which is a function of the prevailing winds. Therefore, it can be concluded that the receptors to the west are the most likely impacted for the development due to their proximity to the development and the prevailing winds. Based on the criteria in Section 2 compliance is predicated at Cassim Island and the Nandeebie Claypan roost site during Stage 2.

Although compliance is predicted for the criteria that applies to health and biodiversity of ecosystem and natural vegetation, the dust management plan for the site should include management measures which focus on operations during high risk winds for those areas, namely northerly through westerly winds.

**Table 5-2: Stage 2 Predicted concentrations**

| Pollutant | Averaging Period | Statistic | Units | Criteria | Maximum concentration (including background) | Sensitive Receptor |
|---|---|---|---|---|---|---|
| TSP | Annual | Average | µg/m³ | 90 | 25.7 | SR58 |
| $PM_{10}$ | 24 hour | Maximum | µg/m³ | 50 | 23.5 | SR58 |
| | Annual | Average | µg/m³ | 25 | 16.0 | SR41 |
| $PM_{2.5}$ | 24 hour | Maximum | µg/m³ | 25 | 12.5 | SR58 |
| | Annual | Average | µg/m³ | 8 | 7.2 | SR41 |
| Dust Deposition | Monthly | Maximum | g/m²/month | 4 | 2.2 | SR34 |
| $NO_2$ | 1 hour | Maximum | µg/m³ | 250 | 108 | SR60 |
| | Annual | Average | µg/m³ | 62 | 19.6 | SR61 |
| CO | 8 hour | Average | µg/m³ | 11,000 | 402 | SR58 |
| $SO_2$ | 1 hour | Maximum | µg/m³ | 570 | 3.6 | SR41 |
| | 24 hour | Average | µg/m³ | 229 | 4.1 | SR1 |
| | Annual | Average | µg/m³ | 57/31/21 | 3.9 | Multiple[12] |
| Benzene | Annual | Average | µg/m³ | 5.4 | 4.5 | Multiple |
| Toluene | 30 minute | Maximum | µg/m³ | 1,100 | 26.2 | Multiple |
| | 24 hour | Average | µg/m³ | 4,100 | 18.0 | Multiple |
| | Annual | Average | µg/m³ | 400 | 17.9 | Multiple |
| Xylene | 24 hour | Average | µg/m³ | 1,200 | 23.6 | Multiple |
| | Annual | Average | µg/m³ | 950 | 23.2 | Multiple |

[12] Multiple sensitive receptors are similar in predicted concentrations and are dominated by background data

### 5.1.3 Potential Odour Impacts

The odour guideline requires proponents to ensure that their operations, in this case, the dredging and reclamation work, do not lead to offsite nuisance.

The odour guideline states that the assessment of the risk of odour nuisance can be evaluated using the 'standard criteria' of the EP Act and that proponents must demonstrate the use of best practice environmental management which has a hierarchy of control through to buffering.

Odour impact assessment criteria are set out in the odour guideline for use in atmospheric dispersion modelling studies. However, as the potential strength and extent of odour emissions from the Development cannot be quantified, an odour dispersion modelling study cannot be performed and odour impact assessment criteria are not useful in assessing or managing odour impacts from the Development.

Sediment analysis carried out in 2019 indicates that there are no significant organics present based on borehole data, and the operations are not expected to generate odour.

It is possible that during dredging, short term $H_2S$ generation can occur as a result of the dredged material being exposed to the air and oxidising, however if this occurs it will be treated while saturated so that acid sulphate soils do not form to reduce the risk of adverse impacts.

By adopting the management measures in Section 6, the risk of odour impacts can be managed for Stage 1 and Stage 2 of the project.

### 5.1.4 Civil Construction

Emissions to air from the civil construction include particulate matter (TSP, $PM_{10}$ and $PM_{2.5}$) and combustion products similar to those modelled and assessed in the dredging and reclamation phase of the development.

The primary sources of emissions are as follows;

- Concrete cutting, drilling and storage;
- Grinding and welding of steel;
- Light and medium sized vehicles on unsealed roads;
- Minor earthworks and excavation;
- Wind erosion from exposed surfaces; and
- Diesel combustion from onsite equipment and machinery.

The emissions to air from civil construction are similar to the excavation and handling of the dried out dredged material. However, the potential to create adverse air quality impacts are considered to be low due to a smaller scope of work including the size of area exposed and intensity of earthworks.

Using the management measures detailed in Section 6, as well as making use of good practice construction dust management principles, the potential impacts of these works would comply with the identified criterion.

### 5.1.5 Ongoing Use and Operations

Compared to the other two elements, ongoing use and operations are expected to have a low risk and not be significantly different from what is occurring now.

The management methods to manage the risk of particulate impacts are described in Sections 6 and 7.

Other ongoing uses relevant to air quality will include harbour operations, the boat ramp and marina and maintenance dredging. Based on the masterplan, the capacity of the harbour in unlikely to significantly change compared to what is indicated in the current project masterplan

By adopting the best practice management methods detailed in Section 6 the risks associated with future maintenance dredging work can be minimised.

## 5.2 Potential Residual Significant Impacts to Matters of National Environmental Significance

The significant impact guidelines (Australian Government, 2013) provide overarching guidance on determining whether an action is likely to have a significant impact on a matter protected under national environment law — the Environment Protection and Biodiversity Conservation Act 1999.

Concerning air quality, to determine if the impacts will be significant, the Significant impact criteria are as follows:

> An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will:
>
> - result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health.

Based on the assessment results provided above, as well as the proposed Management Measures, it is concluded that there will not be a substantial change in air quality which may impact human or exceed the vegetation criteria in Table 2-1.

## 5.3 Potential Residual Significant Impacts to Matters of Stage Environmental Significance

The guideline *Queensland Environmental Offsets Policy - Significant Residual Impact Guideline* (State of Queensland , 2014) assists in deciding whether or not a prescribed activity will, or is likely to have a significant residual impact on a matter of state environmental significance (MSES).

Relevant to air quality for the site are wetlands and watercourses. The significant impact criteria are as follows:

> An action is likely to have a significant residual impact on prescribed wetlands or watercourses if it is likely that the action will result in environmental values being affected in any of the following ways:
>
> - areas of the wetland or watercourse being destroyed or artificially modified;
> - a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or

- the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or
- a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or
- an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland.

Due to the prevailing winds, and time of day for operations, the modelling has indicated at there is a low risk of air quality impacts to Moreton Bay.

## 5.4 Cumulative Impacts

For air quality, cumulative impacts are considered by adding the background concentrations in Section 4.4 above to the predicted concentrations. The concentration at each receptor, with and without background concentrations can be found APPENDIX B and APPENDIX C.

# 6 MANAGEMENT MEASURES

## 6.1 Summary

The objective of this assessment was to prepare an air quality assessment to ensure that the development is planned, designed, constructed and operated to protect air quality. The management of potential emissions from the project, in particular particulate (dust) emissions during dredging and reclamation and civil construction, have been assessed.

The assessment has focused on the largest scale activities (dredging and reclamation and other works for Stages 1 and 2), as this assumes a large number of emission sources (including wind generated dust). Ongoing activities after Stages 1 and 2 due to their limited requirements for earthworks and construction have a much lower potential for impact.

The results must be looked at in the context of the following factors:

- Emission estimation and modelling methods;
- Distance to receptors; and
- Likely control measures.

First, concerning emission estimation methods, the methodology is based on standard equations, that are typically applied to mining and other sites, resulting in a conservative assessment for a wet process such as that proposed here. Unlike a typically dry mine site away from the coast, the reclamation works makes use of wet materials, and there is sufficient water available for mitigation.

The distance between the receptors and potential activities varies subject to the staging of the site. For the northern development and reclamation work (Stage 1), the distance to receptors is far closer than to the south for Stage 2. Therefore, for Stage 1 receptors to the west, in and around GJ Walker park have a higher risk than the other receptors. This was confirmed by the model results in Section 5. The modelling showed exceedances only occur for the annual average $PM_{2.5}$ at a location in GJ Walker Park, which is due to the high background concentration included in the assessment (6.8 $\mu g/m^3$) at the Cannon Hill DES monitoring site.

With appropriate mitigation measures and controls, the risk of impacts can be reduced even further and managed through the life of the project, especially for the dredging and reclamation works, and although posing a lesser risk, during the civil construction works.

The prevailing winds and times of operation (predominantly easterly winds, and works occurring during the day under easterly winds) mean that the impacts are more to the west than east over Moreton Bay, and the impacts are localised. However, given the relatively short distances between the development and existing receptors careful management is still required.

Guidance is provided in this regard in the document *Guidance on the assessment of dust from demolition and construction* (IAQM, 2014). Using the IQAM methodology, the relative risk of potential impacts from the development activities can be defined.

Whilst the IAQM method has not been adopted in full, Table 6-1 summarises the potential risks based on IAQM (2014). Note that they are typically applied to a generic construction activity.

**Table 6-1: Risk adopted for magnitude of potential dust emissions (IAQM)**

| Activity | Potential dust emissions magnitude classification | Comment |
|---|---|---|
| Demolition | N/A – Use **Small** | No demolition |
| Construction of Rockwall Breakwater | N/A – Use **Small** | Given the works are in the marine environment dust will not be a significant concern.<br>If required, ample water available for dust suppression. |
| Earthworks (i.e. excavating materials, internal haulage, tipping and stockpiling, site levelling and landscaping) includes civil construction | **Large**: Total site area >10,000 m2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes | Includes reclamation and dredging, and civil works over time. Assumes large area continually disturbed, however, dredged material will be predominantly wet with ample water available for dust suppression. |
| Construction (new buildings as ongoing use) at any time | **Small**: Total building volume <25,000 m3, construction material with low potential for dust release (e.g. metal cladding or timber). | Unlikely to have on site concrete batching. |
| Transport of dust from site onto nearby roads | **Small** – Less than 10 heavy vehicle movements in any one day, surface material with low potential for dust<br>release, unpaved road length less than 50 m. | Unpaved roads considered in modelling and earthworks component. Majority of material will be transported on wet internal roads. |

Concerning receptor risks, the dwellings in the area would be considered by IAQM (2014) as a “high sensitivity receptor” and the parkland “medium sensitivity receptor”.

Concerning ecological risks, the area as a whole under IAQM (2014) would fall into the “high sensitivity receptor” category due to the location of the site with regard to Moreton Bay.

Based on the information above, and using the methodology in IAQM as a guide, the risk of impacts during reclamation, when considering the location of the closest receptors, would be low. However, its acknowledged that sites immediately north west of the Project, in particular GJ Walter Park, are likely to be impacted for a short period during Stage 1 reclamation and dredging works if the mitigation measures are not adequately applied. For construction, the risk would also be low risk (high sensitivity and small magnitude).

Whilst the modelling indicates compliance with relevant criteria, and therefore there is a low risk in the context of the Legislation and Policies detailed in Section 2, considering the distance between the most potentially affected receptors, and the risk framework previously detailed, a series of overarching and specific mitigation measures have been prepared based on the high risk activity ratings in IAQM (2014). These are detailed below in Table 6-2.

**Table 6-2: Recommended Mitigation Measures – Earthworks – High Risk – Based on IAQM (2014)**

| Recommended Mitigation Measure | Comment |
|---|---|
| **Communication** | |

| Recommended Mitigation Measure | Comment |
|---|---|
| Maintain stakeholder and community engagement plan. | Walker corporation has existing plan in place. This should be maintained. |
| Implement 24 hour complaints hotline. | Complaint hotline will assist in site pro-actively and reactively managing dust emissions. |
| Develop and implement a Dust Management Plan (DMP) to achieve mitigation measures. Include triggers for action including monitoring, complaints and dust observed leaving site.<br><br>Plan includes reliance on real time dust monitoring to assist in optimising management. | The DMP should be worked in a way which enables any site user to adopt the methodology. DMP can be broken down into specific elements to enable it to be used across the site. Should include checklists to enable easy auditing. |
| **Site Management** | |
| Incorporate on and offsite inspection methodology for assessing the potential for impact on receptors and roads and to record findings of observations. | Check list type approaches on either fixed timeframes or ad hoc basis can be used to examine if dust is leaving the site. |
| Carry out regular inspections of site operations to ensure compliance with the DMP. Record results of inspections and any follow up actions for areas of concern. | Check list type approaches on either fixed timeframes or ad hoc basis can be used to examine if the management measures are being complied with. |
| Modify inspection frequencies for days where dust emissions may increase, for example extended dry periods, windy days or during periods where complaints may have occurred. | Should be performed in line with the results of the real time monitoring. (see below). |
| Establish real time air quality monitoring station at or near most likely affected receptor to monitor Total Suspended Particulates and $PM_{10}$. Monitoring to be performed in line with relevant Australian Standards or alternative methods detailed in DEC NSW (2006).<br><br>Establish dust deposition monitoring gauges at least 6 community locations and 1 background location. Monitoring to be performed in line with AS3580.10.1.<br><br>Real time concentrations for TSP to be compared to the nuisance criterion for TSP detailed in NZMFE (2016) for a 24 hour rolling average. If rolling average moves towards the 60 $\mu g/m^3$ limit (i.e. 75% of total), results to be monitored and mitigation put in place which could consist of more watering or controls or limiting work being perform. The data should be | Real time data from at least 1 location to be used to provide real time feedback on dust concentrations near the site with site operations being adjusted to reduce the risk of impacts. |

| Recommended Mitigation Measure | Comment |
|---|---|
| viewed in the context of whether or not the results are being biased by extreme events including bushfires or dust storms.<br><br>Real time concentrations for $PM_{10}$ to be compared to the criterion detailed in the EPP (Air) a 24 hour period (health criterion). If concentrations near or above the limit and investigation should be performed to determine a) whether the concentrations were impacted by other events, i.e. bushfires, dust storms, b) from normal or abnormal operations or c) from operations which require more controls. | |
| **Preparing and maintain the site** | |
| Earthworks near the closest receptors should be minimised as far as practicable. Controls for sources which may include haul roads and stockpiles should be maximised if located near to receptors. These should be located as far as practicable from the receptors.<br><br>Walking tracked equipment or driving wheeled equipment for storage near receptors should be avoided | Use of management measures combined with real time monitoring near potentially most impacted receptors (around GJ Walter Park) will reduce the risk in these areas. |
| Barriers and/or fencing should be installed on site on the site boundary or near potential sources of dust (stockpiles) to reduce the risk of dust impacts. | |
| Ensure any activities from fixed equipment (e.g. screening activities) which operate over an extended period use best practice dust control, which may include enclosing equipment. | |
| Inspect fencing and barriers weekly to ensure they do not build up with particulate matter or are damaged. | |
| Avoid storing materials on site that may lead to additional dust emissions, unless the materials are to be re used on site. If kept on site adopt controls described below. | |
| Cover, seed or fence stockpiles, and revegetate or stabilise exposed areas with environmentally safe dust suppression sprays. Reapply if surface is disturbed or if dust emissions are observed. | |
| Where possible adopt a modern equipment fleet. | |
| Avoid idling vehicles especially when located near sensitive receptors. | |
| Avoid the use of diesel generators and rely on mains power where possible. | |

| Recommended Mitigation Measure | Comment |
|---|---|
| Set a maximum speed limit of 20 km/hr on site on unpaved/unsealed roads. | |
| **Operations** | |
| If cutting, grinding or sawing equipment is to be used, ensure dust suppression techniques are used, such as local extraction systems or water sprays. | Relevant to future uses including building construction. |
| Use of water for dust suppression.<br>Water collected through the sediment dewatering process will be used for dust suppression | Used for water trucks/carts and sprays |
| If used, ensure chutes and conveyors are enclosed, and bins and skips are covered where practicable. | Relevant to future uses including building construction. |
| Minimise drop heights during loading and unloading operations. Use water sprays as required for loading and loading operations if dust emissions occur. | |
| If required ensure that raw materials including sand and aggregates are stored as far as practicable from sensitive receptors. Moisture content of material should be maintained to avoid the risk of emissions with other control methods including fencing and covers or stabilisation used as appropriate. | |
| If bulk materials including cement and/or lime are used to help stabilise the dredged material, the materials should be delivered in enclosed tankers and stored in suitable containers to prevent escape | |
| For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust. | |
| For hardstand or sealed roads, water assisted sweepers and/or dry sweepers should be used to avoid the risk of building of materials which could be re-entrained. | |
| Avoid dry sweeping large areas if dust is re-entrained by the process. | |
| All trucks leaving and entering the site (whether loaded or unloaded) should be covered to ensure dust emissions from trucks are minimised. | |
| Maintain haul roads and/or hardstand areas to avoid degradation of the roads. | |
| Record all inspections of haul roads and other activities. | |

| Recommended Mitigation Measure | Comment |
|---|---|
| Where possible ensure haul roads have a hard surface or are regularly watered with a water cart or truck to minimise emissions. Frequency of watering should be increased due to visible emissions or during dry periods. | Management can be performed having regard to real time dust measurements. |
| Install a wheel wash and rumble grid at entry points where trucks may pass on and off site. | |
| Ensure there is a sealed section of roadway between the wheel wash and exit point. | |

Additionally, the following standard measures are also recommended:

- Regularly water exposed and disturbed areas including stockpiles, especially during inclement weather conditions;
- For exposed areas which will not be actively worked, cover or stabilising the areas with dust suppression agents or hydroseeding;
- Cover materials planned to be stockpiled for more than one week.
- Use the real-time monitoring data, and monthly dust fall results to adjust the intensity of activities concerning the nearest receptors;
- Wherever possible and practical, limit the amount of materials stockpiled around the site;
- Clean loose materials and debris from the tailgate of vehicles unloading materials to stockpiles before departure from site;
- Position stockpiling areas as far as possible from surrounding receivers;
- Limit activities where practicable during conditions where winds are blowing strongly in the direction(s) from the location to nearby receivers; and
- Moving the Location 2 logger from its current location towards the northern receptors. If $H_2S$ is detected above background levels once dredging occurs.

## 6.2 Recommended Monitoring Locations

The proposed air quality monitoring program for the Development is recommended to consist of:

- Real time measurement methods complying with Australian Standards for TSP and $PM_{10}$; and
- Six impact dust deposition gauges and one background location in line with Australian Standards for measurement of dust fall out.

As the highest risk is for the Stage 1 activities, it is recommended that the monitoring be performed for at least the duration of the Stage 1 works.

The requirement for air quality monitoring for Stage 2 should be reviewed and based on the monitoring results from Stage 1 which will enable the efficacy of the mitigation measures to be evaluated. The monitoring criteria applicable to the Development is described in Schedule 1 of the *Environmental Protection (Air) Policy 2019* (OQPC, 2019a).

The proposed locations[13] of air quality monitoring equipment for the Development are presented in Figure 6-1.

