CrossRiverRail

15. Air Quality and Greenhouse Gas Assessment

Cross River Rail

CHAPTER 15

AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

JULY 2011

15 Air quality and greenhouse gas assessment

15.1 Introduction

This chapter addresses Sections 3.6 and 3.7 of the Terms of Reference (ToR). It describes the existing air quality within the study corridor and assesses the potential air quality impacts from both construction and operation of the Project. The chapter also presents estimates of greenhouse gas (GHG) emissions from the construction and operation phases.

The Project has the potential to generate air quality impacts during construction through:

- dust from construction activities, including excavation and materials handling
- exhaust emissions from diesel powered construction equipment.

There is the potential for minor air quality impacts from operation through:

- coal dust from freight rail movements and exhaust emissions from diesel powered locomotives
- indirect emissions by the off-site generation of electricity
- changes in regional transport emissions from changes in motor vehicle use, due to the availability and access to rail services.

Regional air quality improvements in relation to increased use of the rail system, rather than motor vehicles, are also discussed. The potential impacts, opportunities and constraints for the Project with respect to climate change are examined in **Chapter 6 Climate Change and Sustainability**.

The main community air quality concerns in relation to construction of tunnel works are about dust generation from excavation and materials handling.

The existing air quality conditions for the study corridor have been assessed with reference to the northern section (Wooloowin to the northern portal), central section (Victoria Park/northern portal) to Yeerongpilly (southern portal)) and the southern section (Yeerongpilly to Salisbury). The potential impacts and mitigations are generally consistent across the Project so the impact assessment has not been divided into the three separate geographical sections. Where necessary, individual worksites, with references to the section of the corridor where they are located, are highlighted to demonstrate where specific impacts may occur and/or where site specific controls are required.

The potential direct and indirect GHG emissions of the Project during the construction and operation phases are estimated with total emissions expressed in carbon dioxide (CO_2) equivalent terms. Greenhouse gas abatement measures are described and assessed in the context of how they reduce emissions and achieve energy efficiency. Beneficial air quality impacts from the Project have been considered with respect to:

- reduced GHG emissions, arising from additional train services alleviating demand for both private and heavy vehicle travel and reducing vehicle kilometres travelled (in comparison to the Project not proceeding)
- improved efficiency of traffic flows on the existing road network, thereby reducing vehicle emissions.

15.1.1 Air quality methodology

The methodology used to undertake the air quality and GHG assessment involved:

- reviewing the Australian air quality legislation including the *Environmental Protection (Air) Policy 2008* and National Environment Protection Measure (NEPM) for Ambient Air Quality
- describing the dispersion meteorology of the study corridor by reviewing meteorological data from the Bureau of Meteorology (BoM)
- describing the existing air quality environment by identifying the major sources of air emissions, reviewing air quality data from Department of Environment and Resource Management (DERM) and the nearby Airport Link project to establish background air quality levels in the study corridor
- describing potential nuisance dust impacts resulting from construction activities
- estimating dust emissions from each of the worksites using National Pollutant Inventory emission factors
- modelling dust emissions with CALPUFF (pollutant dispersion modelling software) and comparing results with the ambient air quality guidelines
- describing potential air quality impacts resulting from operation of the Project
- estimating GHG emissions from the construction and operation of the Project in alignment with the requirements of the National Greenhouse and Energy Reporting System
- describing measures to reduce GHG emissions from the construction and operation of the Project.

The methodology used to assess the potential GHG impacts of the Project is described in **Section 15.6**.

There are two components to the air quality modelling that were used to predict the impacts and assist with development of potential mitigation measures for the Project; meteorological modelling, and air dispersion modelling. The methodology for these two components is discussed generally as follows and in further detail in *Technical Report No. 7 – Air Quality and Greenhouse Gas Assessment*.

Meteorological modelling

Meteorology varies across the region, particularly wind patterns. The meteorology has been incorporated into the assessment by considering data from relevant monitoring stations and extrapolating this data to other areas using a wind-field model. The result is a three-dimensional, time-varying wind-field.

On a relatively small scale, local winds are affected by the topography. At larger scales, winds are affected by synoptic scale winds, which are modified by convective processes in the daytime and also by a complex pattern of regional drainage flows, which is governed by sloping terrain. In the modelling undertaken for this EIS, it is not necessary to document the complex mechanisms that affect air movements in the area, it is simply necessary to ensure that these air movements are incorporated into the dispersion modelling studies that are conducted.

This assessment has made use of the CALPUFF dispersion model. The CALPUFF model, through the CALMET meteorological processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model.

Surface meteorological data, including 10 minute records of wind speed, wind direction, relative humidity and temperature, were sourced from the BOM automatic weather stations at Brisbane Airport and Archerfield Airport. These sites provide coverage of the northeastern and southwestern regions of the study corridor and are not adversely affected by complex local terrain or building environments.

Wind patterns for the Brisbane Airport and Archerfield Airport sites were reviewed by preparing wind roses shown in **Figure 15-1**. The plot shows the frequency (length of petals) of winds from a particular direction and the strength (colour of petals) of these winds.

The wind roses show that at Archerfield Airport the most common winds are from the south. A slightly different pattern of winds is observed at Brisbane Airport where the most common winds are from the southwest. It was found that 2008 was the year with the most complete meteorological records (for both sites) and wind roses for 2008 have also been included in **Figure 15-1**. The wind patterns for 2008 show consistency with the longer term (2005-2009) patterns and it was concluded that 2008 is a representative meteorological year. Data for 2008 have been the focus of the meteorological modelling.

Figure 15-1 Wind roses for Archerfield Airport and Brisbane Airport

Source*:* BoM 2010

Upper air temperature, wind speed, wind direction, pressure and height data are also required by the CALMET model. In this instance, upper air data from the BOM Brisbane Airport site were obtained and processed into a form suitable for CALMET. In addition, the CSIRO's prognostic model known as TAPM (The Air Pollution Model) was used to generate the necessary three-dimensional meteorological information that was used as CALMET's initial guess wind-field.

A summary of the data and parameters used as part of the meteorological component of the EIS is shown in **Table 15-1**.

Table 15-1 Summary of meteorological parameters

TAPM (v 4.0.3)	
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 (north/south) x 35 (east/west) x 25 (vertical)
Year of analysis	January 2008 to December 2008, with one "spin-up" day. The spin-up day allows the meteorological variables to adjust to the model terrain and land use.
Centre of analysis	Brisbane (27^{o}28' S, 153^{o}1' E)
Meteorological data assimilation	None
CALMET (v 6.326)	
Meteorological grid domain	20 km x 20 km (80 x 80 x 10 grid dimensions)
Meteorological grid resolution	0.25 km
Meteorological stations	Two stations: Archerfield Airport, using hourly records of temperature, wind speed, wind direction and relative humidity. Brisbane Airport, using hourly records of temperature, wind speed, wind direction and relative humidity. Barometric pressure, cloud cover and ceiling height data generated for Archerfield Airport and Brisbane Airport by the TAPM simulation.
Upper air meteorological station	Brisbane Airport. Missing soundings were supplemented with TAPM prognostic output. The 3-dimensional meteorological output from TAPM was also used as the initial guess wind-field for CALMET.
Simulation length	8,760 hours (January 2008 to December 2008)

The two BoM meteorological monitoring stations were selected because:

- both had Automatic Weather Stations installed which record meteorological data every minute
- the locations covered the extents of the modelling domain
- they are sited in accordance with *AS 2923-1987: Guide for Measurement of Horizontal Wind for Air Quality Applications*.

Terrain information was extracted from the NASA Shuttle Research Topography Mission (SRTM) database, which has global coverage at approximately 90 m resolution. Land use data were extracted from aerial imagery.

Air dispersion modelling

Dust concentrations and deposition levels due to construction activities were predicted using the air dispersion model known as CALPUFF (Version 6.263). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long range transport and near calm conditions. It is the preferred model of the United States Environmental Protection Agency for the long range transport of pollutants and for complex terrain (TRC 2007).

The modelling was performed using the meteorological information provided by the CALMET model and the estimated emissions from **Section 15.4.3**. The model was used in this study to predict the dust concentrations and deposition levels in the vicinity of the five major worksites. Dispersion coefficients used turbulence computed from micrometeorology and partial plume path was used for terrain adjustment.

The dispersion modelling options assumed that:

- emissions were volume sources across the Project worksites
- emissions were emitted every hour of every day between 6 am and 6 pm, apart from blasting emissions which occurred for one hour each day
- dust deposition rates were determined from the highest monthly average
- geometric mean diameter for coarse particulates (>10 µm) and fine particulate matter (PM_{10}) is 17 µm and 7 µm respectively
- geometric standard deviation for coarse particulates and PM_{10} is 2 µm and 1 µm respectively.

15.2 Air quality guidelines

15.2.1 Legislation

The *Environmental Protection Act 1994* provides for the management of the air environment in Queensland. Air quality guidelines are specified by the DERM in the Queensland *Environmental Protection (Air) Policy 2008* (EPP (Air)). The air quality objectives in the EPP (Air) considered relevant to the Project for operation are presented in **Table 15-2**.

Table 15-2 Air quality objectives in EPP (Air) - operation

Pollutant	Air Quality Objectives		Averaging Period	Allowable Exceedances
Total Suspended Particulates (TSP)	90 µg/m^3	-	1 year	none
Particulate matter (PM_{10})	50 µg/m^3	-	24 hours	5 days each year
Particulate matter ($PM_{2.5}$)	25 µg/m^3	-	24 hours	none
	8 µg/m^3	-	1 year	none
Carbon monoxide (CO)	11,000 µg/m^3	9 ppm	8 hours	1 day each year
Nitrogen dioxide (NO_2)	250 µg/m^3	0.12 ppm	1 hour	1 day each year
	62 µg/m^3	0.03 ppm	1 year	none
Sulphur dioxide (SO_2)	570 µg/m^3	0.2 ppm	1 hour	1 day each year
	230 µg/m^3	0.08 ppm	24 hours	1 day each year
	57 µg/m^3	0.02 ppm	1 year	none

The NEPM was released in 2003 by the National Environment Protection Council (NEPC, 2003). Generally the NEPM standards and the EPP (Air) air quality objectives are consistent with each other. The NEPM has not set standards for $PM_{2.5}$, only recommending an advisory reporting standard for $PM_{2.5}$ of 25 µg/m^3 (24 hour averaging period) and 8 µg/m^3 (annual averaging period). The $PM_{2.5}$ standards were developed to facilitate collection of sufficient data for subsequent review of the standards.

There are no formal dust nuisance guidelines in the EPP (Air). However, DERM has recommended the following dust nuisance goals on other major infrastructure projects, including the Northern Link EIS (Legacy Way) (SKM-Connell Wagner JV 2008a):

- Total Suspended Particulate (TSP) concentration of 90 µg/m^3 (24 hour average)
- dust deposition rates of 120 mg/m^2/day averaged over one month.

15.2.2 Air quality goals for construction

The ambient air quality goals for construction of the Project are presented in **Table 15-3**.

Table 15-3 Air quality goals - construction

Objective	Air Quality Indicator	Goals	Averaging Period	Allowable exceedances
Human Health	Total Suspended Particulates	90 µg/m^3	1 year	none
	Particulate matter (PM_{10})	50 µg/m^3	24 hours	5 exceedances per year
Nuisance	Total Suspended Particulates	80 µg/m^3	24 hours	none
	Deposited dust	120 mg/m^2/day	30 days	none

15.2.3 Air quality goals for operation

The operation air quality goals, as specified by DERM in EPP (Air*),* are summarised in **Table 15-2** in **Section 15.2.1**.

15.3 Existing air quality

This section identifies the nearest sensitive receptors to the Project and describes the local environment, including meteorology and ambient air quality.

15.3.1 Sensitive receptors

Sensitive receptors are locations where people are regularly present. These receptors include:

- residential dwellings
- educational, community and health buildings
- parks, outdoor education and recreational areas.

Due to the urban nature of the Project, sensitive receptors occur throughout each section of the study corridor. Although the majority of the sensitive receptors are ubiquitous across the Project, each of the three study corridor sections have specific key receptors which are directly related to individual worksites and/or activities.

The key sensitive receptors for each section have been characterised as:

- open space (Victoria Park), and community areas (RNA Showgrounds), with some localised residential dwellings for the northern section
- higher density residential/commercial, open space (such as the Roma Street Parklands and City Botanic Gardens) and educational facilities including schools and universities in the central section
- residential areas (suburban communities) with some industrial, education facilities (high schools) and community/open space areas contributing to the key receptors for the southern section.

The locations of air quality sensitive receptors within the study corridor are presented in:

- **Figure 15-2** for the northern section
- **Figure 15-3** for the central section
- **Figure 15-4** for the southern section.

The construction phase will require a number of worksites across the study corridor which are listed in **Table 15-4** and **Table 15-5**. Worksites for tunnelling activities would be located at the northern portal, Woolloongabba and Yeerongpilly. Worksites would also be located at each of the proposed underground stations, at proposed surface stations, at Fairfield to support construction of the ventilation shaft and emergency access building and at Mayne Rail Yard and Salisbury to support construction activities associated with surface works. The nearest air quality sensitive receptors to the worksites are presented in **Table 15-4** and **Table 15-5**.

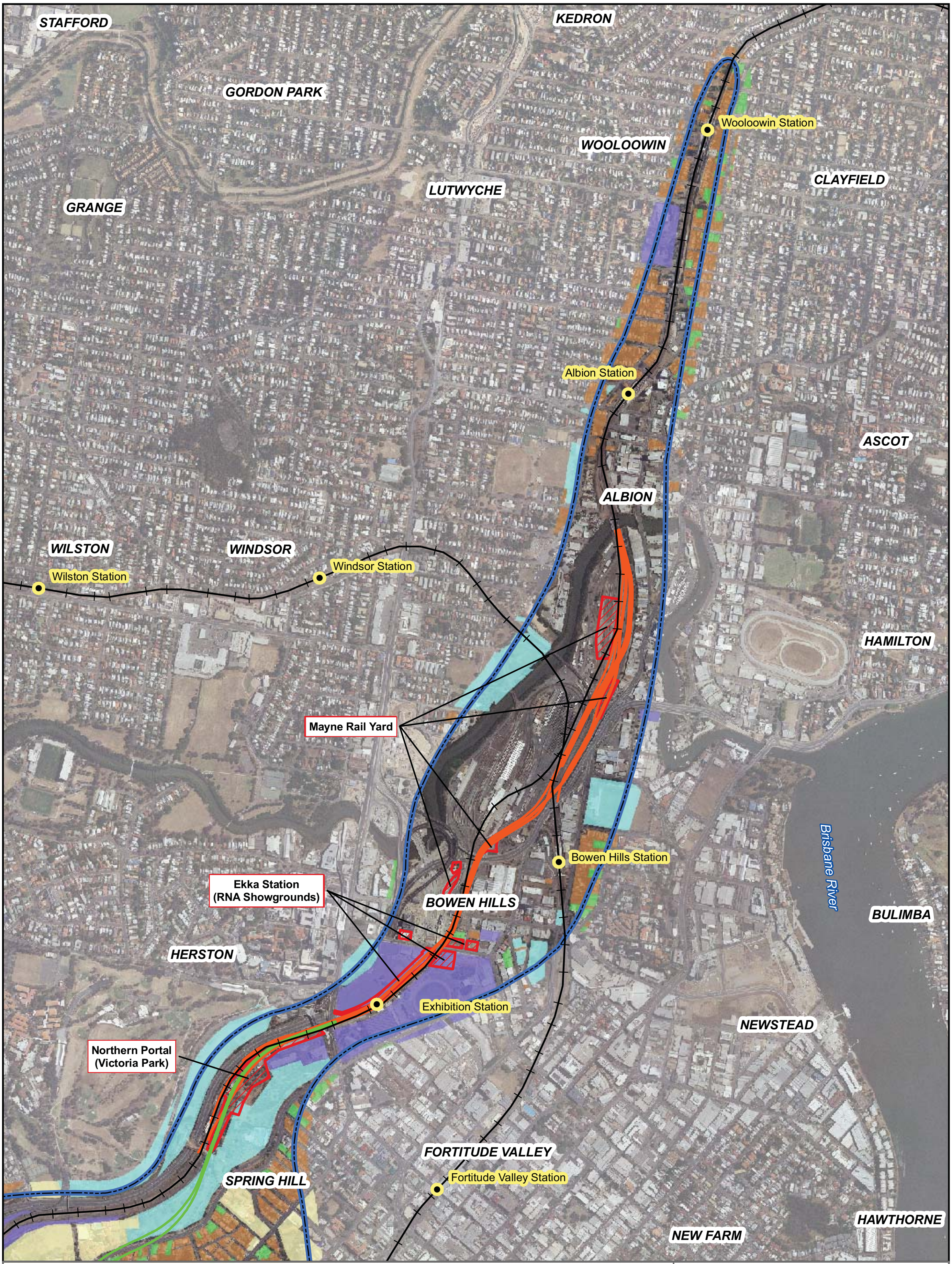
Table 15-4 Sensitive receptors nearest to tunnelling worksites

Worksite	Sensitive Receptors	Distance from Worksites
Victoria Park (northern portal), Spring Hill	Gregory Terrace - residential St Josephs College Centenary Aquatic Centre Gregory Terrace - residential Gregory Terrace - commercial Gregory Terrace - residential Bowen Bridge Road - commercial	230 m 150 m 25 m 130 m 150 m 170 m 20 m
Woolloongabba	Vulture Street - residential Vulture Street - commercial Vulture Street - residential St Nicholas Cathedral Main Street - commercial Vulture Street - commercial Stanley Street - commercial St Josephs Primary School	125 m 60 m 25 m 25 m 150 m 15 m 60 m 180 m
Yeerongpilly	St Fabien's Church Tees Street - residential Wilkie Street - residential Livingstone Street – residential Fairfield Road - residential Cardross Street - residential	20 m 30 m 30 m 35 m 50 m 80 m

Table 15-5 Sensitive receptors nearest to other worksites

Worksite	Sensitive Receptors	Distance From Construction Works
Mayne Rail Yard	Residential west of Mayne Rail Yard Residential east of Mayne Rail Yard	300 m 180 m
RNA Showgrounds	Residential northeast of RNA Showgrounds Residential northwest of RNA Showgrounds Royal Brisbane and Women's Hospital	60 m 220 m 300 m

Worksite	Sensitive Receptors	Distance From Construction Works
Roma Street Station	Wickham Terrace - commercial St Alban Liberal Catholic Church Wickham Terrace - residential Wickham Terrace - commercial Brisbane Private Hospital Brisbane Dental Educational Turbot Street - commercial Roma Street Station - commercial Holiday Inn - residential Parkland Crescent - residential	150 m 125 m 120 m 140 m 130 m 100 m 40 m 10 m 50 m 150 m
Albert Street Station	Queensland University of Technology Parliament House Alice Street - residential Albert Street - commercial Albert Street - residential Charlotte Street - commercial Mary Street - residential Margaret Street - commercial	270 m 260 m 25 m 20 m 5 m 5 m 20 m 45 m
Boggo Road Station	Ecosciences Precinct - commercial Rawnsley Street - residential Maldon Street - commercial Maldon Street - residential Grantham Street - commercial Annerley Road - residential Boggo Road Police Station Dutton Park Primary School Leukemia Support Village	5 m 15 m 45 m 40 m 35 m 75 m 90 m 40 m 100 m
Ventilation shaft and emergency access building	Railway Road - residential Sunbeam Street - residential Baptist Union of QLD Church Railway Road - commercial Venner Road - residential Fairfield Road - residential Byrnes Street - commercial Fairfield Road - residential Love Street - residential	15 m 50 m 60 m 15 m 15 m 30 m 25 m 40 m 90 m
Clapham Rail Yard	Residential east of Clapham Rail Yard Residential West of Clapham Rail Yard	100 m 250 m
Moorooka	Residential east of Moorooka Residential west of Moorooka	130 m 500 m
Rocklea	Residential west of Rocklea Residential east of Rocklea	40 m 170 m
Salisbury	Residential south of Salisbury Residential northeast of Salisbury	50 m 350 m