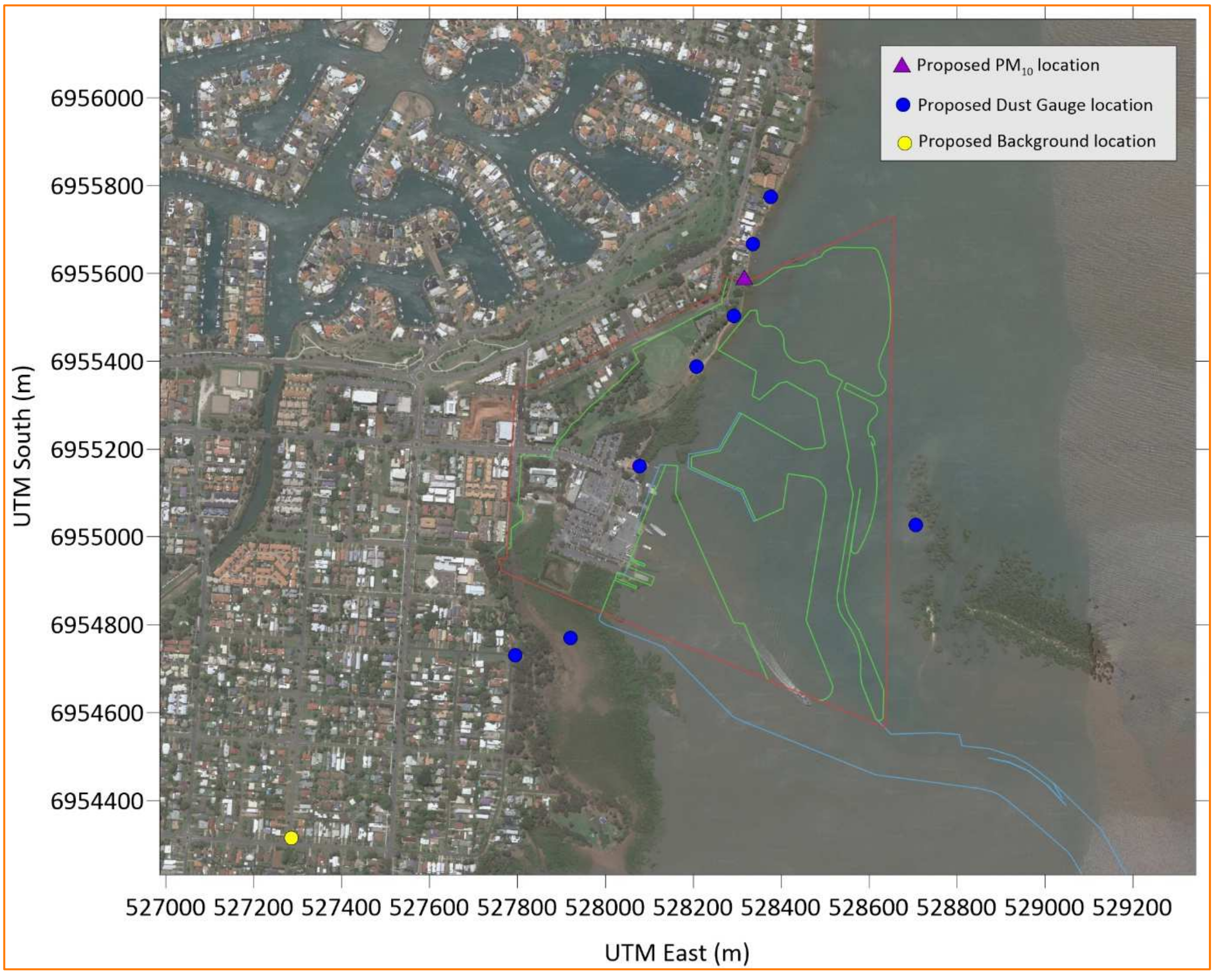



**Figure 6-1 Proposed Air Quality Monitoring Locations**

[13] Subject to change based on siting and safety considerations and access.

# 7 RISK ASSESSMENT

The risk of significant residual impacts to MNES and MSES have been assessed using the following tables:

- Table 7-1: Scale of Impact;
- Table 7-2: Duration / Irreversibility of Impact;
- Table 7-3: Impact Risk Category; and
- Table 7-4: Likelihood of a significant impact to MNES or MSES.

With regard to the assessment of risk, it is first worthwhile nothing that the modelling, which is in effect a risk assessment, predicted compliance for the majority of receptors for the majority of compounds, including the criteria for vegetation.

Limited exceedances were predicted for annual average $PM_{2.5,}$ however, this is not considered significant as:

- The emissions estimation methods adopted here for particulate and combustion gas emissions is conservative; and
- The $PM_{2.5}$ annual exceedance is in a park, and it is unlikely that anyone would be present in the park for an entire year;
- The $PM_{2.5}$ exceedances are driven by a high annual background, with the maximum predicted concentrations from the site being low;
- The results do not reflect the proposed management measures, which include using real time particulate measurements to scale the scope of on-site operations (i.e. limit extent of work on days where impacts may exceed limits).

**Table 7-1: Scale of Impact**

| Scale | Definition |
|---|---|
| Regional Scale | Impacts to MNES or MSES will occur beyond the site and immediate surrounds (potentially across several habitat types) |
| Local Scale | Impacts will occur to MNES or MSES at the site or immediate surrounds but will not have any measurable effect outside of |
| Individual Scale | Impacts will only occur to specific species or assemblages that are not identified as an MNES or MSES. |

**Table 7-2: Duration / Irreversibility of Impact**

| Duration | Definition |
|---|---|
| Permanent or Long Term (Irreversible) | Recovery of environmental feature measured in decades or irreversible |
| Medium Term Impact | Recovery of environmental feature measured in years |
| Short Term Impact | Recovery of environmental feature measured in days to months |

**Table 7-3: Impact Risk Category**

| Duration | Definition |
|---|---|
| High | Irreversible Impacts at the Local or Regional Scale |
| | Medium Term Impact at the Regional Scale |
| Medium | Medium Term Impact at the Local Scale |
| | Short Term impact at a Regional Scale |
| Low | Irreversible Impact at the Individual Scale |
| | Medium Term Impact at an Individual scale |
| | Short Term impact at a Local or Individual Scale |

Considering the above, the risk can be defined as follows:

- Scale – Local Scale – note compliance is generally predicted;
- Duration/irreversibility – short term impact – note compliance is generally predicted;
- Impact risk – low – short term impact at local or individual scale.

Considering the above, and the significance of the site, Table 7-4 can be interpreted as follows; there is an unlikely risk of significant residual impact, and the possible degree of impact would be low. Therefore, there is a very low risk of significant impact to the MNES and/or MSES as a result of changes in air quality.

**Table 7-4: Likelihood of a significant impact to MNES or MSES**

| Likelihood of Significant Residual Impact | High Impact | Medium Impact | Low Impact |
|---|---|---|---|
| Likely or Certain | 4 - High Risk | 4 - High Risk | 3 - Medium Risk |
| Possible | 4 - High Risk | 3 - Medium Risk | 2 - Low Risk |
| Not Likely | 3 - Medium Risk | 2 - Low Risk | 1 - Very Low Risk |

# 8 CONCLUSION

The assessment has been performed in line with Application Requirements For Activities With Impacts to Air (DES, 2019) and has involved modelling using recognised meteorological and dispersion models and estimating both particulate emissions from earthworks and other related activities, and combustion emissions from earthmoving equipment located on site.

The assessment was performed to address the Guidelines for the preparation of a draft Environmental Impact Statement for the Toondah Harbour Development, Queensland as well as other relevant State and Federal requirements. This involved describing the potential emission sources, estimating emissions to air and predicting the impacts of the emissions having regard to State and Federal policies and legislation. Background air quality concentrations were included to allow consideration of cumulative impacts. Recommended mitigation measures and how these would be monitored, audited and managed have also been provided.

Air quality impacts due to the Development in isolation, and with the inclusion of background concentrations of relevant pollutants, were determined at identified sensitive receptors and within the model domain. The results were then compared to the identified air quality criteria considering both human health as well as agriculture, forest, natural vegetation and ecosystem standards within the EPP Air as required by the Draft Environmental Impact Statement for the Toondah Harbour Development, Queensland.

The air quality assessment found the following:

- TSP – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- $PM_{10}$ – Predicted compliance at all sensitive receptors in isolation and cumulatively.
- $PM_{2.5}$ - Predicted:
    - Compliance for annual average concentrations at all receptors except receptor 41 for Stage 1.
        - Concentrations dominated by background concentration which makes up 85% of the allowable criteria.
        - Maximum site contribution at these receptors was 1.2 µg/m$^3$.
    - Compliance for all receptors for 24 hour concentrations.
- Compliance for annual average concentrations at all receptors except receptors 40 to 49 for Stage 1
- Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Carbon monoxide – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Nitrogen Dioxide – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Sulfur dioxide – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Benzene – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Toluene – Predicted compliance at all sensitive receptors in isolation and cumulatively;
- Xylene – Predicted compliance at all sensitive receptors in isolation and cumulatively;

Even though compliance was generally predicted, and the exceedance occurred due to a high background concentration (annual $PM_{2.5}$), the proposed management measures in this report are based on the high risk requirements in IAQM (2014) which includes the use of real time particulate measurement which is used to optimise site mitigation and ensure that actions on the site are performed in a way to minimise the risk of adverse impacts on the site and surrounds.

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## APPENDIX A. EMISSIONS ESTIMATION EQUATIONS AND ACTIVITY DATA

### 9.1.1 Swamp Dozer

Emissions for the swamp dozer and compactor site were taken from the NPI Mining Manual (NPI, 2012)) for bulldozers on material other than coal:

a. $EF_{TSP}$ (kg/h/vehicle) = k x $\frac{(s)^{1.2}}{(M)^{1.3}}$

Where:

b. k = TSP = 2.6, $PM_{10}$ = 0.34, $PM_{2.5}$ = 0.051;

c. U =mean site wind speed in m/s;

d. M = moisture content (%).;

### 9.1.2 Trucks dumping dredged material

Unloading emissions were estimated based on Section 1.1.16 of the NPI Mining Manual (NPI, 2012) for Loading Trucks and Unloading Trucks (rear dumping):

e. $EF_{TSP}$ (kg/ton/truck) = k x 0.0016 x $\frac{(\frac{U}{2.2})^{1.3}}{(\frac{M}{2})^{1.4}}$

Where:

f. k = TSP = 0.74, $PM_{10}$ = 0.35, $PM_{2.5}$ = 0.0525;

g. U =mean site wind speed in m/s;

h. M = moisture content (%).;

### 9.1.3 Grader

Emissions for the graders were taken from the NPI Mining Manual (NPI, 2012)) for graders:

i. $EF_{TSP}$ = 0.19 kg/ton material

j. $EF_{PM10}$ = 0.085 kg/ton of material

k. $EF_{PM2.5}$ = 0.01275 kg/ton of material

### 9.1.4 Excavators on dredged material

Excavators on the dredged material were estimated based on Section 1.1.16 of the NPI Mining Manual (NPI, 2012) for Excavators/shovels/front-end loaders (on overburden):

l. $EF_{TSP}\ (kg/ton/truck) = k \times 0.0016 \times \frac{(\frac{U}{2.2})^{1.3}}{(\frac{M}{2})^{1.4}}$

Where:

m. $k = TSP = 0.74$, $PM_{10} = 0.35$, $PM_{2.5} = 0.0525$;

n. U =mean site wind speed in m/s;

o. M = moisture content (%).;

**Table 9-1: Point Source Emissions (g/kWh)**

| ID | Power (kW) | $PM_{10}$ | $PM_{2.5}$ | NOx | CO | $SO_2$ | TVOCs |
|---|---|---|---|---|---|---|---|
| Tugboats | 1,140 | 0.28 | 0.28 | 9.3 | 2.46 | 0.015 | 0.17 |
| Dredging excavator | 502 | 0.2 | 0.2 | 2.0 | 3.5 | 0.0245 | 0.19 |
| Dump truck | 260 | 0.2 | 0.2 | 2.0 | 3.5 | 0.0077 | 0.19 |
| Swamp dozer | 157 | 0.2 | 0.2 | 2.0 | 3.5 | 0.0073 | 0.19 |
| Excavator | 205 | 0.2 | 0.2 | 2.0 | 3.5 | 0.0075 | 0.19 |
| Grader | 133 | 0.2 | 0.2 | 2.0 | 3.5 | 0.0075 | 0.19 |
| Compactor | 185 | 0.2 | 0.2 | 2.0 | 3.5 | 0.0073 | 0.19 |

**Table 9-2: Activity Data**

| Source | Input Variable | Adopted Factor | Source of Adopted Factor |
|---|---|---|---|
| Wheel generated dust | s (silt content) | 5% | Assumed silt content of dredged material |
| | S (average speed km/hr) | 10 | Estimated |
| | Vehicles per hour | 10 | Estimated |
| | W (vehicle weight in tons) | 3 – light vehicle<br>60 – dump truck | Light vehicle<br>3 axle |
| | w (number of wheels) | 4 – light vehicle<br>6 – dump truck | Light vehicle<br>3 axle |
| | p (rainfall days) | 92 | days based on Redland BOM |
| | Operating hours | 9 hours a day (day time) | Represents a typical 10-hour workday with breaks |
| | Control factor | 75% | Watering and high moisture content by weight |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |
| Wind erosion | Wind erosion threshold | >5.4 m/s | NPI Mining Manual |

| Source | Input Variable | Adopted Factor | Source of Adopted Factor |
|---|---|---|---|
| | Control factor | 75% | Watering and high moisture content by weight |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |
| | Working hours | 24 hours a day | |
| | Control Factor | 50% | High moisture content by weight |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |
| Grader | Kms/day | 20 | Assumed value |
| | Control Factor | 50% | High moisture content by weight |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |
| | Working hours | 12 hours a day | Operator |
| Dredging excavator | Tons/day | NA | Operator |
| | Control factor | NA | No dust emissions due to wet product |
| | Operating hours | 24 hours a day | 144 hours a week (modelled as 168 hours) |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |
| Trucks dumping | Tons/day | 422 per truck | Client |
| | Control factor | 50% | High moisture content by weight |
| | Operating hours | 8am – 5pm | Represents a typical 12-hour work day |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |
| Excavation | Tons/day | 1,685 per excavator | Client |
| | Control factor | 50% | High moisture content by weight |
| | Operating hours | 8am – 5pm | Represents a typical 12-hour work day |
| | $PM_{10}$:$PM_{2.5}$ ratio | 1: 0.15 | AP-42 Chapter 13.2.4 Aggregate Handling and Storage Piles |

**Table 9-3: Volume Source modelling parameters**

| ID | Z level (m) | Height (m) | Sigma Y (m) | Sigma Z (m) |
|---|---|---|---|---|
| Swamp dozer | 3 | 3.1 | 0.9 | 1.4 |
| Excavator | 3 | 1.5 | 1.4 | 2.8 |
| Compactor | 3 | 1.7 | 2.1 | 1.9 |
| Grader | 3 | 2.0 | 2.1 | 1.9 |
| Dump truck | 3 | 1.9 | 2.3 | 1.7 |

**Table 9-4: Point Source modelling parameters**

| ID | Exit Temperature (K) | Exhaust diameter (m) | Velocity (m/s) |
|---|---|---|---|
| Tugboats | 793 | 0.3 | 31.2 |
| Dredging excavator | 773 | 0.39 | 26.2 |
| Dump truck | 723 | 0.2 | 33.7 |
| Swamp dozer | 723 | 0.15 | 33.0 |
| Excavator | 723 | 0.20 | 23.9 |
| Grader | 673 | 0.15 | 28.3 |
| Compactor | 723 | 0.15 | 38.7 |

**Table 9-5: Area Source modelling parameters**

| ID | Z level (m) | Height (m) | Sigma Z (m) |
|---|---|---|---|
| Wind erosion | 3 | 1 | 0.5 |
| Wheel generated dust | 3 | 1 | 0.5 |

## 9.2 Predicted Air Quality Impacts in Isolation

**Table 9-6 Stage 1 Predicted Ground Level Concentrations in Isolation (µg/m³; Particulates)**

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition ($g/m^2$/month) |
|---|---|---|---|---|---|---|
| SR1 | 3.3 | 2.3 | 0.3 | 2.4 | 0.3 | 0.1 |
| SR2 | 3.3 | 2.5 | 0.3 | 2.6 | 0.3 | 0.1 |
| SR3 | 3.1 | 2.3 | 0.2 | 2.5 | 0.2 | 0.1 |
| SR4 | 3.3 | 2.2 | 0.2 | 2.3 | 0.2 | 0.1 |
| SR5 | 3.3 | 1.9 | 0.2 | 1.9 | 0.2 | 0.1 |
| SR6 | 3.0 | 1.6 | 0.2 | 2.1 | 0.2 | 0.1 |
| SR7 | 2.8 | 1.5 | 0.2 | 1.9 | 0.2 | 0.1 |
| SR8 | 2.8 | 1.5 | 0.2 | 1.9 | 0.2 | 0.1 |
| SR9 | 2.8 | 1.5 | 0.2 | 1.9 | 0.2 | 0.1 |
| SR10 | 2.9 | 1.6 | 0.2 | 2.1 | 0.2 | 0.1 |
| SR11 | 2.9 | 1.7 | 0.2 | 2.2 | 0.2 | 0.1 |
| SR12 | 2.9 | 1.8 | 0.2 | 2.3 | 0.2 | 0.1 |
| SR13 | 3.0 | 1.8 | 0.2 | 2.3 | 0.2 | 0.1 |
| SR14 | 3.0 | 1.9 | 0.2 | 2.3 | 0.2 | 0.1 |
| SR15 | 3.0 | 1.9 | 0.2 | 2.2 | 0.2 | 0.1 |
| SR16 | 2.9 | 1.9 | 0.2 | 2.1 | 0.2 | 0.1 |
| SR17 | 3.0 | 1.9 | 0.2 | 2.0 | 0.2 | 0.1 |
| SR18 | 3.3 | 1.5 | 0.2 | 1.7 | 0.2 | 0.1 |
| SR19 | 3.2 | 1.2 | 0.1 | 1.6 | 0.2 | 0.1 |
| SR20 | 3.0 | 1.2 | 0.1 | 1.4 | 0.2 | 0.1 |
| SR21 | 3.8 | 1.4 | 0.2 | 1.6 | 0.2 | 0.1 |
| SR22 | 4.1 | 1.3 | 0.2 | 1.6 | 0.2 | 0.1 |
| SR23 | 4.3 | 1.4 | 0.2 | 1.7 | 0.2 | 0.1 |
| SR24 | 4.5 | 1.4 | 0.2 | 1.7 | 0.2 | 0.1 |
| SR25 | 4.6 | 1.5 | 0.2 | 1.6 | 0.3 | 0.1 |
| SR26 | 4.7 | 1.5 | 0.2 | 1.6 | 0.3 | 0.1 |
| SR27 | 4.7 | 1.4 | 0.2 | 1.6 | 0.3 | 0.1 |
| SR28 | 4.6 | 1.4 | 0.2 | 1.5 | 0.3 | 0.1 |
| SR29 | 6.1 | 1.8 | 0.4 | 1.9 | 0.4 | 0.1 |
| SR30 | 5.8 | 1.8 | 0.4 | 2.0 | 0.4 | 0.1 |
| SR31 | 5.1 | 1.9 | 0.4 | 1.9 | 0.5 | 0.2 |
| SR32 | 4.7 | 2.0 | 0.5 | 2.2 | 0.5 | 0.2 |
| SR33 | 4.5 | 2.4 | 0.5 | 2.6 | 0.5 | 0.2 |
| SR34 | 4.4 | 2.8 | 0.6 | 2.5 | 0.6 | 0.2 |
| SR35 | 4.2 | 3.0 | 0.7 | 2.3 | 0.6 | 0.2 |
| SR36 | 4.0 | 3.0 | 0.7 | 2.3 | 0.6 | 0.3 |
| SR37 | 3.8 | 3.1 | 0.8 | 2.3 | 0.6 | 0.3 |
| SR38 | 3.6 | 3.3 | 0.8 | 2.1 | 0.6 | 0.3 |