LEGEND

- Study Corridor
- Station
- Track
- Worksites

Alignment

- Above Ground
- Underground

- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-2

Air Quality Sensitive Receptors (Northern Section)

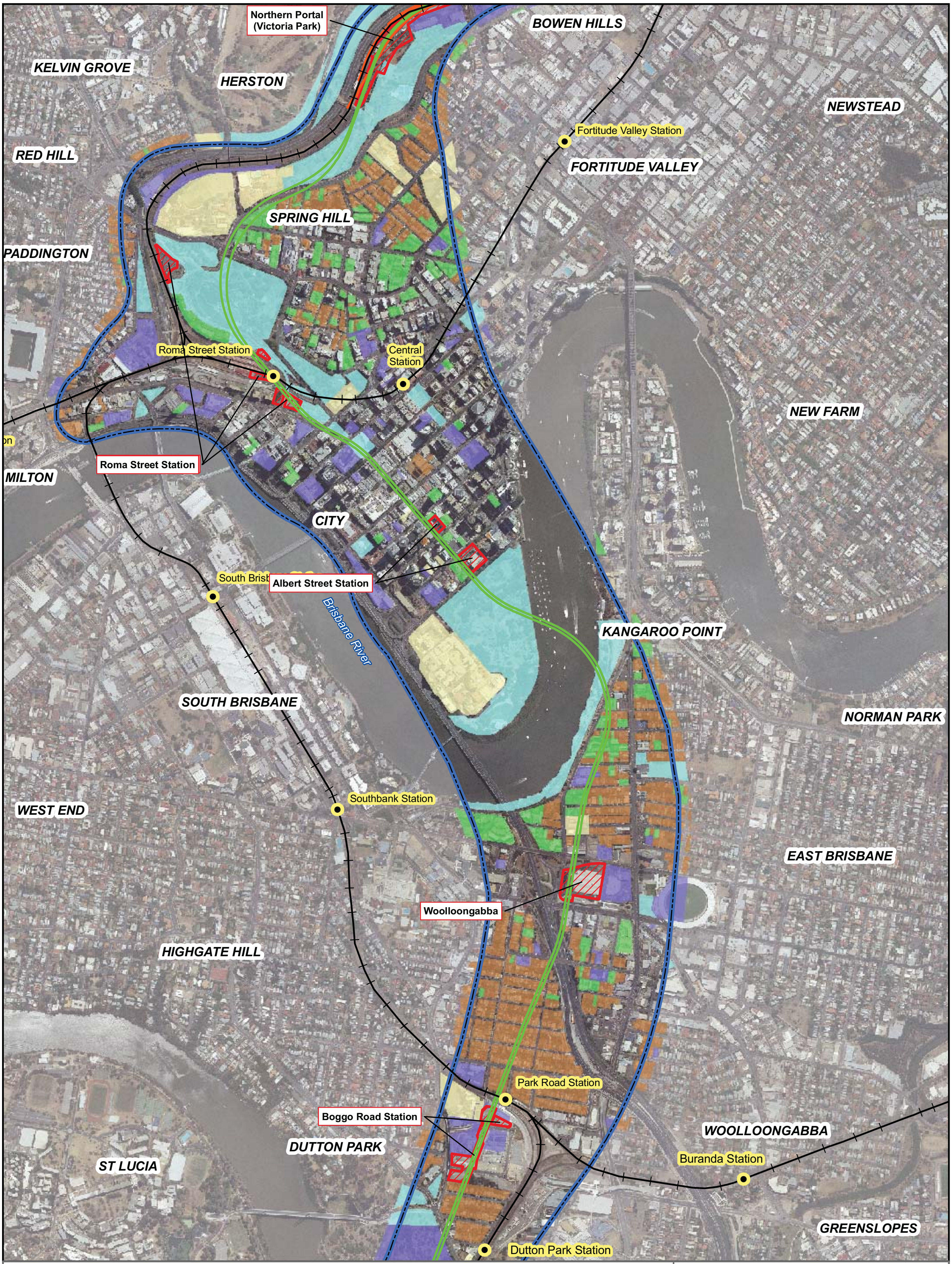
0 250 500 750 m

1:20,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_2_Sensitive_Receptors_North.mxd 08/07/2011 12:30



LEGEND

- Study Corridor
- Station
- Track
- Worksites

Alignment

- Above Ground
- Underground

- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-3

Air Quality Sensitive Receptors (Central Section)

0 250 500 750 m

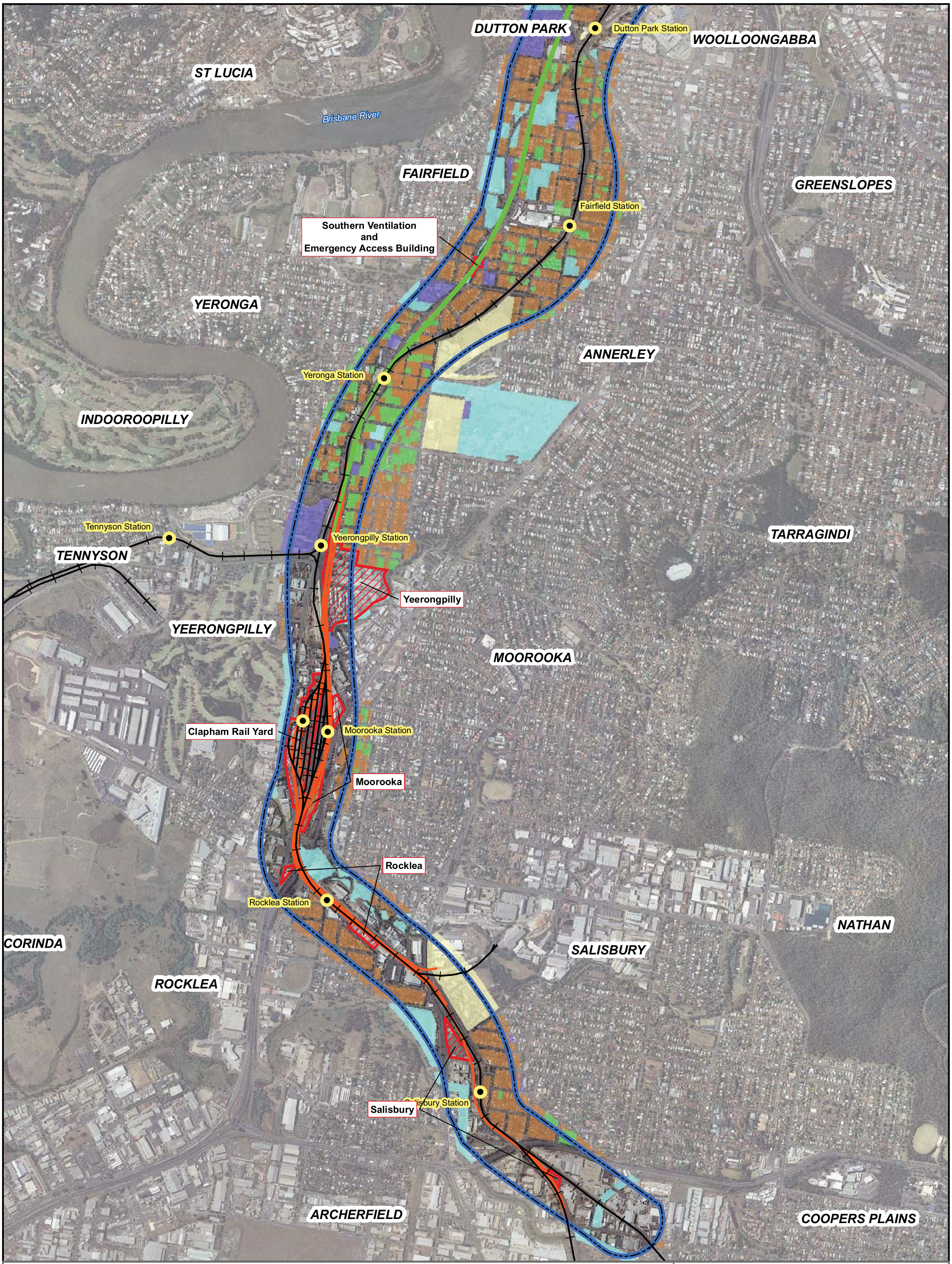
1:22,000 at A4

N

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_3_Sensitive_Receptors_Central.mxd 08/07/2011 12:30



LEGEND

- Study Corridor
- Station
- Track
- Worksites

Alignment

- Above Ground
- Underground
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-4

Air Quality Sensitive Receptors (Southern Section)

0 250 500 750 1,000 m

1:30,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_4_Sensitive_Receptors_South.mxd 08/07/2011 12:32

15.3.2 Dispersion meteorology

The dispersion of air emissions following release from a source, for example a worksite, would vary depending on the terrain and the prevailing meteorological conditions. Dispersion modelling requires hourly breakdown of temperature, wind speed and direction, and other meteorological parameters.

This section describes the dispersion meteorology and climatic data recorded by two BoM meteorological monitoring stations at:

- Brisbane Airport, located 10 km to the northeast of the northern section of the study corridor
- Archerfield Airport, located 3 km to the southwest of the southern section of the study corridor.

The locations of these meteorological stations, as well as other DERM air quality monitoring stations are presented in **Figure 15-5**.

15.3.3 Existing meteorological conditions (Brisbane Airport)

Brisbane Airport

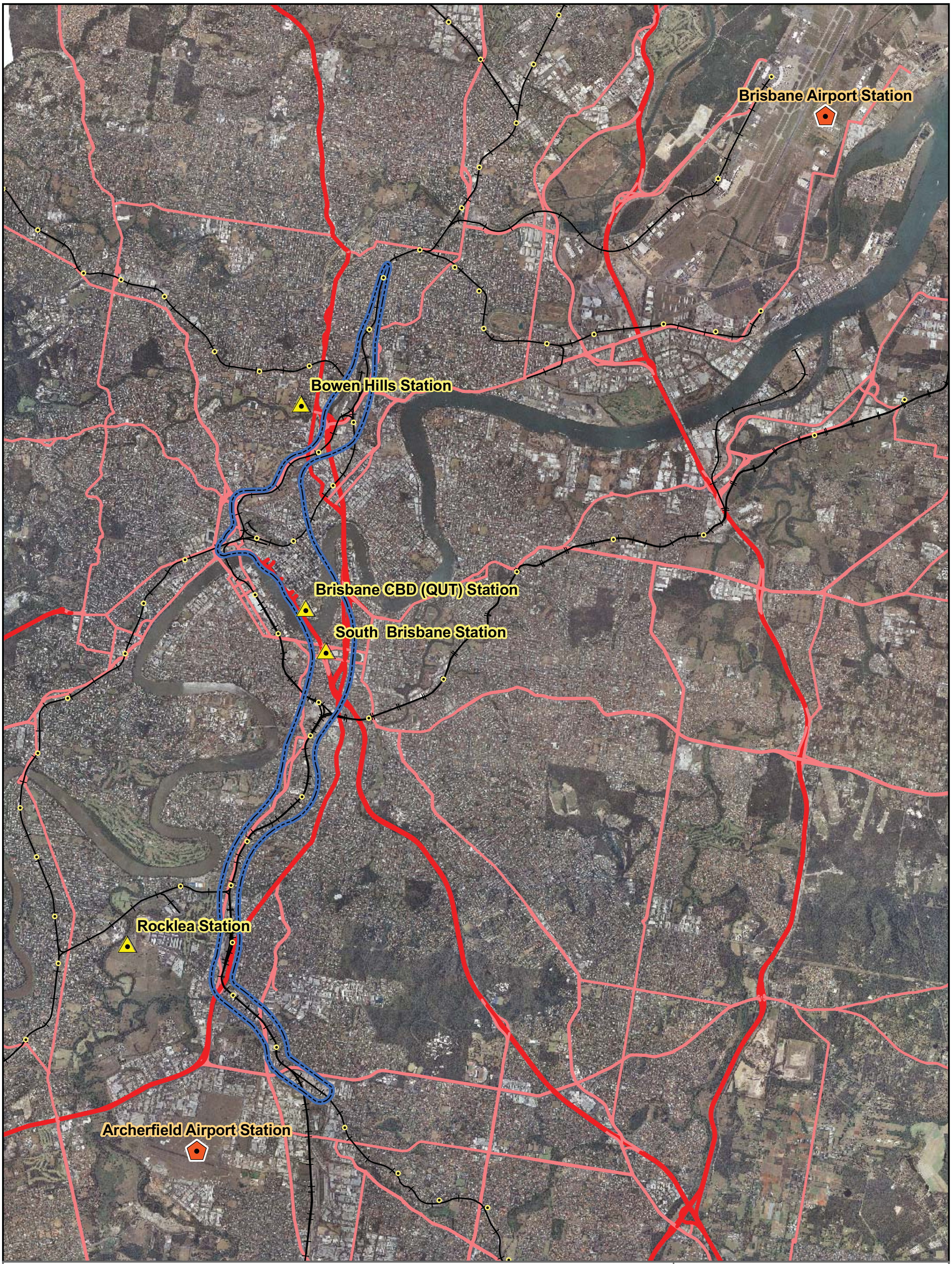
The Brisbane Airport meteorological station is located 10 km to the northeast of the northern end of the study corridor and is representative of conditions in the northern part of the study corridor (refer to **Figure 15-5**). Wind patterns for the Brisbane Airport are shown in **Figure 15-1**. The key Project related aspects of the dispersion meteorology at Brisbane Airport are:

- the dominant wind directions throughout the year are from the southwest/south southwest and north/north-northeast
- winds during summer are predominantly from the east-southeast and the north-northeast with an average wind speed of 4.6 m/s
- winds during autumn and winter are predominantly from the southwest/south-southwest with an average wind speed of 3.9 m/s in autumn and 3.7 m/s in winter
- winds during spring are predominantly from the north/north northeast with an average wind speed of 4.2 m/s
- strong winds are most frequent from the north and north-northeast during spring and summer
- calm conditions (wind speed less than 0.5 m/s) occur 2.3 % of the year and are most common during winter (3.8 %).

Table 15-6 provides a summary of the temperature, humidity and rainfall data for the Brisbane Airport meteorological station from 1994 to 2010.

Brisbane Airport typically has warm days during summer with average maximum daytime temperatures around 29 °C in January and February, falling to 21 °C in June and July. Temperatures overnight are mild during summer and cool during the winter months, with average minimum daily temperatures of 9 °C in July, rising to almost 21 °C in January and February.

Highest rainfall is generally recorded during summer months with monthly rain averaging above 100 mm/month from November to February and also in May. Mean monthly rainfall is low from July to September with average monthly rainfall less than 40 mm.



LEGEND

- Study Corridor
- Station
- Track
- Road Network
- Major Roads
- Other Roads
- BOM Meteorological Monitoring Station
- DERM Air Quality Monitoring Station

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-5

Meteorological and Air Quality Monitoring Stations

0 1 2 3 Km

1:100,000 at A4

N

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_5_Air_Quality_MetStation_Locations.mxd 08/07/2011 12:32

Table 15-6 Climatic data for Brisbane Airport

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean daily maximum temperature (°C)	29	29.1	27.9	26	23.6	21.3	20.9	21.8	24.2	25.5	26.8	28.3	25.4
Mean daily minimum temperature (°C)	21.2	21.1	19.4	16.3	12.8	10.5	8.8	9.6	12.7	15.7	18	20.1	15.5
Mean 9.00 am air temp (°C)	26.4	26.2	25.1	22.4	18.9	16.1	15.3	17.1	20.5	22.6	24.1	25.6	21.7
Mean 9.00 am relative humidity (%)	66	68	67	67	68	70	65	60	58	59	62	64	64
Mean 3.00 pm air temp (°C)	27.4	27.5	26.4	24.5	22.3	20	19.6	20.4	22.5	23.6	24.9	26.5	23.8
Mean 3.00 pm relative humidity (%)	63	63	61	58	56	55	50	51	54	58	61	62	58
Mean monthly rainfall (mm)	109	121	85	66	123	71	27	35	33	65	102	121	947
Highest monthly rainfall (mm)	285	284	201	192	577	213	112	138	122	175	228	253	1,729

Source: BoM 2010

15.3.4 Existing meteorological conditions (Archerfield Airport)

Archerfield Airport

The Archerfield Airport meteorological station is located 3 km to the southwest of the southern end of the study corridor and is representative of conditions in the southern part of the study corridor (refer to **Figure 15-5**). Wind patterns for Archerfield Airport are shown in **Figure 15-1**. The key features of the dispersion meteorology at Archerfield Airport are:

- the dominant wind directions throughout the year are from the south, east-southeast and north-northeast
- winds during summer are predominantly from the east-southeast and the north-northeast with an average wind speed of 3.9 m/s
- winds during autumn and winter are predominantly from the south-southwest/southwest with an average wind speed of 3.2 m/s in autumn and 3 m/s in winter
- winds during spring are predominantly from the north/north-northeast with an average wind speed of 3.9 m/s
- strong winds are most frequent from the north and north-northeast during spring and summer although strong westerly winds occur during winter
- calm conditions (wind speed less than 0.5 m/s) occur 8.5 % of the year and are most common during winter (12.5 %).

Table 15-7 provides a summary of the temperature, humidity and rainfall data for the Archerfield Airport meteorological station from 1939 to 2010.

Archerfield Airport typically has warm days during summer with average maximum daytime temperatures around 30 °C in January and February falling to 21 °C in June and July. Overnight temperatures are mild during summer and cool during the winter months, with average minimum daily temperatures of 7 °C in July, rising to almost 20 °C in January and February.

Highest rainfall is generally recorded during summer months with monthly rain averaging above 100 mm/month from November to March. Mean monthly rainfall is low from August to September with average monthly rainfall less than 40 mm.

Table 15-7 Climatic summary for Archerfield Airport

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean daily maximum temperature (°C)	30.4	29.7	28.7	26.4	23.8	21.4	21.1	22.5	25.1	27	28.3	29.6	26.2
Mean daily minimum temperature (°C)	20.2	20	18.2	15	11.9	9.2	7.4	8	10.9	14.3	17	19	14.3
Mean 9.00 am air temp (°C)	25.8	25.1	23.7	20.9	17.4	14.3	13.3	15	18.7	21.8	23.7	25.1	20.4
Mean 9.00 am relative humidity (%)	66	70	70	71	74	75	71	67	62	60	61	64	67
Mean 3.00 pm air temp (°C)	28.8	28.2	27.1	25	22.8	20.5	20.2	21.4	23.6	25.1	26.4	27.8	24.7
Mean 3.00 pm relative humidity (%)	55	58	56	54	53	51	45	43	44	50	53	54	51
Mean monthly rainfall (mm)	133	153	125	80	75	66	50	37	36	77	101	126	1061
Highest monthly rainfall (mm)	623	600	458	462	551	494	375	138	115	395	392	444	1,964

Source: BoM 2010

15.3.5 Ambient air quality

The air quality of the study corridor is influenced by both regional air pollution and localised sources. The ambient air quality within the study corridor has been described by:

- identifying the regional influences on air quality in South East Queensland
- reviewing ambient air quality data recorded by the DERM and other available sources
- identifying localised sources of air emissions in the study corridor
- establishing background air quality levels for the study corridor.