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition ($g/m^2$/month) |
|---|---|---|---|---|---|---|
| SR39 | 3.6 | 3.6 | 0.8 | 2.4 | 0.6 | 0.3 |
| SR40 | 4.6 | 4.9 | 1.3 | 2.9 | 0.8 | 0.5 |
| SR41 | 8.9 | 5.8 | 2.5 | 3.8 | 1.2 | 0.8 |
| SR42 | 11.3 | 8.9 | 3.1 | 2.9 | 1.1 | 1.1 |
| SR43 | 8.2 | 9.4 | 2.7 | 4.2 | 1.1 | 1.1 |
| SR44 | 6.1 | 8.5 | 2.2 | 3.7 | 1.0 | 0.9 |
| SR45 | 5.7 | 8.5 | 2.0 | 3.5 | 1.0 | 0.8 |
| SR46 | 5.4 | 8.1 | 1.9 | 3.6 | 1.0 | 0.8 |
| SR47 | 4.9 | 7.4 | 1.7 | 3.8 | 0.9 | 0.8 |
| SR48 | 4.6 | 6.8 | 1.6 | 3.9 | 0.9 | 0.9 |
| SR49 | 4.5 | 6.6 | 1.5 | 4.3 | 0.8 | 0.9 |
| SR50 | 4.2 | 6.8 | 1.4 | 4.1 | 0.7 | 0.8 |
| SR51 | 3.7 | 6.6 | 1.1 | 3.3 | 0.6 | 0.6 |
| SR52 | 3.5 | 5.8 | 1.0 | 3.0 | 0.6 | 0.6 |
| SR53 | 3.0 | 5.5 | 0.9 | 3.3 | 0.5 | 0.6 |
| SR54 | 2.7 | 5.2 | 0.7 | 3.1 | 0.4 | 0.5 |
| SR55 | 2.4 | 4.6 | 0.6 | 2.4 | 0.3 | 0.4 |
| SR56 | 2.2 | 4.4 | 0.5 | 2.1 | 0.3 | 0.3 |
| SR57 | 1.9 | 4.2 | 0.4 | 1.8 | 0.2 | 0.3 |
| SR58 | 0.8 | 2.8 | 0.2 | 1.8 | 0.1 | 0.1 |
| SR59 | 0.3 | 1.8 | 0.1 | 1.1 | 0.1 | 0.1 |
| SR60 | 4.0 | 2.4 | 0.3 | 2.6 | 0.3 | 0.1 |
| SR61 | 5.9 | 2.9 | 0.5 | 3.8 | 0.5 | 0.1 |

**Table 9-7 Stage 1 Predicted Ground Level Concentrations in Isolation (µg/m$^3$; Combustion Gases)**

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR1 | 94 | 1.5 | 72 | 0.6 | 0.12 | 0.01 |
| SR2 | 77 | 1.7 | 82 | 0.6 | 0.13 | 0.01 |
| SR3 | 72 | 1.5 | 74 | 0.6 | 0.12 | 0.01 |
| SR4 | 64 | 1.6 | 68 | 0.5 | 0.11 | 0.01 |
| SR5 | 66 | 1.6 | 60 | 0.4 | 0.10 | 0.01 |
| SR6 | 82 | 1.3 | 57 | 0.6 | 0.11 | 0.01 |
| SR7 | 79 | 1.1 | 57 | 0.6 | 0.11 | 0.01 |
| SR8 | 77 | 1.1 | 57 | 0.6 | 0.10 | 0.01 |
| SR9 | 71 | 1.1 | 56 | 0.6 | 0.11 | 0.01 |
| SR10 | 74 | 1.1 | 57 | 0.6 | 0.12 | 0.01 |
| SR11 | 71 | 1.1 | 61 | 0.6 | 0.13 | 0.01 |
| SR12 | 73 | 1.1 | 62 | 0.6 | 0.13 | 0.01 |
| SR13 | 71 | 1.1 | 63 | 0.5 | 0.14 | 0.01 |
| SR14 | 70 | 1.1 | 62 | 0.5 | 0.14 | 0.01 |
| SR15 | 69 | 1.1 | 61 | 0.5 | 0.14 | 0.01 |

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR16 | 67 | 1.1 | 58 | 0.5 | 0.14 | 0.01 |
| SR17 | 64 | 1.3 | 55 | 0.4 | 0.13 | 0.01 |
| SR18 | 57 | 1.2 | 46 | 0.4 | 0.11 | 0.01 |
| SR19 | 59 | 1.1 | 42 | 0.5 | 0.11 | 0.01 |
| SR20 | 54 | 1.0 | 40 | 0.4 | 0.10 | 0.01 |
| SR21 | 43 | 1.3 | 43 | 0.3 | 0.11 | 0.01 |
| SR22 | 42 | 1.5 | 46 | 0.3 | 0.10 | 0.01 |
| SR23 | 45 | 1.5 | 47 | 0.4 | 0.10 | 0.01 |
| SR24 | 41 | 1.6 | 49 | 0.3 | 0.10 | 0.02 |
| SR25 | 43 | 1.7 | 50 | 0.3 | 0.12 | 0.02 |
| SR26 | 44 | 1.7 | 49 | 0.4 | 0.12 | 0.02 |
| SR27 | 45 | 1.7 | 48 | 0.4 | 0.12 | 0.02 |
| SR28 | 45 | 1.8 | 45 | 0.3 | 0.11 | 0.02 |
| SR29 | 54 | 2.9 | 56 | 0.4 | 0.14 | 0.03 |
| SR30 | 52 | 2.9 | 57 | 0.4 | 0.14 | 0.03 |
| SR31 | 58 | 2.9 | 57 | 0.4 | 0.13 | 0.03 |
| SR32 | 61 | 3.0 | 59 | 0.4 | 0.15 | 0.03 |
| SR33 | 74 | 3.0 | 68 | 0.5 | 0.15 | 0.03 |
| SR34 | 80 | 3.1 | 71 | 0.5 | 0.14 | 0.03 |
| SR35 | 87 | 3.0 | 80 | 0.6 | 0.15 | 0.03 |
| SR36 | 78 | 2.8 | 85 | 0.6 | 0.15 | 0.03 |
| SR37 | 77 | 2.6 | 88 | 0.6 | 0.14 | 0.03 |
| SR38 | 82 | 2.5 | 88 | 0.6 | 0.14 | 0.03 |
| SR39 | 84 | 2.4 | 96 | 0.6 | 0.16 | 0.03 |
| SR40 | 93 | 2.6 | 122 | 0.6 | 0.11 | 0.03 |
| SR41 | 102 | 3.4 | 136 | 0.7 | 0.16 | 0.04 |
| SR42 | 105 | 2.7 | 105 | 0.9 | 0.13 | 0.03 |
| SR43 | 72 | 2.7 | 147 | 0.6 | 0.13 | 0.04 |
| SR44 | 67 | 2.7 | 150 | 0.5 | 0.13 | 0.03 |
| SR45 | 61 | 2.6 | 142 | 0.5 | 0.12 | 0.03 |
| SR46 | 59 | 2.6 | 149 | 0.5 | 0.12 | 0.03 |
| SR47 | 57 | 2.4 | 158 | 0.5 | 0.13 | 0.03 |
| SR48 | 54 | 2.3 | 163 | 0.4 | 0.13 | 0.03 |
| SR49 | 50 | 2.2 | 183 | 0.4 | 0.15 | 0.03 |
| SR50 | 47 | 2.0 | 177 | 0.4 | 0.14 | 0.03 |
| SR51 | 43 | 1.7 | 141 | 0.4 | 0.11 | 0.02 |
| SR52 | 41 | 1.5 | 113 | 0.5 | 0.12 | 0.02 |
| SR53 | 38 | 1.3 | 131 | 0.4 | 0.12 | 0.02 |
| SR54 | 38 | 1.1 | 128 | 0.4 | 0.11 | 0.01 |
| SR55 | 37 | 0.9 | 102 | 0.3 | 0.09 | 0.01 |
| SR56 | 35 | 0.8 | 88 | 0.3 | 0.08 | 0.01 |
| SR57 | 34 | 0.6 | 72 | 0.3 | 0.07 | 0.01 |
| SR58 | 59 | 0.4 | 78 | 0.4 | 0.08 | 0.00 |
| SR59 | 42 | 0.2 | 43 | 0.3 | 0.04 | 0.00 |
| SR60 | 85 | 2.0 | 73 | 0.5 | 0.19 | 0.02 |
| SR61 | 111 | 3.5 | 96 | 0.7 | 0.23 | 0.03 |

Table 9-8 Stage 1 Predicted Ground Level Concentrations in Isolation (µg/m$^3$; Air Toxics)

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR1 | 0.01 | 0.3 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR2 | 0.01 | 0.4 | 0.08 | 0.01 | 0.02 | 0.002 |
| SR3 | 0.01 | 0.4 | 0.08 | 0.01 | 0.02 | 0.002 |
| SR4 | 0.01 | 0.3 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR5 | 0.01 | 0.3 | 0.06 | 0.01 | 0.02 | 0.002 |
| SR6 | 0.01 | 0.4 | 0.06 | 0.01 | 0.02 | 0.002 |
| SR7 | 0.01 | 0.4 | 0.06 | 0.01 | 0.02 | 0.001 |
| SR8 | 0.01 | 0.4 | 0.06 | 0.01 | 0.02 | 0.002 |
| SR9 | 0.01 | 0.4 | 0.06 | 0.01 | 0.02 | 0.001 |
| SR10 | 0.01 | 0.4 | 0.06 | 0.01 | 0.02 | 0.001 |
| SR11 | 0.01 | 0.4 | 0.07 | 0.01 | 0.02 | 0.001 |
| SR12 | 0.01 | 0.4 | 0.07 | 0.01 | 0.02 | 0.001 |
| SR13 | 0.01 | 0.4 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR14 | 0.01 | 0.4 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR15 | 0.01 | 0.3 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR16 | 0.01 | 0.3 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR17 | 0.01 | 0.3 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR18 | 0.01 | 0.2 | 0.05 | 0.01 | 0.01 | 0.002 |
| SR19 | 0.01 | 0.4 | 0.05 | 0.01 | 0.01 | 0.001 |
| SR20 | 0.01 | 0.3 | 0.05 | 0.01 | 0.01 | 0.001 |
| SR21 | 0.01 | 0.3 | 0.05 | 0.01 | 0.01 | 0.002 |
| SR22 | 0.01 | 0.3 | 0.05 | 0.01 | 0.01 | 0.002 |
| SR23 | 0.01 | 0.3 | 0.06 | 0.01 | 0.01 | 0.002 |
| SR24 | 0.01 | 0.3 | 0.06 | 0.01 | 0.02 | 0.002 |
| SR25 | 0.01 | 0.3 | 0.06 | 0.01 | 0.01 | 0.002 |
| SR26 | 0.01 | 0.3 | 0.05 | 0.01 | 0.01 | 0.002 |
| SR27 | 0.01 | 0.2 | 0.05 | 0.01 | 0.01 | 0.002 |
| SR28 | 0.01 | 0.2 | 0.05 | 0.01 | 0.01 | 0.002 |
| SR29 | 0.02 | 0.3 | 0.06 | 0.01 | 0.02 | 0.004 |
| SR30 | 0.02 | 0.3 | 0.06 | 0.01 | 0.02 | 0.004 |
| SR31 | 0.02 | 0.3 | 0.06 | 0.02 | 0.02 | 0.004 |
| SR32 | 0.02 | 0.3 | 0.07 | 0.02 | 0.02 | 0.004 |
| SR33 | 0.02 | 0.3 | 0.08 | 0.02 | 0.02 | 0.004 |
| SR34 | 0.02 | 0.3 | 0.08 | 0.02 | 0.02 | 0.005 |
| SR35 | 0.02 | 0.3 | 0.07 | 0.02 | 0.02 | 0.005 |
| SR36 | 0.02 | 0.4 | 0.08 | 0.02 | 0.02 | 0.005 |
| SR37 | 0.02 | 0.4 | 0.08 | 0.02 | 0.02 | 0.005 |
| SR38 | 0.02 | 0.4 | 0.08 | 0.02 | 0.02 | 0.005 |
| SR39 | 0.02 | 0.4 | 0.08 | 0.02 | 0.02 | 0.005 |
| SR40 | 0.03 | 0.5 | 0.11 | 0.03 | 0.03 | 0.007 |
| SR41 | 0.05 | 0.6 | 0.14 | 0.04 | 0.04 | 0.011 |
| SR42 | 0.04 | 0.8 | 0.10 | 0.03 | 0.03 | 0.008 |
| SR43 | 0.04 | 0.5 | 0.13 | 0.03 | 0.04 | 0.009 |
| SR44 | 0.04 | 0.4 | 0.13 | 0.03 | 0.04 | 0.009 |
| SR45 | 0.04 | 0.4 | 0.12 | 0.03 | 0.03 | 0.009 |
| SR46 | 0.04 | 0.4 | 0.13 | 0.03 | 0.03 | 0.009 |
| SR47 | 0.04 | 0.4 | 0.14 | 0.03 | 0.04 | 0.008 |
| SR48 | 0.04 | 0.4 | 0.15 | 0.03 | 0.04 | 0.008 |

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR49 | 0.03 | 0.5 | 0.16 | 0.03 | 0.04 | 0.007 |
| SR50 | 0.03 | 0.5 | 0.15 | 0.03 | 0.04 | 0.007 |
| SR51 | 0.03 | 0.5 | 0.13 | 0.02 | 0.03 | 0.006 |
| SR52 | 0.02 | 0.5 | 0.11 | 0.02 | 0.03 | 0.005 |
| SR53 | 0.02 | 0.5 | 0.12 | 0.02 | 0.03 | 0.004 |
| SR54 | 0.02 | 0.4 | 0.12 | 0.01 | 0.03 | 0.003 |
| SR55 | 0.01 | 0.4 | 0.09 | 0.01 | 0.03 | 0.003 |
| SR56 | 0.01 | 0.3 | 0.08 | 0.01 | 0.02 | 0.002 |
| SR57 | 0.01 | 0.3 | 0.07 | 0.01 | 0.02 | 0.002 |
| SR58 | 0.01 | 0.3 | 0.06 | 0.01 | 0.02 | 0.002 |
| SR59 | 0.004 | 0.3 | 0.04 | 0.003 | 0.01 | 0.001 |
| SR60 | 0.002 | 0.4 | 0.09 | 0.002 | 0.02 | 0.000 |
| SR61 | 0.01 | 0.4 | 0.12 | 0.01 | 0.03 | 0.003 |

**Table 9-9 Stage 2 Predicted Ground Level Concentrations in Isolation (µg/m$^3$; Particulates)**

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition (g/m$^2$/month) |
|---|---|---|---|---|---|---|
| SR1 | 0.3 | 2.9 | 0.3 | 3.0 | 0.3 | 0.09 |
| SR2 | 0.2 | 2.8 | 0.3 | 2.7 | 0.2 | 0.07 |
| SR3 | 0.1 | 2.4 | 0.2 | 2.3 | 0.2 | 0.06 |
| SR4 | 0.1 | 2.3 | 0.2 | 2.0 | 0.2 | 0.06 |
| SR5 | 0.1 | 2.2 | 0.2 | 1.9 | 0.2 | 0.06 |
| SR6 | 0.1 | 1.9 | 0.1 | 1.7 | 0.1 | 0.05 |
| SR7 | 0.1 | 1.5 | 0.1 | 1.7 | 0.1 | 0.05 |
| SR8 | 0.1 | 1.5 | 0.1 | 1.7 | 0.1 | 0.05 |
| SR9 | 0.1 | 1.5 | 0.1 | 1.6 | 0.1 | 0.05 |
| SR10 | 0.1 | 1.5 | 0.1 | 1.6 | 0.1 | 0.04 |
| SR11 | 0.1 | 1.6 | 0.1 | 1.6 | 0.1 | 0.04 |
| SR12 | 0.1 | 1.7 | 0.1 | 1.5 | 0.1 | 0.04 |
| SR13 | 0.1 | 1.8 | 0.1 | 1.5 | 0.1 | 0.04 |
| SR14 | 0.1 | 2.0 | 0.1 | 1.5 | 0.1 | 0.04 |
| SR15 | 0.1 | 2.1 | 0.1 | 1.7 | 0.1 | 0.04 |
| SR16 | 0.1 | 2.2 | 0.2 | 1.8 | 0.2 | 0.04 |
| SR17 | 0.1 | 1.8 | 0.2 | 1.8 | 0.2 | 0.04 |
| SR18 | 0.1 | 1.8 | 0.2 | 1.9 | 0.2 | 0.04 |
| SR19 | 0.1 | 1.5 | 0.1 | 1.7 | 0.1 | 0.04 |
| SR20 | 0.1 | 1.4 | 0.1 | 1.5 | 0.1 | 0.04 |
| SR21 | 0.1 | 1.3 | 0.2 | 1.3 | 0.2 | 0.06 |
| SR22 | 0.1 | 1.2 | 0.2 | 1.3 | 0.2 | 0.06 |
| SR23 | 0.1 | 1.2 | 0.2 | 1.2 | 0.2 | 0.06 |
| SR24 | 0.1 | 1.2 | 0.2 | 1.1 | 0.2 | 0.07 |
| SR25 | 0.1 | 1.1 | 0.2 | 1.0 | 0.2 | 0.07 |
| SR26 | 0.1 | 1.1 | 0.2 | 1.0 | 0.2 | 0.07 |
| SR27 | 0.1 | 1.1 | 0.2 | 0.9 | 0.2 | 0.08 |
| SR28 | 0.2 | 1.0 | 0.2 | 1.0 | 0.2 | 0.09 |