Regional influences on air quality

The Queensland Environmental Protection Agency (EPA) and Brisbane City Council (2003) prepared an air emissions inventory for South East Queensland and identified the following key regional influences on air quality:

- particulate matter from dust storms (infrequent)
- particulate matter from bushfires and controlled burns, which occur once or twice per year in cooler months
- motor vehicle emissions including NO_X, PM_{10}, $PM_{2.5}$, CO and SO_2
- biogenic emissions of volatile organic compounds (VOCs) which can be a precursor to the formation of photochemical smog.

Project alignment - ambient air quality data

The ambient air quality of the study corridor has been described by reviewing air quality data recorded by DERM at Rocklea, South Brisbane and Brisbane CBD (QUT) from 2005 to 2009, and data recorded by Airport Link at Bowen Hills from 2004 and 2005. The locations of these air quality monitoring stations represent the northern, central and southern sections of the Project and are presented in **Figure 15-5**. The air quality monitoring data from these monitoring stations are discussed as follows.

Northern section (Bowen Hills monitoring station)

Bowen Hills monitoring station is located at an elevated position near the Inner City Bypass. The site measures meteorological data and concentrations of PM_{10} and $PM_{2.5}$. Air quality monitoring data for daily PM_{10} and $PM_{2.5}$ concentrations at Bowen Hills from 2004 and 2005 are presented in **Table 15-8** and in **Figure 15-6** and **Figure 15-7**.

The data from Bowen Hills show that PM_{10} and $PM_{2.5}$ concentrations have been below the air quality goals, with the exception of four exceedances for $PM_{2.5}$ in 2004.

Table 15-8 Air quality monitoring data at Bowen Hills from 2004 to 2005

Pollutant	Air Quality Objective	Averaging Period	Pollutant concentrations ($\mu g/m^3$)				
			Average	70^{th} percentile	95^{th} percentile	99^{th} percentile	Maximum
PM_{10}	50 $\mu g/m^3$	24 hours	17.4	18.6	32.7	45.5	63.2
	5 exceedances per year		2 exceedances in 2005				
$PM_{2.5}$	25 $\mu g/m^3$	24 hours	8.5	9.1	16.2	24.3	35.5
	0 exceedances per year		4 exceedances in 2004				

Source: DERM 2010

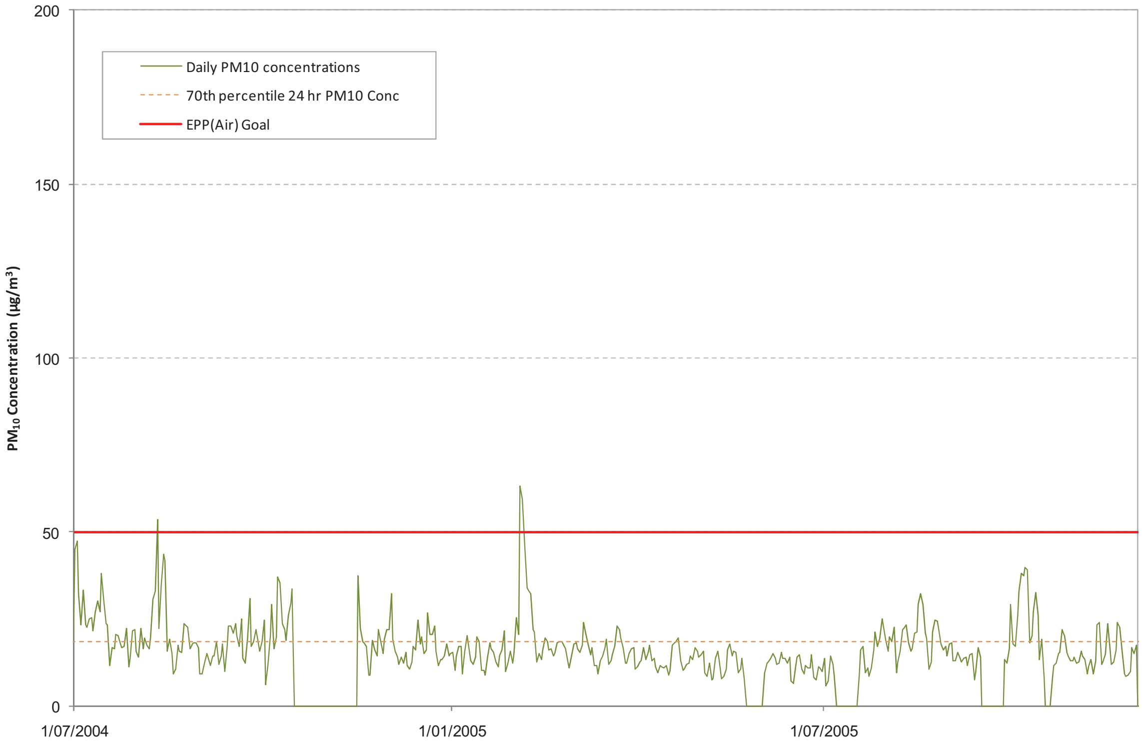


Figure 15-6 Daily PM_{10} Concentrations at Bowen Hills in 2004 and 2005

Source: DERM 2010

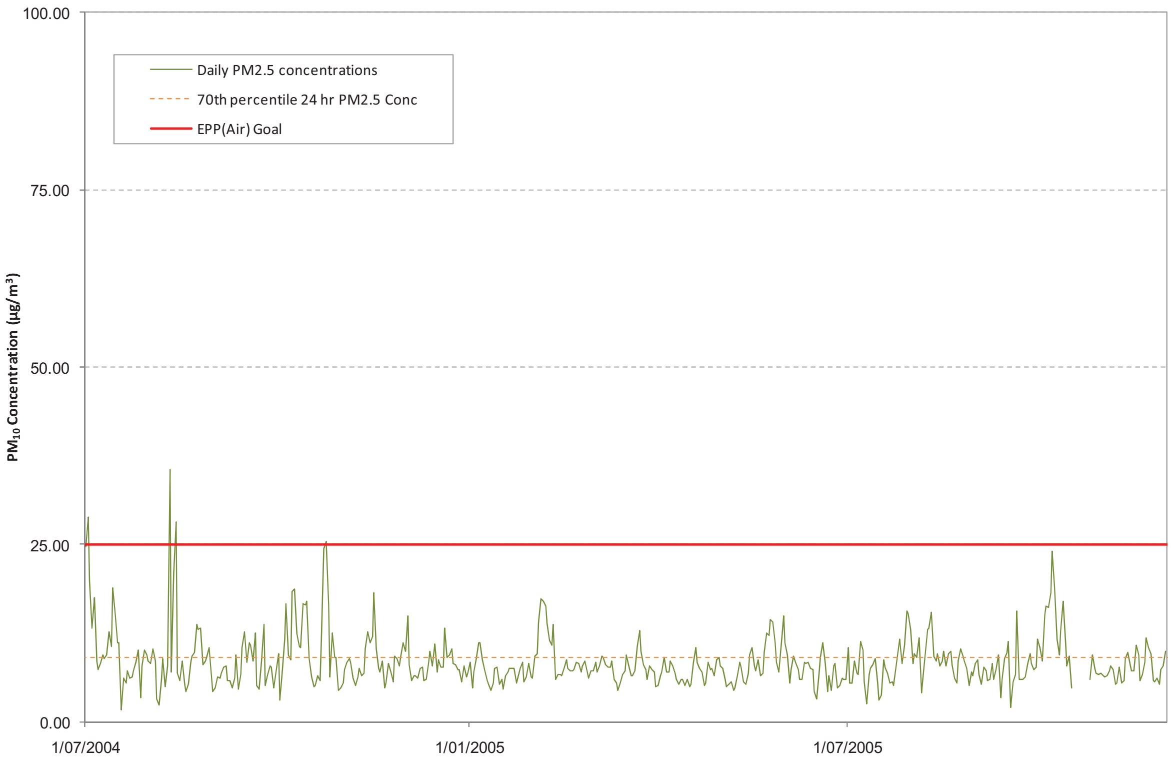


Figure 15-7 Daily $PM_{2.5}$ Concentrations at Bowen Hills in 2004 and 2005

Source: DERM 2010

Central section (Brisbane CBD (QUT) monitoring station)

The Brisbane CBD (Queensland University of Technology (QUT)) monitoring station is located in an elevated position at the Queensland University of Technology campus. The site measures PM_{10} concentrations and meteorological data. Daily PM_{10} concentrations from 2005 to 2009 are presented in **Table 15-9** and **Figure 15-8.** These show that PM_{10} concentrations were below the air quality goal of less than five exceedances per year of the daily concentration of 50 µg/m^3, except in 2009 when major regional dust storms resulted in seven exceedances.