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition ($g/m^2/month$) |
|---|---|---|---|---|---|---|
| SR29 | 0.3 | 1.3 | 0.3 | 1.2 | 0.2 | 0.15 |
| SR30 | 0.3 | 1.4 | 0.3 | 1.2 | 0.2 | 0.16 |
| SR31 | 0.3 | 1.5 | 0.3 | 1.3 | 0.3 | 0.17 |
| SR32 | 0.4 | 1.6 | 0.4 | 1.4 | 0.3 | 0.18 |
| SR33 | 0.4 | 1.8 | 0.4 | 1.5 | 0.3 | 0.18 |
| SR34 | 0.5 | 2.1 | 0.4 | 1.7 | 0.3 | 0.19 |
| SR35 | 0.5 | 2.2 | 0.5 | 1.8 | 0.3 | 0.19 |
| SR36 | 0.5 | 2.2 | 0.5 | 1.8 | 0.3 | 0.18 |
| SR37 | 0.5 | 2.3 | 0.5 | 1.9 | 0.3 | 0.17 |
| SR38 | 0.5 | 2.2 | 0.5 | 1.8 | 0.3 | 0.15 |
| SR39 | 0.5 | 2.3 | 0.5 | 1.9 | 0.3 | 0.14 |
| SR40 | 0.6 | 3.0 | 0.6 | 2.3 | 0.4 | 0.14 |
| SR41 | 0.7 | 3.8 | 0.6 | 3.2 | 0.4 | 0.14 |
| SR42 | 0.5 | 3.5 | 0.4 | 3.2 | 0.3 | 0.12 |
| SR43 | 0.3 | 2.5 | 0.2 | 2.5 | 0.2 | 0.09 |
| SR44 | 0.2 | 2.3 | 0.2 | 2.3 | 0.2 | 0.09 |
| SR45 | 0.2 | 2.3 | 0.2 | 2.3 | 0.1 | 0.09 |
| SR46 | 0.2 | 2.3 | 0.2 | 2.2 | 0.1 | 0.08 |
| SR47 | 0.2 | 2.2 | 0.2 | 2.1 | 0.1 | 0.08 |
| SR48 | 0.2 | 2.2 | 0.2 | 2.1 | 0.1 | 0.08 |
| SR49 | 0.2 | 2.1 | 0.2 | 2.0 | 0.1 | 0.08 |
| SR50 | 0.2 | 2.1 | 0.2 | 1.9 | 0.1 | 0.07 |
| SR51 | 0.2 | 2.1 | 0.2 | 1.7 | 0.1 | 0.07 |
| SR52 | 0.2 | 2.1 | 0.2 | 1.5 | 0.1 | 0.07 |
| SR53 | 0.2 | 2.1 | 0.2 | 1.4 | 0.1 | 0.06 |
| SR54 | 0.1 | 2.1 | 0.1 | 1.5 | 0.1 | 0.06 |
| SR55 | 0.1 | 2.0 | 0.1 | 1.4 | 0.1 | 0.05 |
| SR56 | 0.1 | 1.9 | 0.1 | 1.3 | 0.1 | 0.05 |
| SR57 | 0.1 | 1.7 | 0.1 | 1.2 | 0.1 | 0.05 |
| SR58 | 0.8 | 6.1 | 0.5 | 3.9 | 0.2 | 0.18 |
| SR59 | 0.2 | 3.3 | 0.2 | 2.7 | 0.1 | 0.06 |
| SR60 | 0.2 | 2.5 | 0.3 | 2.7 | 0.3 | 0.06 |
| SR61 | 0.4 | 3.4 | 0.4 | 3.2 | 0.4 | 0.09 |

**Table 9-10 Stage 2 Predicted Ground Level Concentrations in Isolation (µg/m$^3$; Combustion Gases)**

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR1 | 70 | 1.7 | 105 | 0.6 | 0.15 | 0.017 |
| SR2 | 72 | 1.1 | 101 | 0.5 | 0.13 | 0.013 |
| SR3 | 57 | 0.8 | 82 | 0.4 | 0.11 | 0.010 |
| SR4 | 58 | 0.8 | 73 | 0.4 | 0.11 | 0.010 |
| SR5 | 54 | 0.8 | 66 | 0.4 | 0.12 | 0.010 |
| SR6 | 63 | 0.7 | 53 | 0.5 | 0.11 | 0.009 |
| SR7 | 66 | 0.7 | 51 | 0.5 | 0.09 | 0.008 |

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR8 | 68 | 0.7 | 52 | 0.4 | 0.10 | 0.008 |
| SR9 | 66 | 0.7 | 52 | 0.4 | 0.10 | 0.008 |
| SR10 | 58 | 0.7 | 53 | 0.4 | 0.09 | 0.008 |
| SR11 | 49 | 0.7 | 54 | 0.4 | 0.09 | 0.008 |
| SR12 | 47 | 0.8 | 54 | 0.4 | 0.09 | 0.008 |
| SR13 | 50 | 0.8 | 56 | 0.4 | 0.09 | 0.008 |
| SR14 | 56 | 0.8 | 57 | 0.4 | 0.10 | 0.008 |
| SR15 | 63 | 0.8 | 58 | 0.5 | 0.11 | 0.009 |
| SR16 | 69 | 0.8 | 58 | 0.5 | 0.12 | 0.009 |
| SR17 | 69 | 1.0 | 61 | 0.5 | 0.13 | 0.011 |
| SR18 | 69 | 1.0 | 55 | 0.4 | 0.14 | 0.011 |
| SR19 | 71 | 0.8 | 54 | 0.4 | 0.10 | 0.009 |
| SR20 | 79 | 0.8 | 51 | 0.5 | 0.09 | 0.009 |
| SR21 | 51 | 0.9 | 43 | 0.4 | 0.09 | 0.010 |
| SR22 | 54 | 0.9 | 38 | 0.4 | 0.09 | 0.010 |
| SR23 | 55 | 0.8 | 34 | 0.4 | 0.08 | 0.010 |
| SR24 | 53 | 0.8 | 32 | 0.4 | 0.07 | 0.010 |
| SR25 | 48 | 0.8 | 32 | 0.4 | 0.07 | 0.010 |
| SR26 | 44 | 0.8 | 31 | 0.4 | 0.07 | 0.010 |
| SR27 | 39 | 0.8 | 31 | 0.4 | 0.07 | 0.010 |
| SR28 | 30 | 0.8 | 31 | 0.4 | 0.07 | 0.010 |
| SR29 | 31 | 1.0 | 37 | 0.4 | 0.08 | 0.013 |
| SR30 | 30 | 1.1 | 37 | 0.3 | 0.08 | 0.014 |
| SR31 | 33 | 1.1 | 40 | 0.3 | 0.08 | 0.014 |
| SR32 | 37 | 1.1 | 42 | 0.3 | 0.09 | 0.014 |
| SR33 | 41 | 1.2 | 47 | 0.4 | 0.09 | 0.015 |
| SR34 | 47 | 1.3 | 55 | 0.4 | 0.09 | 0.016 |
| SR35 | 50 | 1.3 | 59 | 0.5 | 0.09 | 0.016 |
| SR36 | 54 | 1.3 | 62 | 0.5 | 0.09 | 0.016 |
| SR37 | 58 | 1.3 | 64 | 0.5 | 0.09 | 0.016 |
| SR38 | 60 | 1.3 | 65 | 0.6 | 0.09 | 0.016 |
| SR39 | 61 | 1.3 | 69 | 0.6 | 0.10 | 0.016 |
| SR40 | 56 | 1.5 | 82 | 0.5 | 0.11 | 0.017 |
| SR41 | 75 | 1.6 | 131 | 0.7 | 0.13 | 0.019 |
| SR42 | 69 | 1.1 | 121 | 0.6 | 0.14 | 0.013 |
| SR43 | 56 | 0.7 | 86 | 0.5 | 0.11 | 0.008 |
| SR44 | 52 | 0.6 | 81 | 0.5 | 0.11 | 0.007 |
| SR45 | 47 | 0.6 | 80 | 0.4 | 0.10 | 0.007 |
| SR46 | 45 | 0.6 | 79 | 0.4 | 0.10 | 0.007 |
| SR47 | 42 | 0.6 | 76 | 0.4 | 0.10 | 0.007 |
| SR48 | 37 | 0.5 | 74 | 0.3 | 0.09 | 0.006 |
| SR49 | 34 | 0.5 | 71 | 0.3 | 0.09 | 0.006 |
| SR50 | 35 | 0.5 | 67 | 0.3 | 0.09 | 0.006 |
| SR51 | 35 | 0.5 | 60 | 0.3 | 0.08 | 0.006 |
| SR52 | 35 | 0.5 | 55 | 0.3 | 0.07 | 0.006 |
| SR53 | 32 | 0.5 | 46 | 0.3 | 0.07 | 0.006 |
| SR54 | 33 | 0.5 | 43 | 0.3 | 0.07 | 0.005 |
| SR55 | 34 | 0.4 | 41 | 0.3 | 0.07 | 0.005 |
| SR56 | 33 | 0.4 | 37 | 0.3 | 0.06 | 0.005 |
| SR57 | 32 | 0.4 | 32 | 0.3 | 0.06 | 0.004 |

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR58 | 59 | 0.9 | 134 | 0.5 | 0.17 | 0.010 |
| SR59 | 84 | 0.8 | 98 | 0.4 | 0.12 | 0.007 |
| SR60 | 90 | 1.6 | 87 | 0.5 | 0.17 | 0.015 |
| SR61 | 96 | 1.9 | 119 | 0.6 | 0.16 | 0.017 |

**Table 9-11 Stage 2 Predicted Ground Level Concentrations in Isolation (µg/m$^3$; Air Toxics)**

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR1 | 0.014 | 0.4 | 0.09 | 0.010 | 0.03 | 0.003 |
| SR2 | 0.010 | 0.4 | 0.08 | 0.007 | 0.03 | 0.002 |
| SR3 | 0.007 | 0.3 | 0.07 | 0.005 | 0.02 | 0.002 |
| SR4 | 0.007 | 0.3 | 0.06 | 0.005 | 0.02 | 0.002 |
| SR5 | 0.007 | 0.3 | 0.06 | 0.005 | 0.02 | 0.001 |
| SR6 | 0.006 | 0.4 | 0.05 | 0.004 | 0.02 | 0.001 |
| SR7 | 0.006 | 0.4 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR8 | 0.006 | 0.4 | 0.05 | 0.004 | 0.02 | 0.001 |
| SR9 | 0.006 | 0.4 | 0.05 | 0.004 | 0.02 | 0.001 |
| SR10 | 0.006 | 0.4 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR11 | 0.006 | 0.4 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR12 | 0.006 | 0.4 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR13 | 0.006 | 0.4 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR14 | 0.006 | 0.5 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR15 | 0.006 | 0.5 | 0.05 | 0.004 | 0.02 | 0.001 |
| SR16 | 0.007 | 0.5 | 0.05 | 0.005 | 0.02 | 0.001 |
| SR17 | 0.008 | 0.3 | 0.06 | 0.005 | 0.02 | 0.002 |
| SR18 | 0.008 | 0.3 | 0.06 | 0.005 | 0.02 | 0.002 |
| SR19 | 0.006 | 0.3 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR20 | 0.006 | 0.3 | 0.04 | 0.004 | 0.01 | 0.001 |
| SR21 | 0.007 | 0.3 | 0.04 | 0.005 | 0.01 | 0.001 |
| SR22 | 0.007 | 0.3 | 0.04 | 0.005 | 0.01 | 0.001 |
| SR23 | 0.007 | 0.3 | 0.04 | 0.005 | 0.01 | 0.001 |
| SR24 | 0.007 | 0.3 | 0.03 | 0.005 | 0.01 | 0.002 |
| SR25 | 0.007 | 0.3 | 0.03 | 0.005 | 0.01 | 0.002 |
| SR26 | 0.007 | 0.4 | 0.03 | 0.005 | 0.01 | 0.002 |
| SR27 | 0.007 | 0.4 | 0.03 | 0.005 | 0.01 | 0.002 |
| SR28 | 0.007 | 0.4 | 0.03 | 0.005 | 0.01 | 0.002 |
| SR29 | 0.010 | 0.4 | 0.04 | 0.007 | 0.01 | 0.002 |
| SR30 | 0.010 | 0.4 | 0.04 | 0.007 | 0.01 | 0.002 |
| SR31 | 0.011 | 0.3 | 0.04 | 0.008 | 0.01 | 0.002 |
| SR32 | 0.012 | 0.3 | 0.04 | 0.008 | 0.01 | 0.002 |
| SR33 | 0.012 | 0.3 | 0.05 | 0.009 | 0.01 | 0.003 |
| SR34 | 0.014 | 0.3 | 0.05 | 0.010 | 0.02 | 0.003 |
| SR35 | 0.014 | 0.4 | 0.06 | 0.010 | 0.02 | 0.003 |
| SR36 | 0.015 | 0.4 | 0.06 | 0.010 | 0.02 | 0.003 |
| SR37 | 0.015 | 0.5 | 0.06 | 0.010 | 0.02 | 0.003 |

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR38 | 0.015 | 0.5 | 0.06 | 0.010 | 0.02 | 0.003 |
| SR39 | 0.015 | 0.5 | 0.06 | 0.011 | 0.02 | 0.003 |
| SR40 | 0.017 | 0.5 | 0.07 | 0.012 | 0.02 | 0.004 |
| SR41 | 0.020 | 0.6 | 0.10 | 0.014 | 0.03 | 0.004 |
| SR42 | 0.013 | 0.5 | 0.11 | 0.009 | 0.03 | 0.003 |
| SR43 | 0.007 | 0.4 | 0.08 | 0.005 | 0.02 | 0.002 |
| SR44 | 0.007 | 0.4 | 0.08 | 0.005 | 0.02 | 0.001 |
| SR45 | 0.006 | 0.4 | 0.07 | 0.004 | 0.02 | 0.001 |
| SR46 | 0.006 | 0.3 | 0.07 | 0.004 | 0.02 | 0.001 |
| SR47 | 0.006 | 0.3 | 0.07 | 0.004 | 0.02 | 0.001 |
| SR48 | 0.006 | 0.3 | 0.07 | 0.004 | 0.02 | 0.001 |
| SR49 | 0.006 | 0.3 | 0.06 | 0.004 | 0.02 | 0.001 |
| SR50 | 0.006 | 0.3 | 0.06 | 0.004 | 0.02 | 0.001 |
| SR51 | 0.005 | 0.3 | 0.05 | 0.004 | 0.02 | 0.001 |
| SR52 | 0.005 | 0.3 | 0.05 | 0.004 | 0.01 | 0.001 |
| SR53 | 0.005 | 0.3 | 0.04 | 0.003 | 0.01 | 0.001 |
| SR54 | 0.005 | 0.3 | 0.04 | 0.003 | 0.01 | 0.001 |
| SR55 | 0.004 | 0.3 | 0.04 | 0.003 | 0.01 | 0.001 |
| SR56 | 0.004 | 0.3 | 0.04 | 0.003 | 0.01 | 0.001 |
| SR57 | 0.004 | 0.3 | 0.03 | 0.003 | 0.01 | 0.001 |
| SR58 | 0.009 | 0.5 | 0.11 | 0.007 | 0.03 | 0.002 |
| SR59 | 0.006 | 0.3 | 0.08 | 0.004 | 0.03 | 0.001 |
| SR60 | 0.012 | 0.4 | 0.07 | 0.008 | 0.02 | 0.003 |
| SR61 | 0.015 | 0.4 | 0.10 | 0.010 | 0.03 | 0.003 |

## 9.3 Predicted Air Quality Impacts – Cumulative Assessment

**Table 9-12 Stage 1 Predicted Ground Level Concentrations; Cumulative including Background (µg/m³; Particulates)**

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition (g/m²/month) |
|---|---|---|---|---|---|---|
| SR1 | 28.2 | 19.7 | 15.7 | 11.0 | 7.1 | 2.1 |
| SR2 | 28.2 | 19.9 | 15.7 | 11.2 | 7.1 | 2.1 |
| SR3 | 28.0 | 19.7 | 15.6 | 11.1 | 7.0 | 2.1 |
| SR4 | 28.2 | 19.6 | 15.6 | 10.9 | 7.0 | 2.1 |
| SR5 | 28.2 | 19.3 | 15.6 | 10.5 | 7.0 | 2.1 |
| SR6 | 27.9 | 19.0 | 15.6 | 10.7 | 7.0 | 2.1 |
| SR7 | 27.7 | 18.9 | 15.6 | 10.5 | 7.0 | 2.1 |
| SR8 | 27.7 | 18.9 | 15.6 | 10.5 | 7.0 | 2.1 |
| SR9 | 27.7 | 18.9 | 15.6 | 10.5 | 7.0 | 2.1 |
| SR10 | 27.8 | 19.0 | 15.6 | 10.7 | 7.0 | 2.1 |
| SR11 | 27.8 | 19.1 | 15.6 | 10.8 | 7.0 | 2.1 |
| SR12 | 27.8 | 19.2 | 15.6 | 10.9 | 7.0 | 2.1 |
| SR13 | 27.9 | 19.2 | 15.6 | 10.9 | 7.0 | 2.1 |
| SR14 | 27.9 | 19.3 | 15.6 | 10.9 | 7.0 | 2.1 |
| SR15 | 27.9 | 19.3 | 15.6 | 10.8 | 7.0 | 2.1 |
| SR16 | 27.8 | 19.3 | 15.6 | 10.7 | 7.0 | 2.1 |
| SR17 | 27.9 | 19.3 | 15.6 | 10.6 | 7.0 | 2.1 |
| SR18 | 28.2 | 18.9 | 15.6 | 10.3 | 7.0 | 2.1 |
| SR19 | 28.1 | 18.6 | 15.5 | 10.2 | 7.0 | 2.1 |
| SR20 | 27.9 | 18.6 | 15.5 | 10.0 | 7.0 | 2.1 |
| SR21 | 28.7 | 18.8 | 15.6 | 10.2 | 7.0 | 2.1 |
| SR22 | 29.0 | 18.7 | 15.6 | 10.2 | 7.0 | 2.1 |
| SR23 | 29.2 | 18.8 | 15.6 | 10.3 | 7.0 | 2.1 |
| SR24 | 29.4 | 18.8 | 15.6 | 10.3 | 7.0 | 2.1 |
| SR25 | 29.5 | 18.9 | 15.6 | 10.2 | 7.1 | 2.1 |
| SR26 | 29.6 | 18.9 | 15.6 | 10.2 | 7.1 | 2.1 |
| SR27 | 29.6 | 18.8 | 15.6 | 10.2 | 7.1 | 2.1 |
| SR28 | 29.5 | 18.8 | 15.6 | 10.1 | 7.1 | 2.1 |
| SR29 | 31.0 | 19.2 | 15.8 | 10.5 | 7.2 | 2.1 |
| SR30 | 30.7 | 19.2 | 15.8 | 10.6 | 7.2 | 2.1 |
| SR31 | 30.0 | 19.3 | 15.8 | 10.5 | 7.3 | 2.2 |
| SR32 | 29.6 | 19.4 | 15.9 | 10.8 | 7.3 | 2.2 |
| SR33 | 29.4 | 19.8 | 15.9 | 11.2 | 7.3 | 2.2 |
| SR34 | 29.3 | 20.2 | 16.0 | 11.1 | 7.4 | 2.2 |
| SR35 | 29.1 | 20.4 | 16.1 | 10.9 | 7.4 | 2.2 |
| SR36 | 28.9 | 20.4 | 16.1 | 10.9 | 7.4 | 2.3 |
| SR37 | 28.7 | 20.5 | 16.2 | 10.9 | 7.4 | 2.3 |
| SR38 | 28.5 | 20.7 | 16.2 | 10.7 | 7.4 | 2.3 |
| SR39 | 28.5 | 21.0 | 16.2 | 11.0 | 7.4 | 2.3 |
| SR40 | 29.5 | 22.3 | 16.7 | 11.5 | 7.6 | 2.5 |
| SR41 | 33.8 | 23.2 | 17.9 | 12.4 | 8.0 | 2.8 |
| SR42 | 36.2 | 26.3 | 18.5 | 11.5 | 7.9 | 3.1 |
| SR43 | 33.1 | 26.8 | 18.1 | 12.8 | 7.9 | 3.1 |
| SR44 | 31.0 | 25.9 | 17.6 | 12.3 | 7.8 | 2.9 |