Table 15-9 Air quality monitoring data at Brisbane CBD (QUT) from 2005 to 2009

Pollutant	Air Quality Objective	Averaging Period	Pollutant concentrations (µg/m^3)				
			Average	70^{th} percentile	95^{th} percentile	99^{th} percentile	Maximum
PM_{10}	50 µg/m^3	24 hours	17.4	18.2	29.9	44.7	1,013
	5 exceedances per year		7 exceedances in 2009 due to major dust storm				

Source: DERM 2010

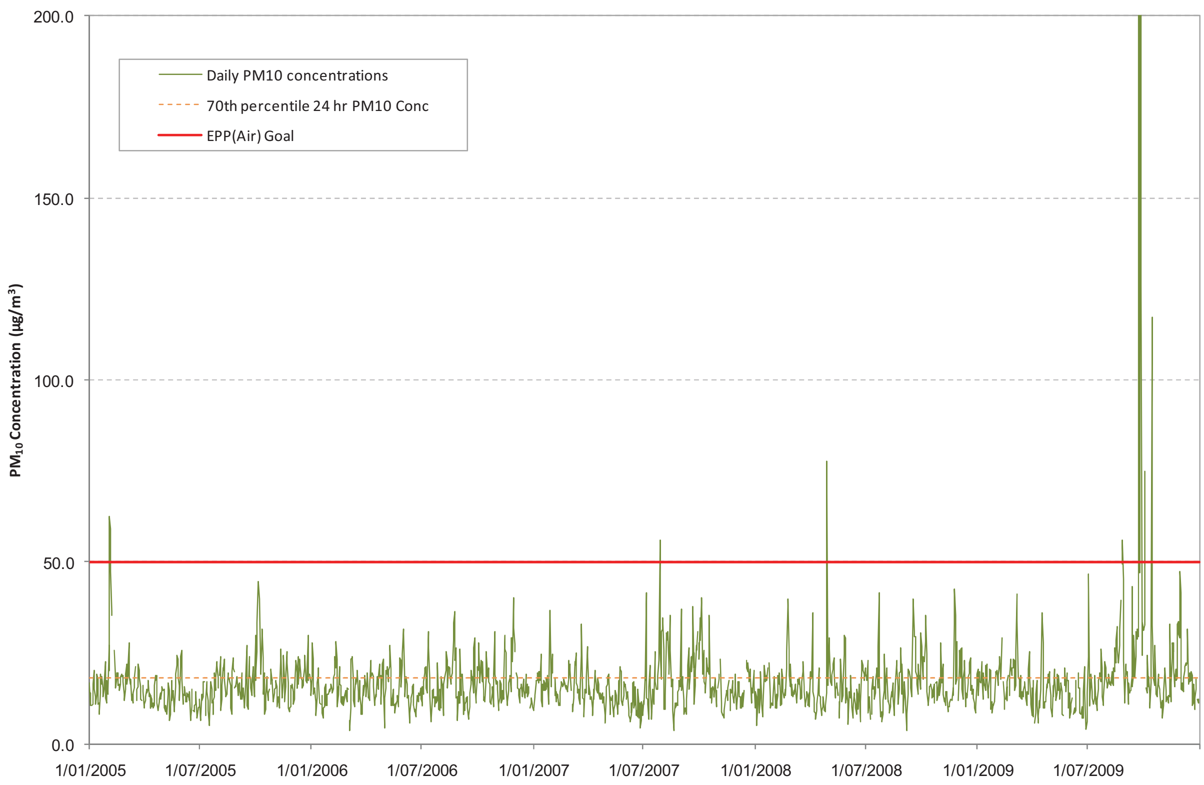


Figure 15-8 Daily PM_{10} Concentrations at Brisbane CBD (QUT) from 2005 to 2009

Source: DERM 2010

Central section (South Brisbane monitoring station)

The South Brisbane monitoring station is located near the Riverside Expressway. The site measures PM_{10} concentrations and meteorological data. Air quality monitoring data from the South Brisbane monitoring station from 2005 to 2009 are presented in **Table 15-10**. Daily PM_{10} concentrations from 2005 to 2009 are presented in **Figure 15-9**.

The data from South Brisbane show that PM_{10} concentrations have been below the air quality goal of 50 µg/m^3, except in 2009 when major dust storms resulted in 14 exceedances.

Table 15-10 Air quality monitoring data at South Brisbane from 2005 to 2009

Pollutant	Air Quality Objective	Averaging Period	Pollutant concentrations (µg/m^3)				
			Average	70th percentile	95th percentile	99th percentile	Maximum
PM_{10}	50 µg/m^3	24 hours	21.3	22.4	35.3	49.6	1060.3
	5 exceedances per year		14 exceedances in 2009 due to major dust storm				
NO_2	250 µg/m^3	1 hour	34.0	41	63.6	80.0	141.6
	62 µg/m^3	1 year	-	-	-	-	36.9 (2005)

Source: DERM 2010

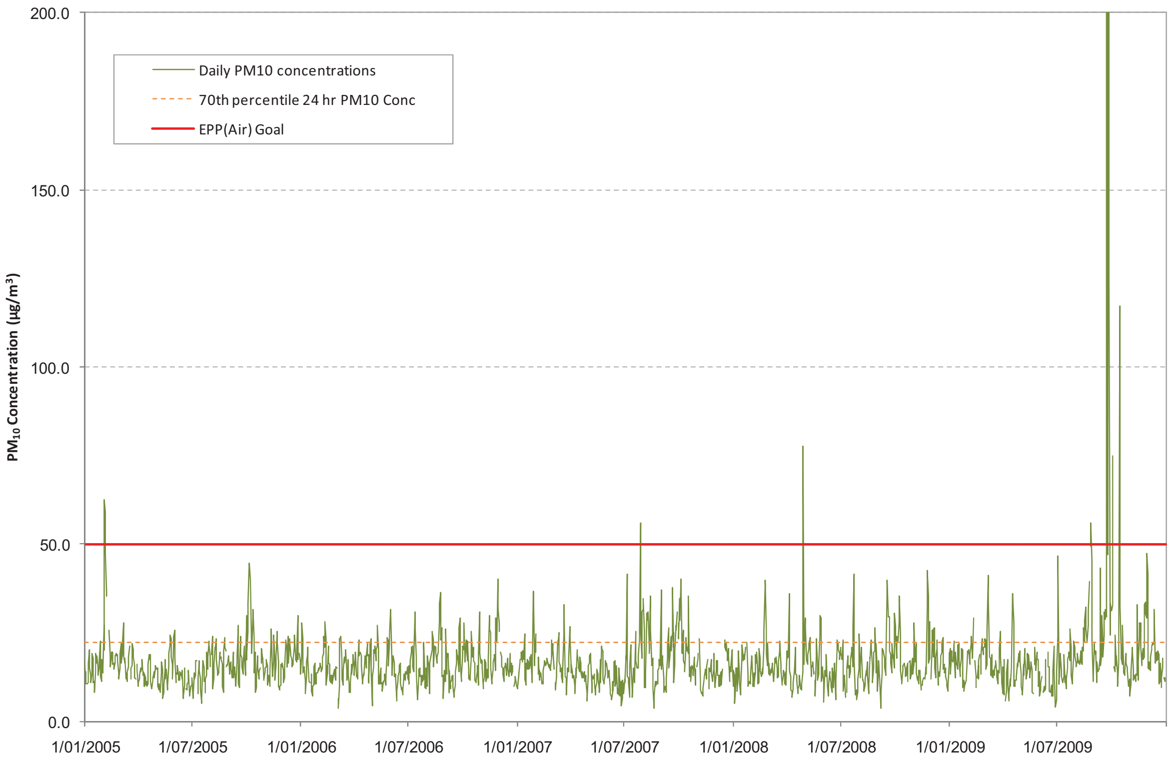


Figure 15-9 Daily PM_{10} Concentrations at South Brisbane from 2005 to 2009

Source: DERM 2010

Southern section (Rocklea)

The Rocklea monitoring station was established in 1978 and is located in an open area surrounded by industry and residential uses. The Rocklea monitoring station measures PM_{10}, $PM_{2.5}$, NO_2, ozone and meteorological data. Air quality monitoring data from Rocklea monitoring station from 2005 to 2009 are presented in **Table 15-11**. Daily PM_{10} and $PM_{2.5}$ concentrations at Rocklea from 2005 to 2009 are presented in **Figure 15-10** and **Figure 15-11**.

The data from Rocklea (**Table 15-11**) show that PM_{10} and NO_2 concentrations are below the air quality goals, except in 2009 when major dust storms resulted in ten exceedances of the PM_{10} goal of 50 µg/m^3.

Exceedances of the 24 hour ambient air quality goal for $PM_{2.5}$ were recorded in 2005, 2007, 2008, and 2009. The annual goal for $PM_{2.5}$ was exceeded on eight occasions in 2009 due to major dust storms.

Table 15-11 Air quality monitoring data at Rocklea from 2005 to 2009

Pollutant	Air Quality Objective	Averaging Period	Pollutant concentrations (µg/m^3)				
			Average	70th percentile	95th percentile	99th percentile	Maximum
PM_{10}	50 µg/m^3	24 hours	18.5	19.2	32.7	45.9	1,033
	5 exceedances per year		10 exceedances in 2009 due to major dust storm				
$PM_{2.5}$	25 µg/m^3	24 hours	7.2	7.8	14.3	21.7	100.7
	0 exceedances per year		8 exceedances in 2009 due to major dust storm				
	8 µg/m^3	1 year	-	-	-	-	10.7 (2009)
NO_2	250 µg/m^3	1 hour	16.5	20.5	43.1	61.6	96.5
	62 µg/m^3	1 year	-	-	-	-	18.5 (2005)