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition ($g/m^2$/month) |
|---|---|---|---|---|---|---|
| SR45 | 30.6 | 25.9 | 17.4 | 12.1 | 7.8 | 2.8 |
| SR46 | 30.3 | 25.5 | 17.3 | 12.2 | 7.8 | 2.8 |
| SR47 | 29.8 | 24.8 | 17.1 | 12.4 | 7.7 | 2.8 |
| SR48 | 29.5 | 24.2 | 17.0 | 12.5 | 7.7 | 2.9 |
| SR49 | 29.4 | 24.0 | 16.9 | 12.9 | 7.6 | 2.9 |
| SR50 | 29.1 | 24.2 | 16.8 | 12.7 | 7.5 | 2.8 |
| SR51 | 28.6 | 24.0 | 16.5 | 11.9 | 7.4 | 2.6 |
| SR52 | 28.4 | 23.2 | 16.4 | 11.6 | 7.4 | 2.6 |
| SR53 | 27.9 | 22.9 | 16.3 | 11.9 | 7.3 | 2.6 |
| SR54 | 27.6 | 22.6 | 16.1 | 11.7 | 7.2 | 2.5 |
| SR55 | 27.3 | 22.0 | 16.0 | 11.0 | 7.1 | 2.4 |
| SR56 | 27.1 | 21.8 | 15.9 | 10.7 | 7.1 | 2.3 |
| SR57 | 26.8 | 21.6 | 15.8 | 10.4 | 7.0 | 2.3 |
| SR58 | 25.7 | 20.2 | 15.6 | 10.4 | 6.9 | 2.1 |
| SR59 | 25.2 | 19.2 | 15.5 | 9.7 | 6.9 | 2.1 |
| SR60 | 28.9 | 19.8 | 15.7 | 11.2 | 7.1 | 2.1 |
| SR61 | 30.8 | 20.3 | 15.9 | 12.4 | 7.3 | 2.1 |
| **CRITERIA (μg/m$^3$)** | **90** | **50** | **25** | **25** | **8** | **4** |

**Table 9-13 Stage 1 Predicted Ground Level Concentrations; Cumulative including Background (μg/m$^3$; Combustion Gases)**

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR1 | 112 | 19.2 | 340 | 3.5 | 4.0 | 3.9 |
| SR2 | 95 | 19.4 | 350 | 3.5 | 4.0 | 3.9 |
| SR3 | 90 | 19.2 | 342 | 3.5 | 4.0 | 3.9 |
| SR4 | 82 | 19.3 | 336 | 3.4 | 4.0 | 3.9 |
| SR5 | 84 | 19.3 | 328 | 3.3 | 4.0 | 3.9 |
| SR6 | 100 | 19.0 | 325 | 3.5 | 4.0 | 3.9 |
| SR7 | 97 | 18.8 | 325 | 3.5 | 4.0 | 3.9 |
| SR8 | 95 | 18.8 | 325 | 3.5 | 4.0 | 3.9 |
| SR9 | 90 | 18.8 | 324 | 3.5 | 4.0 | 3.9 |
| SR10 | 92 | 18.8 | 325 | 3.5 | 4.0 | 3.9 |
| SR11 | 89 | 18.8 | 329 | 3.5 | 4.0 | 3.9 |
| SR12 | 91 | 18.8 | 330 | 3.5 | 4.0 | 3.9 |
| SR13 | 89 | 18.8 | 331 | 3.4 | 4.0 | 3.9 |
| SR14 | 88 | 18.8 | 330 | 3.4 | 4.0 | 3.9 |
| SR15 | 87 | 18.8 | 329 | 3.4 | 4.0 | 3.9 |
| SR16 | 85 | 18.8 | 326 | 3.4 | 4.0 | 3.9 |
| SR17 | 82 | 19.0 | 323 | 3.3 | 4.0 | 3.9 |
| SR18 | 75 | 18.9 | 314 | 3.3 | 4.0 | 3.9 |
| SR19 | 78 | 18.8 | 310 | 3.4 | 4.0 | 3.9 |
| SR20 | 72 | 18.7 | 308 | 3.3 | 4.0 | 3.9 |
| SR21 | 61 | 19.0 | 311 | 3.2 | 4.0 | 3.9 |

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR22 | 60 | 19.2 | 314 | 3.2 | 4.0 | 3.9 |
| SR23 | 63 | 19.2 | 315 | 3.3 | 4.0 | 3.9 |
| SR24 | 59 | 19.3 | 317 | 3.2 | 4.0 | 3.9 |
| SR25 | 61 | 19.4 | 318 | 3.2 | 4.0 | 3.9 |
| SR26 | 63 | 19.4 | 317 | 3.3 | 4.0 | 3.9 |
| SR27 | 63 | 19.4 | 316 | 3.3 | 4.0 | 3.9 |
| SR28 | 63 | 19.5 | 313 | 3.2 | 4.0 | 3.9 |
| SR29 | 72 | 20.6 | 324 | 3.3 | 4.0 | 3.9 |
| SR30 | 70 | 20.6 | 325 | 3.3 | 4.0 | 3.9 |
| SR31 | 76 | 20.6 | 325 | 3.3 | 4.0 | 3.9 |
| SR32 | 79 | 20.7 | 327 | 3.3 | 4.0 | 3.9 |
| SR33 | 92 | 20.7 | 336 | 3.4 | 4.1 | 3.9 |
| SR34 | 98 | 20.8 | 339 | 3.4 | 4.0 | 3.9 |
| SR35 | 105 | 20.7 | 348 | 3.5 | 4.0 | 3.9 |
| SR36 | 96 | 20.5 | 353 | 3.5 | 4.0 | 3.9 |
| SR37 | 95 | 20.3 | 356 | 3.5 | 4.0 | 3.9 |
| SR38 | 100 | 20.2 | 356 | 3.5 | 4.0 | 3.9 |
| SR39 | 102 | 20.1 | 364 | 3.5 | 4.1 | 3.9 |
| SR40 | 111 | 20.3 | 390 | 3.5 | 4.0 | 3.9 |
| SR41 | 120 | 21.1 | 404 | 3.6 | 4.1 | 3.9 |
| SR42 | 123 | 20.4 | 373 | 3.8 | 4.0 | 3.9 |
| SR43 | 90 | 20.4 | 415 | 3.5 | 4.0 | 3.9 |
| SR44 | 85 | 20.4 | 418 | 3.4 | 4.0 | 3.9 |
| SR45 | 79 | 20.3 | 410 | 3.4 | 4.0 | 3.9 |
| SR46 | 77 | 20.3 | 417 | 3.4 | 4.0 | 3.9 |
| SR47 | 75 | 20.1 | 426 | 3.4 | 4.0 | 3.9 |
| SR48 | 72 | 20.0 | 431 | 3.3 | 4.0 | 3.9 |
| SR49 | 69 | 19.9 | 451 | 3.3 | 4.0 | 3.9 |
| SR50 | 65 | 19.7 | 445 | 3.3 | 4.0 | 3.9 |
| SR51 | 61 | 19.4 | 409 | 3.3 | 4.0 | 3.9 |
| SR52 | 59 | 19.2 | 381 | 3.4 | 4.0 | 3.9 |
| SR53 | 56 | 19.0 | 399 | 3.3 | 4.0 | 3.9 |
| SR54 | 56 | 18.8 | 396 | 3.3 | 4.0 | 3.9 |
| SR55 | 55 | 18.6 | 370 | 3.2 | 4.0 | 3.9 |
| SR56 | 53 | 18.5 | 356 | 3.2 | 4.0 | 3.9 |
| SR57 | 52 | 18.3 | 340 | 3.2 | 4.0 | 3.9 |
| SR58 | 77 | 18.1 | 346 | 3.3 | 4.0 | 3.9 |
| SR59 | 60 | 17.9 | 311 | 3.2 | 3.9 | 3.9 |
| SR60 | 103 | 19.7 | 341 | 3.4 | 4.1 | 3.9 |
| SR61 | 129 | 21.2 | 364 | 3.6 | 4.1 | 3.9 |
| **CRITERIA ($\mu g/m^3$)** | **250** | **62** | **11,000** | **570** | **229** | **57/31/21** |

**Table 9-14 Stage 1 Predicted Ground Level Concentrations; Cumulative including Background (μg/m³; Air Toxics)**

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR1 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR2 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR3 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR4 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR5 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR6 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR7 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR8 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR9 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR10 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR11 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR12 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR13 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR14 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR15 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR16 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR17 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR18 | 4.5 | 25.8 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR19 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR20 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR21 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR22 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR23 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR24 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR25 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR26 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR27 | 4.5 | 25.8 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR28 | 4.5 | 25.8 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR29 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR30 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR31 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR32 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR33 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR34 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR35 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR36 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR37 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR38 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR39 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR40 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR41 | 4.5 | 26.2 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR42 | 4.5 | 26.4 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR43 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR44 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR45 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR46 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR47 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR48 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR49 | 4.5 | 26.1 | 18.1 | 17.9 | 23.6 | 23.2 |
| SR50 | 4.5 | 26.1 | 18.1 | 17.9 | 23.6 | 23.2 |
| SR51 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR52 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR53 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR54 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR55 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR56 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR57 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR58 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR59 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR60 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR61 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| **CRITERIA ($\mu g/m^3$)** | **5,400** | **1,100** | **4,100** | **400** | **1,200** | **950** |

**Table 9-15 Stage 2 Predicted Ground Level Concentrations; Cumulative including Background ($\mu g/m^3$; Particulates)**

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition ($g/m^2$/month) |
|---|---|---|---|---|---|---|
| SR1 | 25.2 | 20.3 | 15.7 | 11.6 | 7.1 | 2.1 |
| SR2 | 25.1 | 20.2 | 15.7 | 11.3 | 7.0 | 2.1 |
| SR3 | 25.0 | 19.8 | 15.6 | 10.9 | 7.0 | 2.1 |
| SR4 | 25.0 | 19.7 | 15.6 | 10.6 | 7.0 | 2.1 |
| SR5 | 25.0 | 19.6 | 15.6 | 10.5 | 7.0 | 2.1 |
| SR6 | 25.0 | 19.3 | 15.5 | 10.3 | 6.9 | 2.1 |
| SR7 | 25.0 | 18.9 | 15.5 | 10.3 | 6.9 | 2.0 |
| SR8 | 25.0 | 18.9 | 15.5 | 10.3 | 6.9 | 2.0 |
| SR9 | 25.0 | 18.9 | 15.5 | 10.2 | 6.9 | 2.0 |
| SR10 | 25.0 | 18.9 | 15.5 | 10.2 | 6.9 | 2.0 |
| SR11 | 25.0 | 19.0 | 15.5 | 10.2 | 6.9 | 2.0 |
| SR12 | 25.0 | 19.1 | 15.5 | 10.1 | 6.9 | 2.0 |
| SR13 | 25.0 | 19.2 | 15.5 | 10.1 | 6.9 | 2.0 |
| SR14 | 25.0 | 19.4 | 15.5 | 10.1 | 6.9 | 2.0 |
| SR15 | 25.0 | 19.5 | 15.5 | 10.3 | 6.9 | 2.0 |
| SR16 | 25.0 | 19.6 | 15.6 | 10.4 | 7.0 | 2.0 |
| SR17 | 25.0 | 19.2 | 15.6 | 10.4 | 7.0 | 2.0 |
| SR18 | 25.0 | 19.2 | 15.6 | 10.5 | 7.0 | 2.0 |
| SR19 | 25.0 | 18.9 | 15.5 | 10.3 | 6.9 | 2.0 |
| SR20 | 25.0 | 18.8 | 15.5 | 10.1 | 6.9 | 2.0 |
| SR21 | 25.0 | 18.7 | 15.6 | 9.9 | 7.0 | 2.1 |
| SR22 | 25.0 | 18.6 | 15.6 | 9.9 | 7.0 | 2.1 |
| SR23 | 25.0 | 18.6 | 15.6 | 9.8 | 7.0 | 2.1 |
| SR24 | 25.0 | 18.6 | 15.6 | 9.7 | 7.0 | 2.1 |

| Sensitive Receptor | Annual Average TSP | Maximum 24 hour $PM_{10}$ | Annual Average $PM_{10}$ | Maximum 24 hour $PM_{2.5}$ | Annual Average $PM_{2.5}$ | Maximum Dust Deposition ($g/m^2/month$) |
|---|---|---|---|---|---|---|
| SR25 | 25.0 | 18.5 | 15.6 | 9.6 | 7.0 | 2.1 |
| SR26 | 25.0 | 18.5 | 15.6 | 9.6 | 7.0 | 2.1 |
| SR27 | 25.0 | 18.5 | 15.6 | 9.5 | 7.0 | 2.1 |
| SR28 | 25.1 | 18.4 | 15.6 | 9.6 | 7.0 | 2.1 |
| SR29 | 25.2 | 18.7 | 15.7 | 9.8 | 7.0 | 2.1 |
| SR30 | 25.2 | 18.8 | 15.7 | 9.8 | 7.0 | 2.2 |
| SR31 | 25.2 | 18.9 | 15.7 | 9.9 | 7.1 | 2.2 |
| SR32 | 25.3 | 19.0 | 15.8 | 10.0 | 7.1 | 2.2 |
| SR33 | 25.3 | 19.2 | 15.8 | 10.1 | 7.1 | 2.2 |
| SR34 | 25.4 | 19.5 | 15.8 | 10.3 | 7.1 | 2.2 |
| SR35 | 25.4 | 19.6 | 15.9 | 10.4 | 7.1 | 2.2 |
| SR36 | 25.4 | 19.6 | 15.9 | 10.4 | 7.1 | 2.2 |
| SR37 | 25.4 | 19.7 | 15.9 | 10.5 | 7.1 | 2.2 |
| SR38 | 25.4 | 19.6 | 15.9 | 10.4 | 7.1 | 2.2 |
| SR39 | 25.4 | 19.7 | 15.9 | 10.5 | 7.1 | 2.1 |
| SR40 | 25.5 | 20.4 | 16.0 | 10.9 | 7.2 | 2.1 |
| SR41 | 25.6 | 21.2 | 16.0 | 11.8 | 7.2 | 2.1 |
| SR42 | 25.4 | 20.9 | 15.8 | 11.8 | 7.1 | 2.1 |
| SR43 | 25.2 | 19.9 | 15.6 | 11.1 | 7.0 | 2.1 |
| SR44 | 25.1 | 19.7 | 15.6 | 10.9 | 7.0 | 2.1 |
| SR45 | 25.1 | 19.7 | 15.6 | 10.9 | 6.9 | 2.1 |
| SR46 | 25.1 | 19.7 | 15.6 | 10.8 | 6.9 | 2.1 |
| SR47 | 25.1 | 19.6 | 15.6 | 10.7 | 6.9 | 2.1 |
| SR48 | 25.1 | 19.6 | 15.6 | 10.7 | 6.9 | 2.1 |
| SR49 | 25.1 | 19.5 | 15.6 | 10.6 | 6.9 | 2.1 |
| SR50 | 25.1 | 19.5 | 15.6 | 10.5 | 6.9 | 2.1 |
| SR51 | 25.1 | 19.5 | 15.6 | 10.3 | 6.9 | 2.1 |
| SR52 | 25.1 | 19.5 | 15.6 | 10.1 | 6.9 | 2.1 |
| SR53 | 25.1 | 19.5 | 15.6 | 10.0 | 6.9 | 2.1 |
| SR54 | 25.0 | 19.5 | 15.5 | 10.1 | 6.9 | 2.1 |
| SR55 | 25.0 | 19.4 | 15.5 | 10.0 | 6.9 | 2.1 |
| SR56 | 25.0 | 19.3 | 15.5 | 9.9 | 6.9 | 2.0 |
| SR57 | 25.0 | 19.1 | 15.5 | 9.8 | 6.9 | 2.0 |
| SR58 | 25.7 | 23.5 | 15.9 | 12.5 | 7.0 | 2.2 |
| SR59 | 25.1 | 20.7 | 15.6 | 11.3 | 6.9 | 2.1 |
| SR60 | 25.1 | 19.9 | 15.7 | 11.3 | 7.1 | 2.1 |
| SR61 | 25.3 | 20.8 | 15.8 | 11.8 | 7.2 | 2.1 |
| **CRITERIA ($\mu g/m^3$)** | **90** | **50** | **25** | **25** | **8** | **4** |

**Table 9-16 Stage 2 Predicted Ground Level Concentrations; Cumulative including Background (µg/m$^3$; Combustion Gases)**