Source: DERM 2010

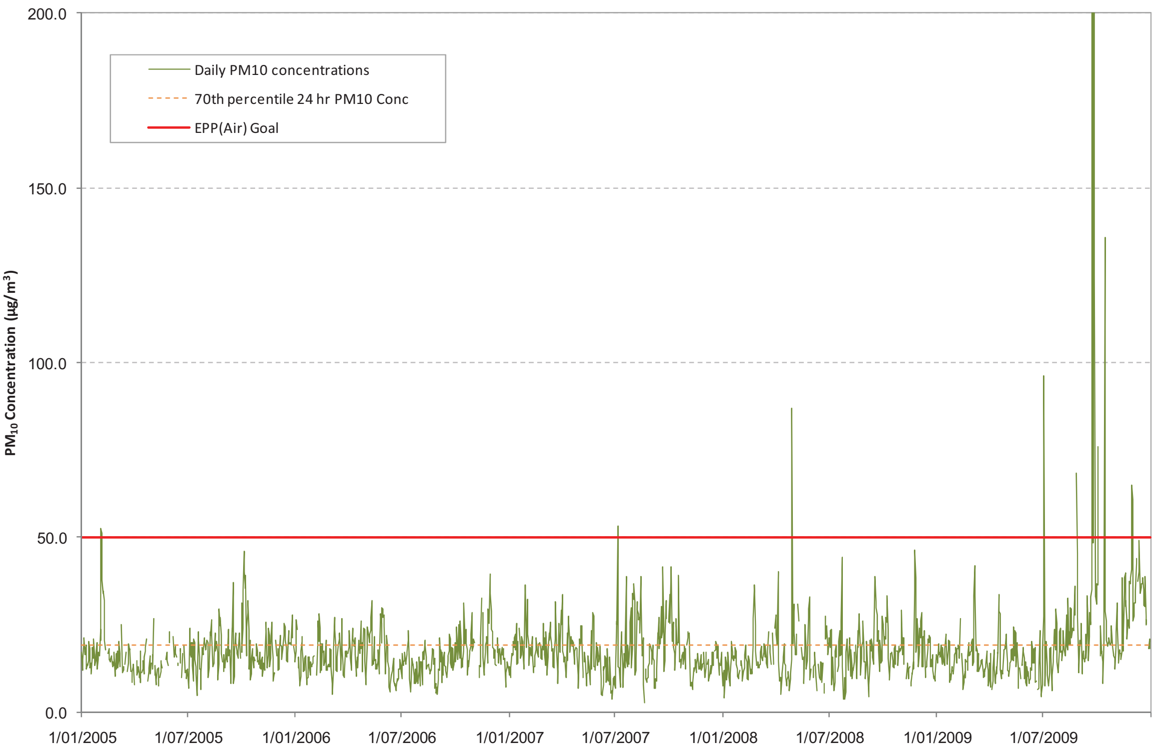


Figure 15-10 Daily PM_{10} Concentrations at Rocklea from 2005 to 2009

Source: DERM 2010

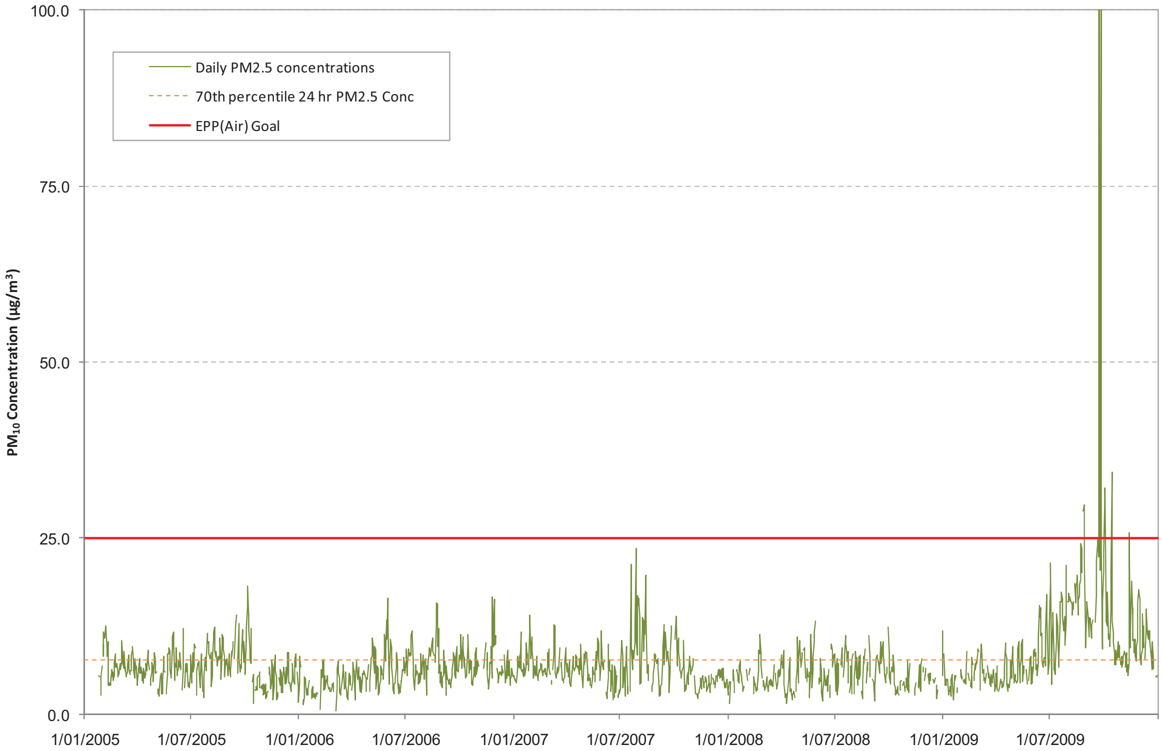


Figure 15-11 Daily $PM_{2.5}$ Concentrations at Rocklea from 2005 to 2009

Source: DERM 2010

15.3.6 Local air quality

This section identifies air emissions within the study corridor and establishes background air quality levels for the air quality impact assessment. Potential localised air emissions sources were identified from aerial imagery and the National Pollutant Inventory database.

Localised air emissions sources in the study corridor include:

- motor vehicle emissions from major roads including the Inner City Bypass, Sandgate Road, Bowen Bridge Road, Lutwyche Road, Riverside Expressway, the Pacific Motorway, Ipswich Road and Fairfield Road
- transport infrastructure, including rail yards and a bus depot
- industrial sources near Rocklea and Acacia Ridge
- incineration of medical wastes from hospitals.

No major sources of odour were identified near the study corridor.

Nearby construction activities which are likely to occur within the Project construction period include:

- Bowen Hills Urban Development Area
- RNA Showgrounds redevelopment
- Woolloongabba Urban Development Area
- Boggo Road Urban Village
- works related to the implementation of the Kangaroo Point South Neighbourhood Plan
- works related to the Yeerongpilly Transit Oriented Development.

Given the absence of major industrial air emissions sources within the study corridor, the regional air quality monitoring data has been used to establish the background air quality data. The adopted background air quality concentrations for the study corridor are presented in **Table 15-12**. For assessment of 24 hour average model predictions, the background particulate levels for PM_{10} have been based on 70th percentile monitoring data recorded at Rocklea. This approach is consistent with the approach suggested by the Victorian EPA, where the 70th percentile of background data is used to determine the potential for the relevant assessment criteria to be exceeded (VEPA 2006). For the assessment of annual average model predictions, the background levels were based on annual average measurement data.

The adopted background air quality concentrations in **Table 15-12** are considered conservative levels. That is, on most days in most parts of the study corridor, concentrations would be expected to be lower than these values.

Table 15-12 Adopted background air quality concentrations

Air Quality Indicator	Value	Averaging Period	Comment
Total Suspended Particulates	28 µg/m^3	1 year	Assumed to be 1.5 times average PM_{10} concentration at Rocklea, due to absence of TSP monitoring
	29 µg/m^3	24 hours	Assumed to be 1.5 times 70th percentile PM_{10} concentration at Rocklea, due to absence of TSP monitoring
Particulate matter (PM_{10})	19 µg/m^3	24 hours	70th percentile concentration at Rocklea
Dust deposition	60 mg/m^2/day	30 days	Assumed value

15.3.7 Summary

The key features of the existing air quality environment in the study corridor are:

- good air quality with concentrations of most pollutants well below the air quality goals except:
  - regional sources, such as controlled burns or dust storms, of PM_{10} typically result in one or two exceedances of the goal each year
  - $PM_{2.5}$ levels in Brisbane occasionally exceed the ambient air quality goals in the EPP (Air)
- air quality within the study corridor is considered to be mainly influenced by regional air emissions
- dispersion meteorology is characterised by winds from the northeast during summer and spring and winds from the southwest during autumn and winter.

15.4 Construction phase air quality impacts and mitigation

15.4.1 Introduction

This section describes the likely air quality impacts expected from the construction of the Project and includes:

- sources of air emissions during construction
- estimating air emissions from worksites
- air dispersion modelling of dust from high risk construction activities
- assessing the potential air quality impacts from construction works
- discussing the implications.

15.4.2 Sources of air emissions

Overview of construction methodology

The greatest potential for dust impacts during construction of the Project are likely to be from the following activities:

- graders working unpaved areas and dozers moving material
- wind erosion from exposed surfaces
- wheel generated dust from vehicles travelling along unpaved or dirty paved surfaces
- handling and transport of spoil.

The potential for air quality impacts from each of the worksites is presented in **Table 15-13** and **Table 15-14**.

Table 15-13 Potential for air quality impacts at tunnelling worksites

Worksite	Description of Activities	Potential for Air Quality Impacts
Northern portal	This worksite would be used for: • construction of the northern portal, dive structure and cut and cover tunnel sections • retrieval of the TBMs for the tunnels between Woolloongabba and Victoria Park.	Excavation activities and spoil handling at the northern portal worksite may generate air quality impacts. The potential dust emissions have been estimated in **Section 15.4.3** and dust concentrations have been predicted in **Section 15.4.4**.
Woolloongabba	The worksite would be used for: • construction of the cut and cover box and station cavern for the Gabba Station • Tunnel Boring Machine (TBM) launch site and removal of spoil from construction of the tunnels between Woolloongabba and Victoria Park • retrieval of the TBMs for the tunnels between Yeerongpilly and Woolloongabba.	Excavation activities and spoil handling at the Woolloongabba worksite may generate air quality impacts. The potential dust emissions have been estimated in **Section 15.4.3** and dust concentrations have been predicted in **Section 15.4.4.**
Yeerongpilly	The site would be used for construction of: • the southern portal and new Yeerongpilly Station • TBM launch site and removal of spoil from the tunnels between Yeerongpilly and Woolloongabba • the extended footbridge to the existing station • construction of the new realigned local streets.	Excavation activities and spoil handling at the Yeerongpilly worksite may generate air quality impacts. The potential dust emissions have been estimated in **Section 15.4.3** and dust concentrations have been predicted in **Section 15.4.4**.