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR1 | 88.1 | 19.4 | 373 | 3.5 | 4.0 | 3.9 |
| SR2 | 90.0 | 18.8 | 369 | 3.4 | 4.0 | 3.9 |
| SR3 | 75.4 | 18.5 | 350 | 3.3 | 4.0 | 3.9 |
| SR4 | 76.3 | 18.5 | 341 | 3.3 | 4.0 | 3.9 |
| SR5 | 71.8 | 18.5 | 334 | 3.3 | 4.0 | 3.9 |
| SR6 | 81.2 | 18.4 | 321 | 3.4 | 4.0 | 3.9 |
| SR7 | 84.5 | 18.4 | 319 | 3.4 | 4.0 | 3.9 |
| SR8 | 86.1 | 18.4 | 320 | 3.3 | 4.0 | 3.9 |
| SR9 | 84.2 | 18.4 | 320 | 3.3 | 4.0 | 3.9 |
| SR10 | 75.7 | 18.4 | 321 | 3.3 | 4.0 | 3.9 |
| SR11 | 66.7 | 18.4 | 322 | 3.3 | 4.0 | 3.9 |
| SR12 | 65.1 | 18.5 | 322 | 3.3 | 4.0 | 3.9 |
| SR13 | 68.1 | 18.5 | 324 | 3.3 | 4.0 | 3.9 |
| SR14 | 74.5 | 18.5 | 325 | 3.3 | 4.0 | 3.9 |
| SR15 | 81.4 | 18.5 | 326 | 3.4 | 4.0 | 3.9 |
| SR16 | 86.8 | 18.5 | 326 | 3.4 | 4.0 | 3.9 |
| SR17 | 87.4 | 18.7 | 329 | 3.4 | 4.0 | 3.9 |
| SR18 | 86.6 | 18.7 | 323 | 3.3 | 4.0 | 3.9 |
| SR19 | 88.6 | 18.5 | 322 | 3.3 | 4.0 | 3.9 |
| SR20 | 97.5 | 18.5 | 319 | 3.4 | 4.0 | 3.9 |
| SR21 | 69.1 | 18.6 | 311 | 3.3 | 4.0 | 3.9 |
| SR22 | 71.7 | 18.6 | 306 | 3.3 | 4.0 | 3.9 |
| SR23 | 73.0 | 18.5 | 302 | 3.3 | 4.0 | 3.9 |
| SR24 | 70.7 | 18.5 | 300 | 3.3 | 4.0 | 3.9 |
| SR25 | 66.0 | 18.5 | 300 | 3.3 | 4.0 | 3.9 |
| SR26 | 62.0 | 18.5 | 299 | 3.3 | 4.0 | 3.9 |
| SR27 | 57.2 | 18.5 | 299 | 3.3 | 4.0 | 3.9 |
| SR28 | 47.6 | 18.5 | 299 | 3.3 | 4.0 | 3.9 |
| SR29 | 48.9 | 18.7 | 305 | 3.3 | 4.0 | 3.9 |
| SR30 | 47.8 | 18.8 | 305 | 3.2 | 4.0 | 3.9 |
| SR31 | 50.7 | 18.8 | 308 | 3.2 | 4.0 | 3.9 |
| SR32 | 55.0 | 18.8 | 310 | 3.2 | 4.0 | 3.9 |
| SR33 | 59.2 | 18.9 | 315 | 3.3 | 4.0 | 3.9 |
| SR34 | 64.6 | 19.0 | 323 | 3.3 | 4.0 | 3.9 |
| SR35 | 67.8 | 19.0 | 327 | 3.4 | 4.0 | 3.9 |
| SR36 | 71.8 | 19.0 | 330 | 3.4 | 4.0 | 3.9 |
| SR37 | 75.7 | 19.0 | 332 | 3.4 | 4.0 | 3.9 |
| SR38 | 77.7 | 19.0 | 333 | 3.5 | 4.0 | 3.9 |
| SR39 | 78.7 | 19.0 | 337 | 3.5 | 4.0 | 3.9 |
| SR40 | 73.7 | 19.2 | 350 | 3.4 | 4.0 | 3.9 |
| SR41 | 93.6 | 19.3 | 399 | 3.6 | 4.0 | 3.9 |
| SR42 | 87.6 | 18.8 | 389 | 3.5 | 4.0 | 3.9 |
| SR43 | 74.3 | 18.4 | 354 | 3.4 | 4.0 | 3.9 |
| SR44 | 70.2 | 18.3 | 349 | 3.4 | 4.0 | 3.9 |
| SR45 | 65.3 | 18.3 | 348 | 3.3 | 4.0 | 3.9 |
| SR46 | 63.2 | 18.3 | 347 | 3.3 | 4.0 | 3.9 |
| SR47 | 59.8 | 18.3 | 344 | 3.3 | 4.0 | 3.9 |

| Sensitive Receptor | 1 hour $NO_2$ | Annual average $NO_2$ | 8 hour average CO | 1 hour $SO_2$ | 24 hour $SO_2$ | Annual average $SO_2$ |
|---|---|---|---|---|---|---|
| SR48 | 55.1 | 18.2 | 342 | 3.2 | 4.0 | 3.9 |
| SR49 | 52.0 | 18.2 | 339 | 3.2 | 4.0 | 3.9 |
| SR50 | 53.1 | 18.2 | 335 | 3.2 | 4.0 | 3.9 |
| SR51 | 53.5 | 18.2 | 328 | 3.2 | 4.0 | 3.9 |
| SR52 | 53.0 | 18.2 | 323 | 3.2 | 4.0 | 3.9 |
| SR53 | 50.5 | 18.2 | 314 | 3.2 | 4.0 | 3.9 |
| SR54 | 51.4 | 18.2 | 311 | 3.2 | 4.0 | 3.9 |
| SR55 | 51.8 | 18.1 | 309 | 3.2 | 4.0 | 3.9 |
| SR56 | 51.0 | 18.1 | 305 | 3.2 | 4.0 | 3.9 |
| SR57 | 50.1 | 18.1 | 300 | 3.2 | 4.0 | 3.9 |
| SR58 | 77.5 | 18.6 | 402 | 3.4 | 4.1 | 3.9 |
| SR59 | 102.0 | 18.5 | 366 | 3.3 | 4.0 | 3.9 |
| SR60 | 108.0 | 19.3 | 355 | 3.4 | 4.1 | 3.9 |
| SR61 | 114.4 | 19.6 | 387 | 3.5 | 4.1 | 3.9 |
| **CRITERIA ($\mu g/m^3$)** | **250** | **62** | **11,000** | **570** | **229** | **57/31/21** |

**Table 9-17 Stage 2 Predicted Ground Level Concentrations; Cumulative including Background ($\mu g/m^3$; Air Toxics)**

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR1 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR2 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR3 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR4 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR5 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR6 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR7 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR8 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR9 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR10 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR11 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR12 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR13 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR14 | 4.5 | 26.1 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR15 | 4.5 | 26.1 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR16 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR17 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR18 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR19 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR20 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR21 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR22 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR23 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR24 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR25 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |

| Sensitive Receptor | Annual Average Benzene | 30 minute Toluene | 24hr Toluene | Annual Average Toluene | 24hr Xylene | Annual Average Xylene |
|---|---|---|---|---|---|---|
| SR26 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR27 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR28 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR29 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR30 | 4.5 | 26.0 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR31 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR32 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR33 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR34 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR35 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR36 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR37 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR38 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR39 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR40 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR41 | 4.5 | 26.2 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR42 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR43 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR44 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR45 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR46 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR47 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR48 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR49 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR50 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR51 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR52 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR53 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR54 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR55 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR56 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR57 | 4.5 | 25.9 | 17.9 | 17.9 | 23.6 | 23.2 |
| SR58 | 4.5 | 26.1 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR59 | 4.5 | 25.9 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR60 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| SR61 | 4.5 | 26.0 | 18.0 | 17.9 | 23.6 | 23.2 |
| **CRITERIA (μg/m$^3$)** | **5,400** | **1,100** | **4,100** | **400** | **1,200** | **950** |

## APPENDIX C. CONTOUR PLOTS – CUMULATIVE ASSESSMENT


| | | | | |
|---|---|---|---|---|
| **Species:** TSP | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (24.9 μg/m³) | **Averaging Period:** Annual | **Percentile:** Average |
| **Criterion:** 90 | **Units:** μg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

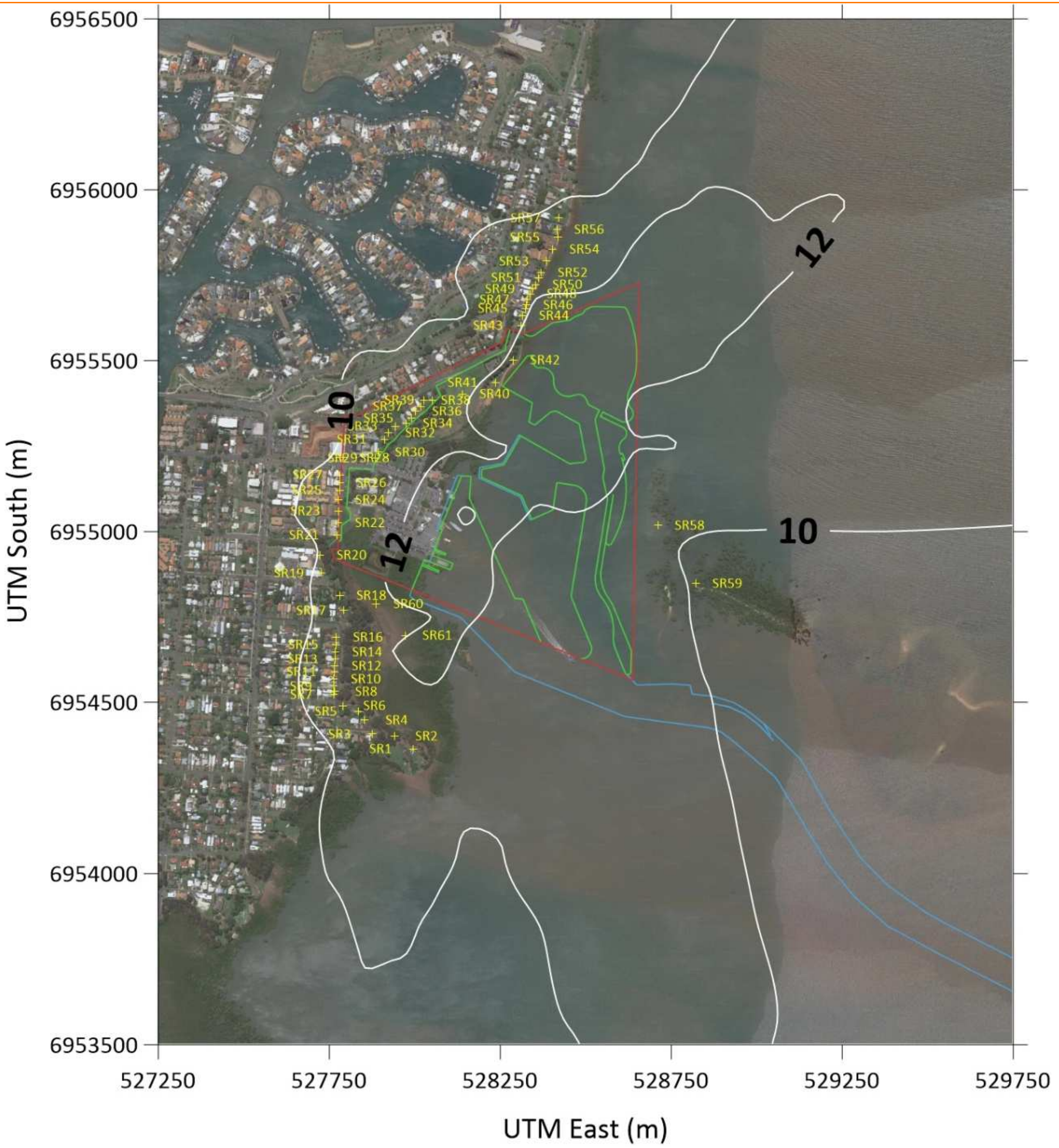
**Figure 9-1: Predicted Ground Level Concentration – TSP Annual Average including Background; Stage 1**


| Species: | Site: | Scenario: | Averaging Period: | Percentile: |
|---|---|---|---|---|
| $PM_{10}$ | Toondah Harbour | Stage 1 – including background (17.4 μg/m$^3$) | 24 hour | Maximum |
| **Criterion:** | **Units:** | **Meteorology:** | **Model:** | **Author:** |
| 50 | μg/m$^3$ | 2017 | CALPUFF v 6.42 | W. Shillito |

**Figure 9-2: Predicted Ground Level Concentration – $PM_{10}$ 24 hour including Background; Stage 1**

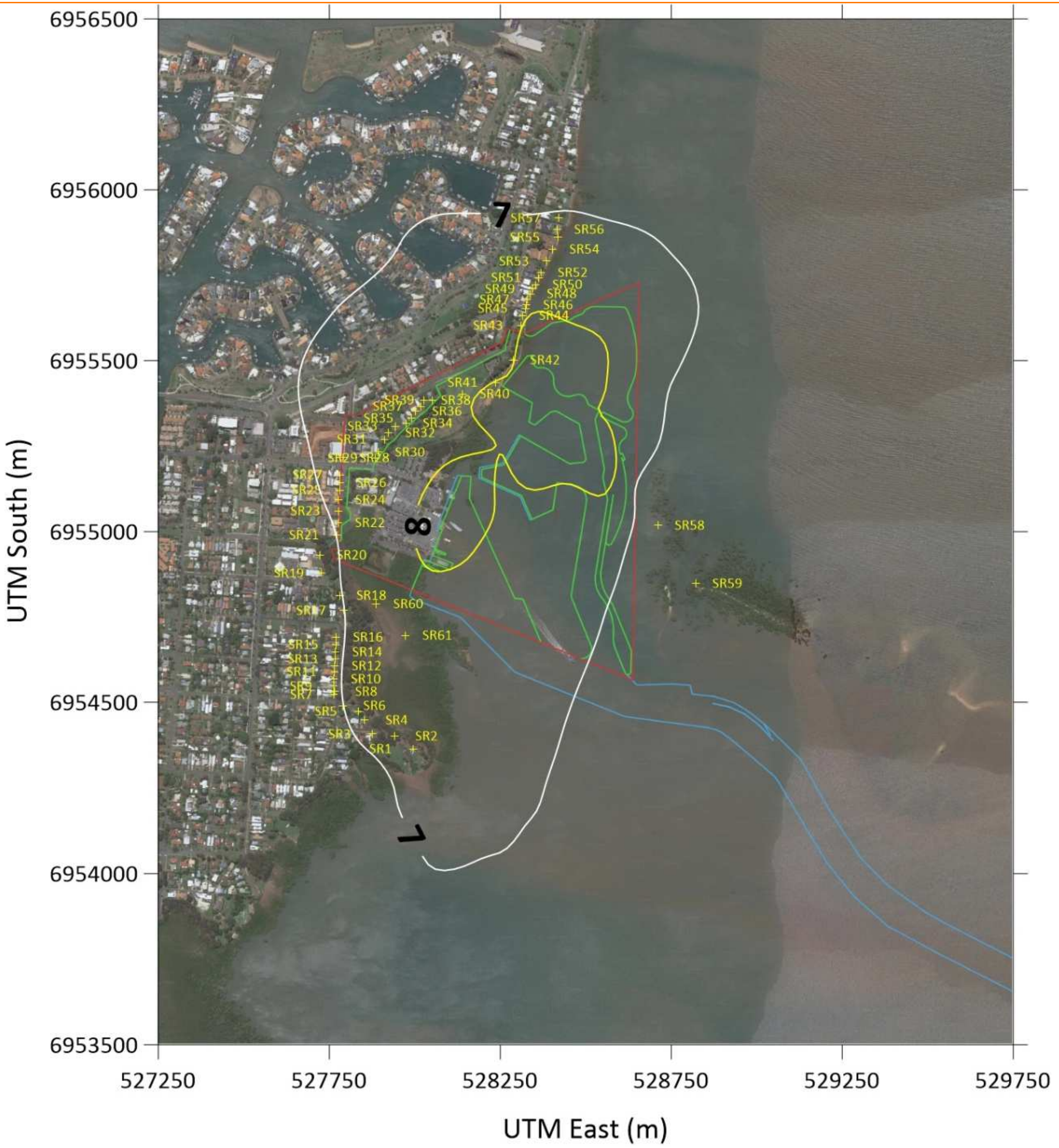

| | | | | |
|---|---|---|---|---|
| **Species:** PM10 | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (15.4 µg/m$^3$) | **Averaging Period:** Annual | **Percentile:** Average |
| **Criterion:** 25 | **Units:** µg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-3: Predicted Ground Level Concentration – $PM_{10}$ 24 Annual Average including Background; Stage 1**




| Species: PM2.5 | Site: Toondah Harbour | Scenario: Stage 1 – including background (8.6 μg/m³) | Averaging Period: 24 hour | Percentile: Maximum |
|---|---|---|---|---|
| **Criterion:** 25 | **Units:** μg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-4: Predicted Ground Level Concentration – $PM_{2.5}$ 24 hour including Background; Stage 1**

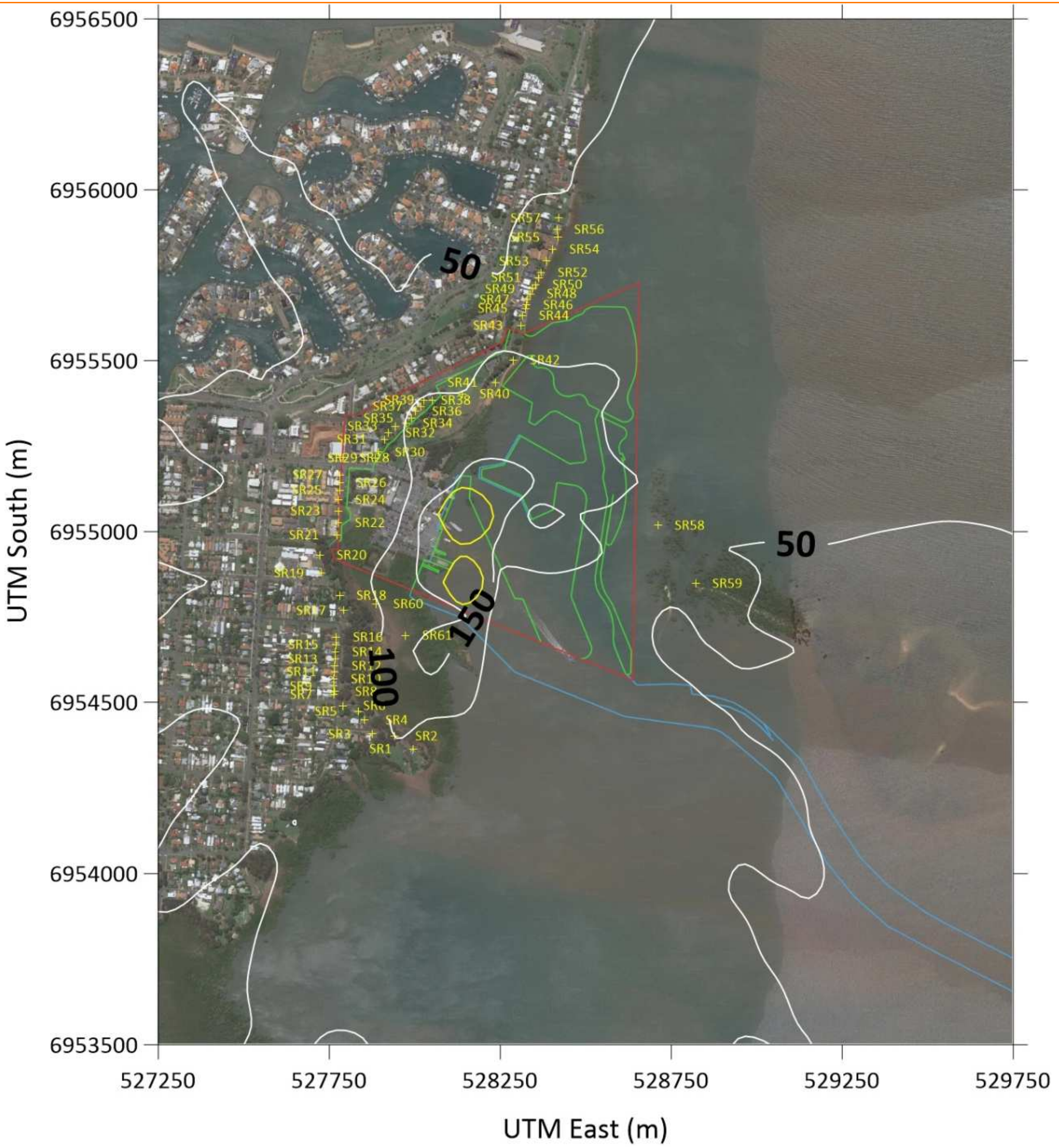



| **Species:**<br>$PM_{2.5}$ | **Site:**<br>Toondah Harbour | **Scenario:**<br>Stage 1 – including background (6.8 µg/m$^3$) | **Averaging Period:**<br>Annual | **Percentile:**<br>Average |
|---|---|---|---|---|
| **Criterion:**<br>8 | **Units:**<br>µg/m$^3$ | **Meteorology:**<br>2017 | **Model:**<br>CALPUFF v 6.42 | **Author:**<br>W. Shillito |

**Figure 9-5: Predicted Ground Level Concentration – $PM_{2.5}$ Annual Average including Background; Stage 1**


| **Species:** Dust Deposition | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background 2 g/m$^2$/month) | **Averaging Period:** Monthly | **Percentile:** Maximum |
|---|---|---|---|---|
| **Criterion:** 4 | **Units:** g/m$^2$/month | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-6: Predicted Ground Level Concentration – Dust Deposition Monthly Maximum including Background; Stage 1**




| Species: NO2 | Site: Toondah Harbour | Scenario: Stage 1– including background (18.1 µg/m³) | Averaging Period: 1 hour | Percentile: Maximum |
|---|---|---|---|---|
| **Criterion:** 250 | **Units:** µg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-7: Predicted Ground Level Concentration – $NO_2$ 1 hour including Background; Stage 1**


| | | | | |
|---|---|---|---|---|
| **Species:** $NO_2$ | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (17.7 μg/m$^3$) | **Averaging Period:** Annual | **Percentile:** Average |
| **Criterion:** 62 | **Units:** μg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-8: Predicted Ground Level Concentration – $NO_2$ Annual Average including Background; Stage 1**


| Species: CO | Site: Toondah Harbour | Scenario: Stage 1 – including background (268 µg/m³) | Averaging Period: 8 hour | Percentile: Average |
|---|---|---|---|---|
| Criterion: 11,000 | Units: µg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-9: Predicted Ground Level Concentration – CO 8 hour including Background; Stage 1**


| Species: SO2 | Site: Toondah Harbour | Scenario: Stage 1 – including background (2.9 μg/m$^3$) | Averaging Period: 1 hour | Percentile: Maximum |
|---|---|---|---|---|
| **Criterion:** 570 | **Units:** μg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-10: Predicted Ground Level Concentration – $SO_2$ 1 hour including Background; Stage 1**


| Species: SO2 | Site: Toondah Harbour | Scenario: Stage 1 – including background (3.9 µg/m³) | Averaging Period: 24 hour | Percentile: Average |
|---|---|---|---|---|
| Criterion: 230 | Units: µg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-11: Predicted Ground Level Concentration – $SO_2$ 24 hour average including Background; Stage 1**


| **Species:** SO₂ | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (3.9 μg/m³) | **Averaging Period:** Annual | **Percentile:** Average |
|---|---|---|---|---|
| **Criterion:** 57 | **Units:** μg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

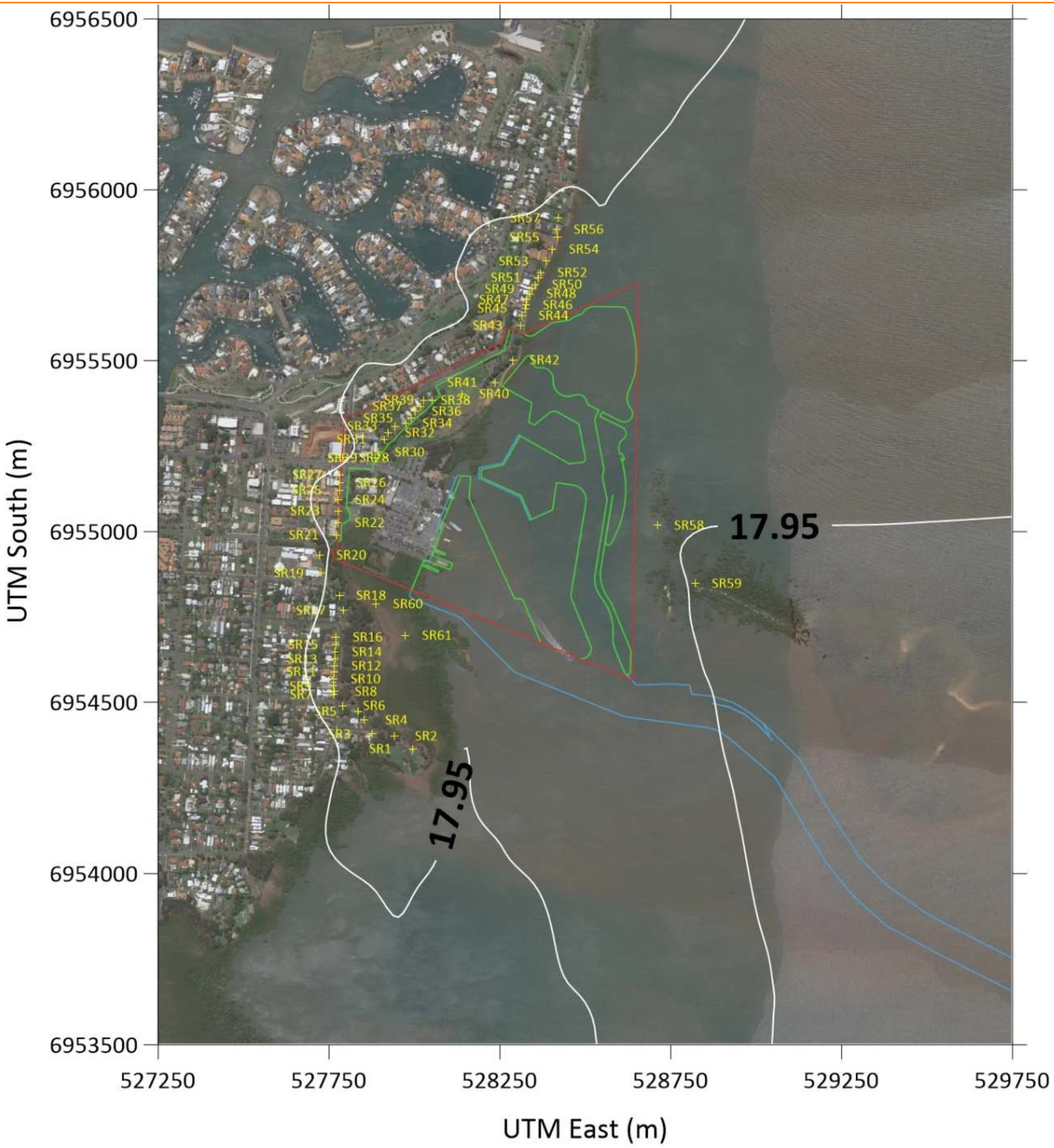
**Figure 9-12: Predicted Ground Level Concentration – $SO_2$ Annual Average including Background; Stage 1**


| Species: Benzene | Site: Toondah Harbour | Scenario: Stage 1 – including background (4.5 µg/m³) | Averaging Period: Annual | Percentile: Average |
|---|---|---|---|---|
| **Criterion:** 5.4 | **Units:** µg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-13: Predicted Ground Level Concentration – Benzene Annual Average including Background; Stage 1**


| | | | | |
|---|---|---|---|---|
| **Species:** Toluene | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (25.6 $\mu g/m^3$) | **Averaging Period:** 30 minute | **Percentile:** Maximum |
| **Criterion:** 1,100 | **Units:** $\mu g/m^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-14: Predicted Ground Level Concentration – Toluene 30 minute Average including Background; Stage 1**

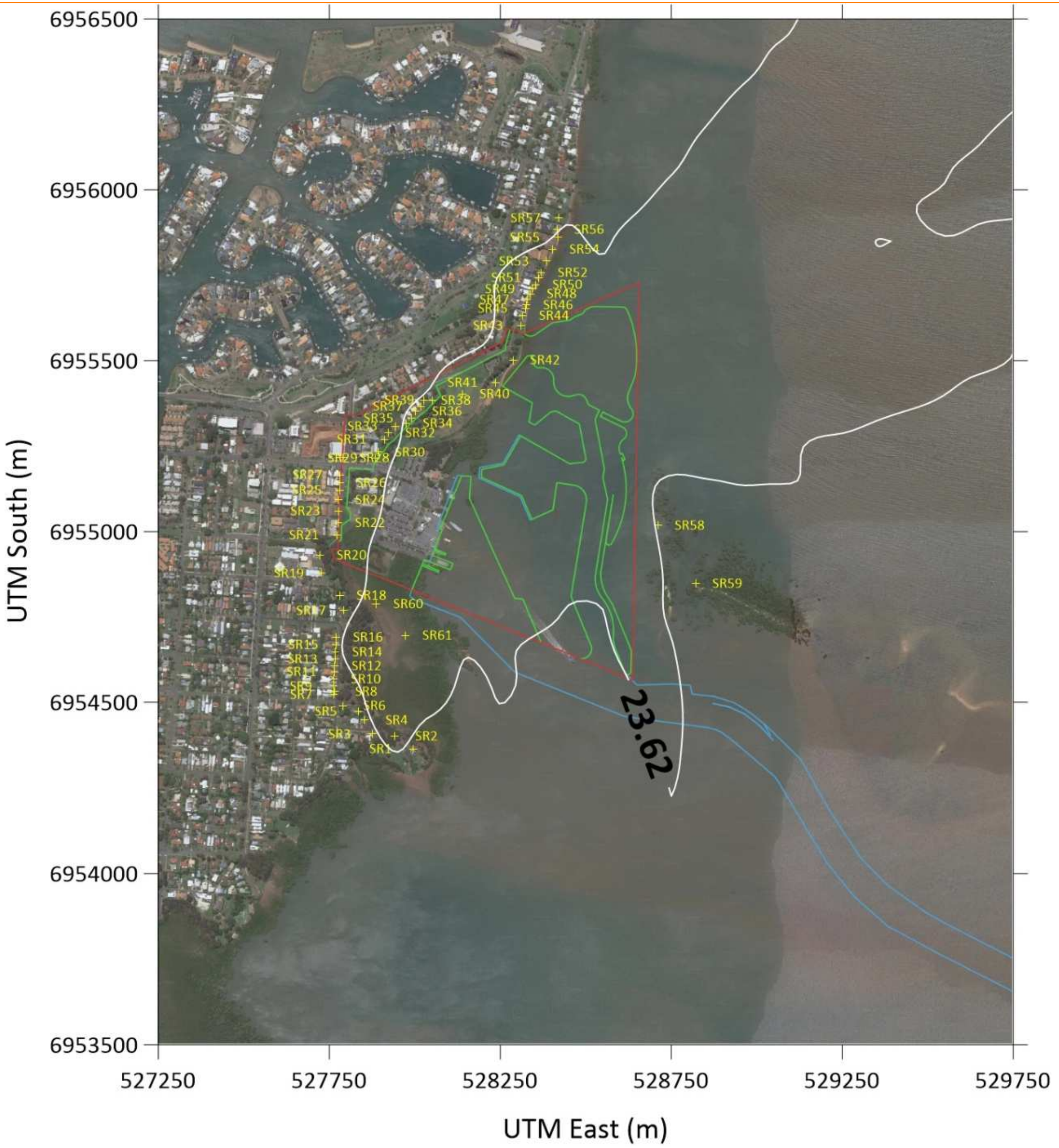



| **Species:** Toluene | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (17.9 µg/m$^3$) | **Averaging Period:** 24 hour | **Percentile:** Average |
|---|---|---|---|---|
| **Criterion:** 4,100 | **Units:** µg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-15: Predicted Ground Level Concentration – Toluene 24 Hour Average including Background; Stage 1**


| | | | | |
|---|---|---|---|---|
| **Species:**<br>Toluene | **Site:**<br>Toondah Harbour | **Scenario:**<br>Stage 1 – including background (17.9 µg/m³) | **Averaging Period:**<br>Annual | **Percentile:**<br>Average |
| **Criterion:**<br>400 | **Units:**<br>µg/m³ | **Meteorology:**<br>2017 | **Model:**<br>CALPUFF v 6.42 | **Author:**<br>W. Shillito |

**Figure 9-16: Predicted Ground Level Concentration – Toluene Annual Average including Background; Stage 1**




| **Species:** Xylene | **Site:** Toondah Harbour | **Scenario:** Stage 1 – including background (23.6 µg/m³) | **Averaging Period:** 24 hour | **Percentile:** Average |
|---|---|---|---|---|
| **Criterion:** 1,200 | **Units:** µg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

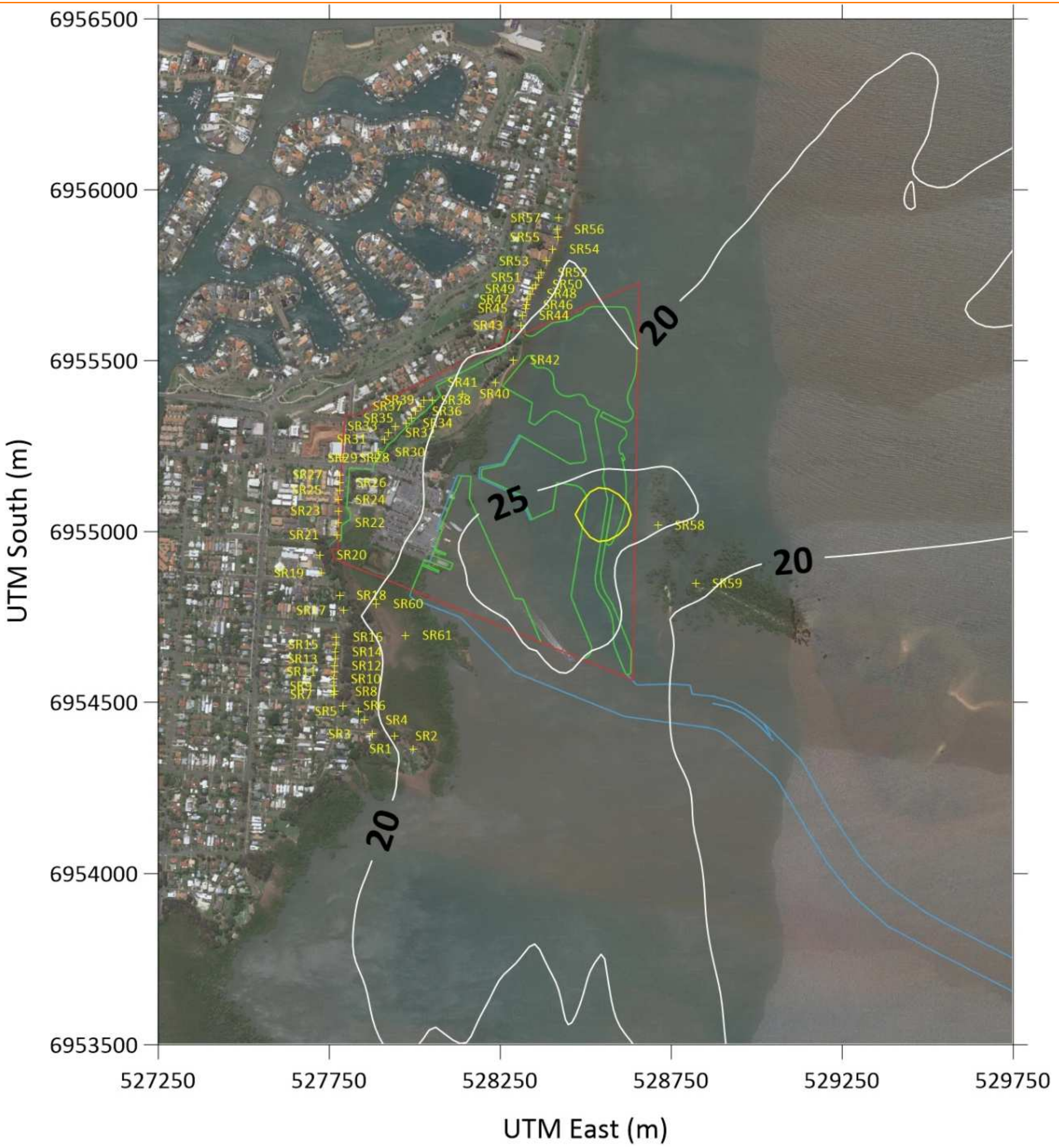
**Figure 9-17: Predicted Ground Level Concentration – Xylene 24 Hour Average including Background; Stage 1**


| Species: Xylene | Site: Toondah Harbour | Scenario: Stage 1 – including background (23.2 µg/m³) | Averaging Period: Annual | Percentile: Average |
|---|---|---|---|---|
| Criterion: 950 | Units: µg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-18: Predicted Ground Level Concentration – Xylene Annual Average including Background; Stage 1**


| Species: TSP | Site: Toondah Harbour | Scenario: Stage 2 – including background (24.9 μg/m$^3$) | Averaging Period: Annual | Percentile: Average |
|---|---|---|---|---|
| Criterion: 90 | Units: μg/m$^3$ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-19 Predicted Ground Level Concentration – TSP Annual Average including Background; Stage 2**




| **Species:** PM10 | **Site:** Toondah Harbour | **Scenario:** Stage 2 – including background (17.7 µg/m3) | **Averaging Period:** 24 hour | **Percentile:** Maximum |
|---|---|---|---|---|
| **Criterion:** 50 | **Units:** µg/m3 | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-20: Predicted Ground Level Concentration – $PM_{10}$ 24 hour including Background; Stage 2**


| | | | | |
|---|---|---|---|---|
| **Species:**<br>$PM_{10}$ | **Site:**<br>Toondah Harbour | **Scenario:**<br>Stage 1 – including background (15.4 μg/m$^3$) | **Averaging Period:**<br>Annual | **Percentile:**<br>Average |
| **Criterion:**<br>25 | **Units:**<br>μg/m$^3$ | **Meteorology:**<br>2017 | **Model:**<br>CALPUFF v 6.42 | **Author:**<br>W. Shillito |

**Figure 9-21: Predicted Ground Level Concentration – $PM_{10}$ 24 Annual Average including Background; Stage 2**


| | | | | |
|---|---|---|---|---|
| **Species:** PM2.5 | **Site:** Toondah Harbour | **Scenario:** Stage 2 – including background (8.6 µg/m$^3$) | **Averaging Period:** 24 hour | **Percentile:** Maximum |
| **Criterion:** 25 | **Units:** µg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-22: Predicted Ground Level Concentration – $PM_{2.5}$ 24 hour including Background; Stage 2**

| Species: | Site: | Scenario: | Averaging Period: | Percentile: |
|---|---|---|---|---|
| $PM_{2.5}$ | Toondah Harbour | Stage 1 – including background (6.8 µg/m$^3$) | Annual | Average |
| **Criterion:** | **Units:** | **Meteorology:** | **Model:** | **Author:** |
| 8 | µg/m$^3$ | 2017 | CALPUFF v 6.42 | W. Shillito |

**Figure 9-23: Predicted Ground Level Concentration – $PM_{2.5}$ Annual Average including Background; Stage 2**


| Species:<br>Dust Deposition | Site:<br>Toondah Harbour | Scenario:<br>Stage 1 – including background 2 g/m$^2$/month) | Averaging Period:<br>Monthly | Percentile:<br>Maximum |
|---|---|---|---|---|
| **Criterion:**<br>4 | **Units:**<br>g/m$^2$/month | **Meteorology:**<br>2017 | **Model:**<br>CALPUFF v 6.42 | **Author:**<br>W. Shillito |

**Figure 9-24: Predicted Ground Level Concentration – Dust Deposition Monthly Maximum including Background; Stage 2**


| **Species:** NO2 | **Site:** Toondah Harbour | **Scenario:** Stage 2– including background (18.8 µg/m$^3$) | **Averaging Period:** 1 hour | **Percentile:** Maximum |
|---|---|---|---|---|
| **Criterion:** 250 | **Units:** µg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-25: Predicted Ground Level Concentration – $NO_2$ 1 hour including Background; Stage 2**


| Species: NO2 | Site: Toondah Harbour | Scenario: Stage 2 – including background (17.7 µg/m³) | Averaging Period: Annual | Percentile: Average |
|---|---|---|---|---|
| **Criterion:** 62 | **Units:** µg/m³ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

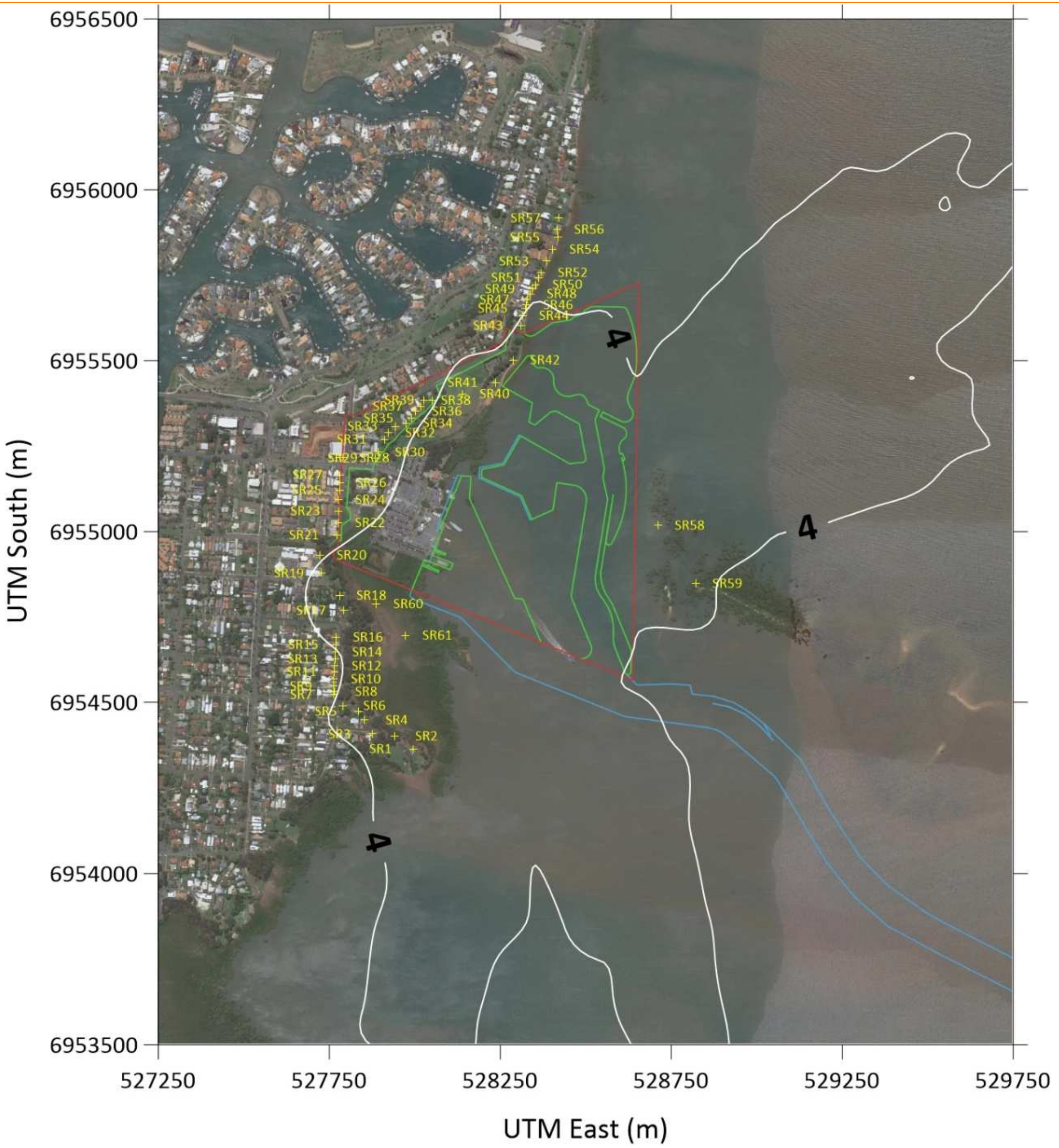
**Figure 9-26: Predicted Ground Level Concentration – $NO_2$ Annual Average including Background; Stage 2**


| Species: CO | Site: Toondah Harbour | Scenario: Stage 2 – including background (268 µg/m³) | Averaging Period: 8 hour | Percentile: Average |
|---|---|---|---|---|
| Criterion: 11,000 | Units: µg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-27: Predicted Ground Level Concentration – CO 8 hour including Background; Stage 2**


| Species: $SO_2$ | Site: Toondah Harbour | Scenario: Stage 2 – including background (2.9 μg/m$^3$) | Averaging Period: 1 hour | Percentile: Maximum |
|---|---|---|---|---|
| Criterion: 570 | Units: μg/m$^3$ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-28: Predicted Ground Level Concentration – $SO_2$ 1 hour including Background; Stage 2**




| Species: | Site: | Scenario: | Averaging Period: | Percentile: |
|---|---|---|---|---|
| $SO_2$ | Toondah Harbour | Stage 2 – including background (3.9 µg/m$^3$) | 24 hour | Average |
| **Criterion:** | **Units:** | **Meteorology:** | **Model:** | **Author:** |
| 230 | µg/m$^3$ | 2017 | CALPUFF v 6.42 | W. Shillito |

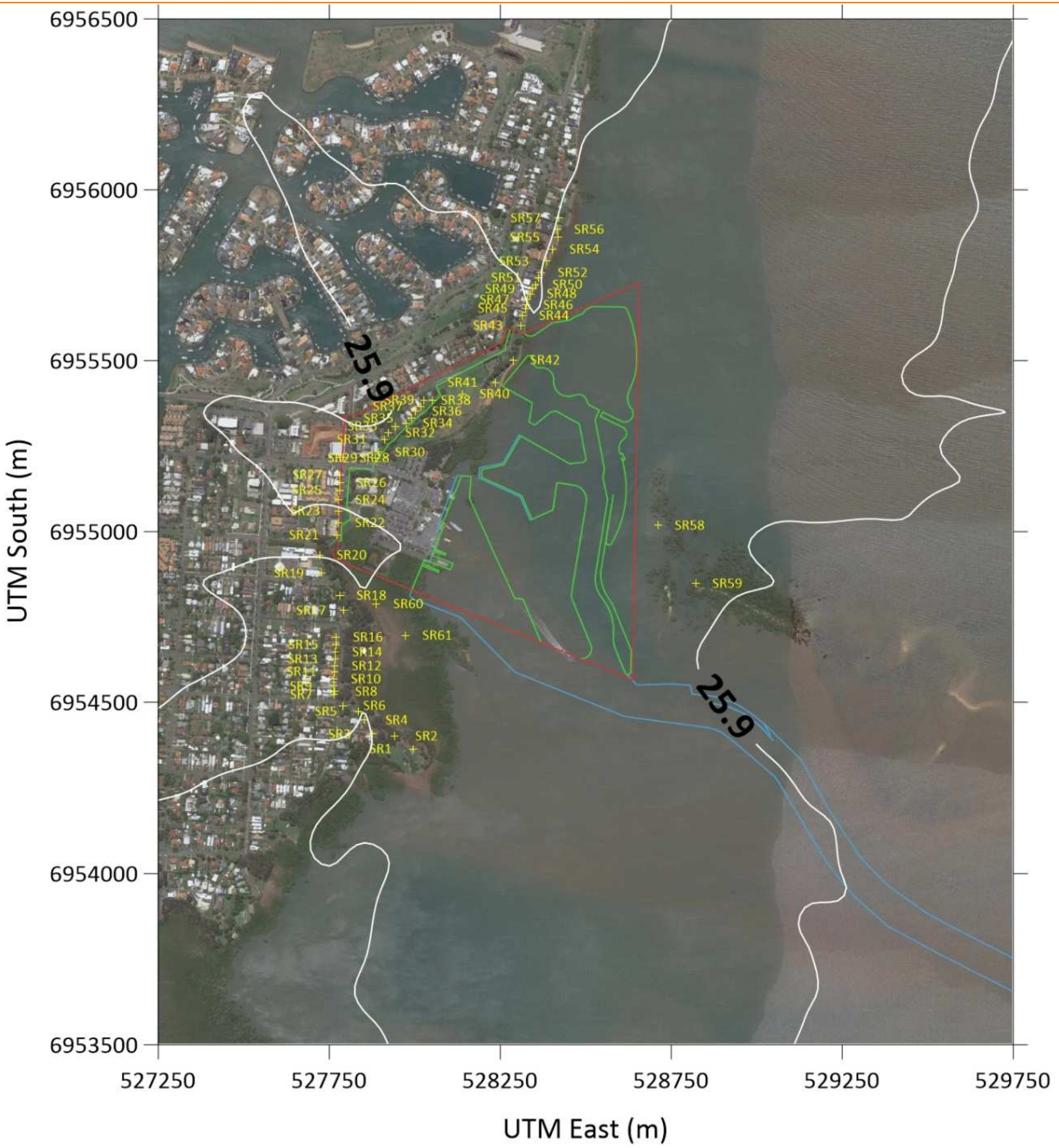
**Figure 9-29: Predicted Ground Level Concentration – $SO_2$ 24 hour average including Background; Stage 2**


| Species: SO2 | Site: Toondah Harbour | Scenario: Stage 2 – including background (3.9 µg/m3) | Averaging Period: Annual | Percentile: Average |
|---|---|---|---|---|
| **Criterion:** 57 | **Units:** µg/m3 | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-30: Predicted Ground Level Concentration – $SO_2$ Annual Average including Background; Stage 2**


| Species: Benzene | Site: Toondah Harbour | Scenario: Stage 2 – including background (4.5 μg/m³) | Averaging Period: Annual | Percentile: Average |
|---|---|---|---|---|
| Criterion: 5.4 | Units: μg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-31: Predicted Ground Level Concentration – Benzene Annual Average including Background; Stage 2**




| Species: Toluene | Site: Toondah Harbour | Scenario: Stage 2 – including background (25.6 µg/m³) | Averaging Period: 30 minute | Percentile: Maximum |
|---|---|---|---|---|
| Criterion: 1,100 | Units: µg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

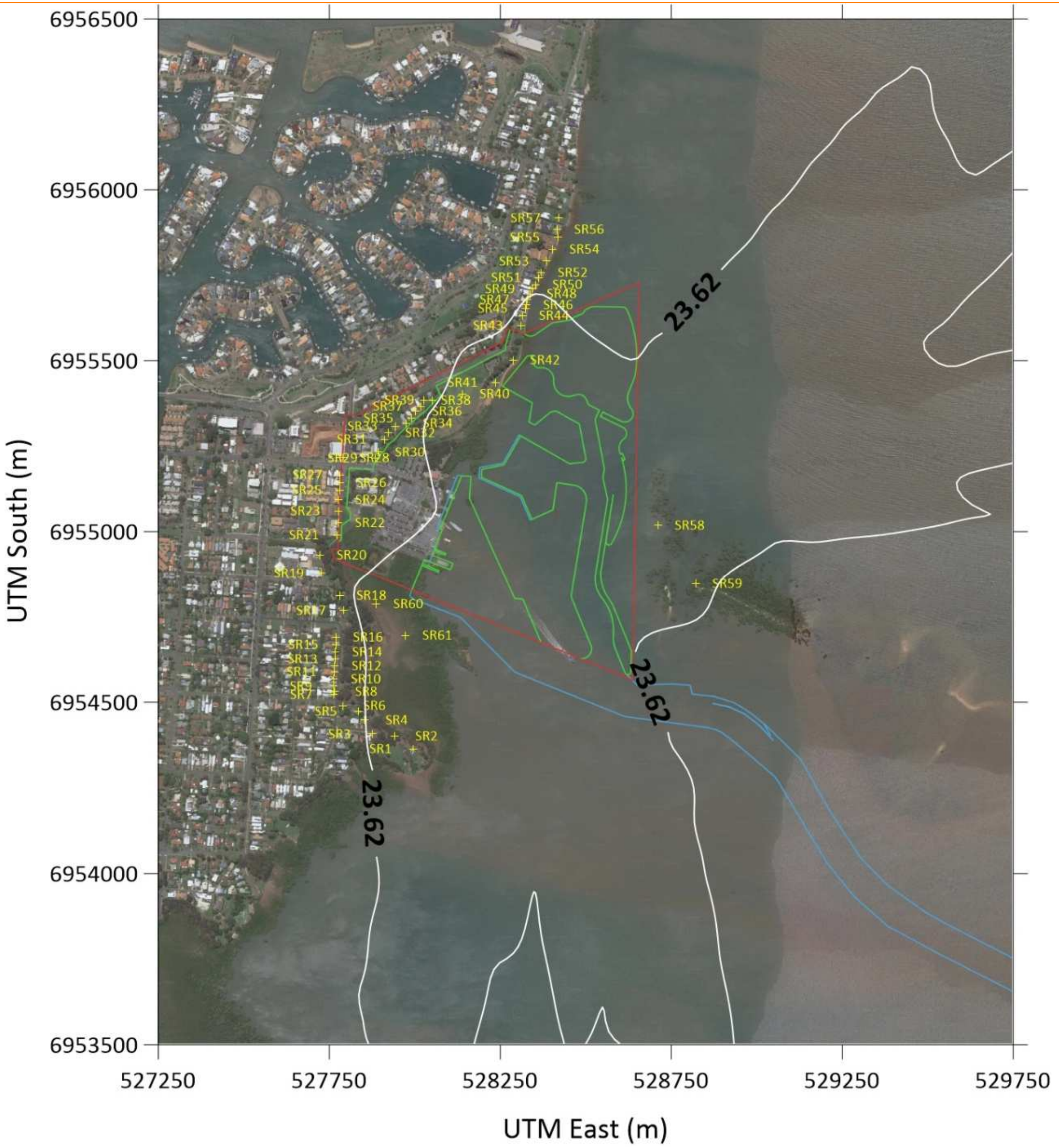
**Figure 9-32: Predicted Ground Level Concentration – Toluene 30 minute Average including Background; Stage 2**


| | | | | |
|---|---|---|---|---|
| **Species:** Toluene | **Site:** Toondah Harbour | **Scenario:** Stage 2 – including background (17.9 µg/m$^3$) | **Averaging Period:** 24 hour | **Percentile:** Average |
| **Criterion:** 4,100 | **Units:** µg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-33: Predicted Ground Level Concentration – Toluene 24 Hour Average including Background; Stage 2**


| Species:<br>Toluene | Site:<br>Toondah Harbour | Scenario:<br>Stage 2 – including background (17.9 µg/m$^3$) | Averaging Period:<br>Annual | Percentile:<br>Average |
|---|---|---|---|---|
| Criterion:<br>400 | Units:<br>µg/m$^3$ | Meteorology:<br>2017 | Model:<br>CALPUFF v 6.42 | Author:<br>W. Shillito |

**Figure 9-34: Predicted Ground Level Concentration – Toluene Annual Average including Background; Stage 2**




| Species: Xylene | Site: Toondah Harbour | Scenario: Stage 2 – including background (23.6 μg/m³) | Averaging Period: 24 hour | Percentile: Average |
|---|---|---|---|---|
| Criterion: 1,200 | Units: μg/m³ | Meteorology: 2017 | Model: CALPUFF v 6.42 | Author: W. Shillito |

**Figure 9-35: Predicted Ground Level Concentration – Xylene 24 Hour Average including Background; Stage 2**


| | | | | |
|---|---|---|---|---|
| **Species:** Xylene | **Site:** Toondah Harbour | **Scenario:** Stage 2 – including background (23.2 μg/m$^3$) | **Averaging Period:** Annual | **Percentile:** Average |
| **Criterion:** 950 | **Units:** μg/m$^3$ | **Meteorology:** 2017 | **Model:** CALPUFF v 6.42 | **Author:** W. Shillito |

**Figure 9-36: Predicted Ground Level Concentration – Annual Average including Background; Stage 2**