Table 15-14 Potential for air quality impacts at other worksites

Worksite	Description of Activities	Potential for Air Quality Impacts
Mayne Rail Yard	Worksite and material laydown area to support construction of the northern viaduct in Mayne Rail Yard. Construction of the Mayne feeder station.	This worksite is considered to have a low potential for air quality impacts. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5.**
RNA Showgrounds	Worksites at the RNA Showgrounds would be used for construction of a new station and surface tracks and regrading of O'Connell Terrace. Construction support sites for the regrading of O'Connell Terrace, including road over rail bridge.	This worksite is considered to have a low potential for air quality impacts. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5.**

Worksite	Description of Activities	Potential for Air Quality Impacts
Roma Street Station	The northern worksite would be used for construction of the: • northern plant shaft and building for Roma Street Station • re-located toilet facilities. The central worksite would be used for construction of the: • central shaft for escalators and lift shaft access to the existing station concourse • re-located toilet facilities. The southern worksite would be used for construction of the: • shaft to accommodate the southern entrance to the station and associated plant • main on-site support for construction of the station cavern.	Excavation activities do have the potential to generate dust at this location. Construction activities will occur in the shaft and dust emissions are not expected to exceed the air quality goals. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5.**
Albert Street Station	The northern worksite would be used for the construction of the northern station entrance and associated plant. The southern worksite would be used for construction of the: • Albert Street Station cavern • shaft accommodating the southern entrance and associated plant • subway and entrance under Alice Street.	Excavation activities have the potential to generate dust at this location. Construction activities will occur in the shaft or purpose built acoustic shed. Dust emissions from construction are not expected to exceed the air quality goals. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5**.
Boggo Road Station	This site would be used for the construction of the cut and cover station box, entrance shafts and associated plant.	Cut and cover tunnelling and proximity to sensitive receptors may generate air quality impacts at this location. The potential dust emissions have been estimated in **Section 15.4.3** and dust concentrations have been predicted in **Section 15.4.4.**
Ventilation shaft	Construction of ventilation shaft.	Construction activities will occur in the shaft and dust emissions are not expected to exceed the air quality goals. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5**.
Clapham Rail Yard	Placing fill to raise the ground level for additional surface tracks. Material laydown and worksite for surface track work within Clapham Rail Yard.	Given the large quantities of fill to be received at Clapham Rail Yard there is potential for air quality impacts at this location. The potential dust emissions have been estimated in **Section 15.4.3** and dust concentrations have been predicted in **Section 15.4.4.**
Moorooka	Worksite and stockpiling of materials for the construction of the viaduct.	The worksite is considered to have a low potential for air quality impacts. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5.**

Worksite	Description of Activities	Potential for Air Quality Impacts
Rocklea	Construction of the Muriel Avenue bridge and road works associated with the Ipswich Road on-ramp. Material laydown area for construction of the new surface tracks.	The worksite is considered to have a low potential for air quality impacts. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5**.
Salisbury	These worksites would be used for: • storage and material laydown • construction of the new footbridge north of Salisbury Station and extension of the existing footbridge at Salisbury Station • southern surface tracks • road realignments.	The worksite is considered to have a low potential for air quality impacts. Dust would be minimised by the contractor through the dust management measures in **Section 15.4.5**.

Major components of construction that may generate emissions to the air include:

- worksite establishment and demolition activities
- tunnelling activities and associated excavation
- shaft excavation
- spoil removal
- spoil placement
- surface road and bridge works
- construction of rail stations and other buildings
- power source emissions from construction equipment, generators and other plant.

Worksite establishment and demolition activities

The initial steps in worksite establishment include the demolition of buildings and removal of kerbs, roadways and fencing. Particular consideration would be given to the demolition of buildings, such as those at Albert Street and Yeerongpilly worksites that may contain harmful substances such as asbestos fibres. In such cases, controls would be implemented to satisfy Part 13 of the *Workplace Health and Safety Regulation 2008* for the protection of construction workers on-site (refer to **Chapter 22 Hazard and Risk**). It is expected that these measures would also be sufficient to adequately manage potential off-site impacts.

Significant surface earthworks and excavations are associated with establishing the worksites for tunnelling activities located at Victoria Park, Woolloongabba and Yeerongpilly, as well as the worksites at each of the proposed underground stations.

Tunnelling activities and other excavation

Tunnelling would be carried out using TBMs between the northern and southern portals (refer to **Chapter 4 Project Description**). The tunnel would be ventilated during excavation works (refer to **Section 15.4.5**).

Surface excavations would be conducted by excavators and frontend loaders down to rock level, with drilling and blasting used on rock. Drilling and blasting may also be used in all shafts and station boxes where blast mats would be used to mitigate vibrations and prevent flyrock.

The portals and dive structures comprise a combination of retaining walls, open cut box, covered box and mined structures. The construction of Boggo Road Station and Gabba Station would use a cut and cover method with pile walls or similar retaining structures. Albert Street and Roma Street Stations would be mined caverns with ventilation and access shafts.

Tunnelling of the portal and trough structure at Yeerongpilly, the station cavern at Woolloongabba and the tunnel access shaft at Albert Street would be expected to be undertaken within an acoustic shed.

Potentially harmful silica dust may be encountered during the excavation through certain types of geological formations. The Woogaroo Subgroup comprises sandstones, siltstones, shales conglomerates and coal deposits found in the vicinity of Moorooka, Rocklea and Salisbury (refer to **Chapter 7 Topography, Geology, Geomorphology and Soils**). Where potentially harmful silica dust is encountered, controls would be implemented to satisfy relevant occupational health and safety requirements. It is expected that these measures would also be sufficient to adequately manage potential off-site impacts from silica dust.

Potential odours could also arise from the excavation of contaminated material. Where contamination or putrescible material in soil and/or groundwater is of a volatile nature or produces gas, there is the potential for odour to arise. This may include former landfills, tips or areas of fill (refer to **Chapter 8 Contaminated Land**). **Section 15.4.5** details measures for managing potential odour problems encountered during construction.

Spoil removal

An estimated total of 3.4 million tonnes of spoil is likely to be produced, with a total volume of 2.1 million m^3 (1.4 million m^3 in-situ). Expected spoil volumes from each worksite are provided in **Table 4-12** in **Chapter 4 Project Description.** The majority of spoil would be generated from the TBM worksites at Woolloongabba and Yeerongpilly, with significant volumes also generated at the northern portal and the station locations. The intended disposal routes from these TBM worksites are via Ipswich Road to the west. Spoil removal over a full 24 hour period is proposed or sufficient storage on the worksite provided, to allow for continuous tunnel excavation.

The movement and handling of excavated spoil would be performed within enclosed purpose built worksheds to minimise dust impacts at Yeerongpilly, Woolloongabba and Albert Street worksites (refer to **Section 15.4.5**). Locations of worksheds are provided in *Volume 2 Reference Design Drawings*.

Spoil placement

It is proposed that spoil from construction would be disposed off-site within an industrial area in Swanbank (refer to **Figure 3-17** in **Chapter 3 Project Development**). The nearest sensitive receptors to the proposed spoil placement location are residences located 1.8 km to the east and south of the Swanbank site.

Spoil material extracted from the TBMs is likely to be damp. To minimise dust generation from spoil haulage, waste materials transported off-site would be covered. Consequently, minimal dust generation is expected from the transport of spoil to the disposal site. For the worksites north of the Brisbane River, the preferred haul routes would include the Inner City Bypass for some sites, linking with Milton Road, the Western Freeway/Centenary Motorway on the Ipswich Motorway, the Cunningham Highway and Redbank Plains Road to Swanbank (refer to **Figure 3-17** in **Chapter 3 Project Development**).

The main source of air emissions at the disposal site would be dust generated from spoil handling. It is expected that trucks would dump spoil at the designated site, where it would be stockpiled and spread by bulldozer.

Surface road and bridge works

Traditional construction methods using excavators, graders, compaction equipment and pavement equipment would be utilised for surface road works and bridge construction. The potential air quality impacts of these activities are expected to be similar to those outlined for worksite establishment and demolition activities and would be managed in accordance with the measures outlined in **Section 15.4.5**.

In order to manage potential dust issues associated with concrete batching, the concrete required for the construction of the stations and road surfaces would be pre-mixed off-site and delivered in trucks in preference to sourcing from an on-site concrete batching plant. In some cases, pre-cast concrete panels may be delivered to the worksites.

Surface rail works

Traditional construction methods including use of excavators, graders, and compaction equipment would be utilised for surface rail works. The potential air quality impacts of these activities are expected to be similar to those outlined earlier for worksite establishment and demolition activities and would be managed in accordance with the measures outlined in **Section 15.4.5**.

Construction of aboveground rail stations and other buildings

Construction of the aboveground stations is expected to generate dust through demolition and excavation and the construction of worksite buildings. The potential air quality impacts of these activities are expected to be similar to those outlined earlier for worksite establishment and demolition activities and would be managed in accordance with the measures outlined in **Section 15.4.5**.

Use of associated construction equipment, generators and other plant

Each worksite would be served by supporting equipment and plant including excavators, cranes, piling rigs, compaction plants, bulldozers and trucks. In case of power outages, generators would provide power to temporary ventilation equipment. The proposed construction activities, indicative equipment and air emission sources are presented in **Table 15-15**.

Table 15-15 Description of construction works, indicative equipment and air emission sources

Indicative Construction Works	Indicative Equipment	Air Emission Sources
• Development of new road and pedestrian bridges • Development of new road intersections and pedestrian crossings • Development of concourses and public forecourt outside stations • Reconfiguration and re-grading of existing rail bridge(s) • Demolition activities • Worksite preparation and earthworks • Cut and cover excavations and earthworks • Retrieval and disassembly of TBMs • Relocation of infrastructure • Station caverns • Vehicle workshops • Laydown/staging areas • Worksite offices/car parks • Stockpiling, handling and transport of spoil • Piling activities • Realignment of existing suburban streets • Development of rail lines and associated infrastructure	• Piling rigs • Franna cranes • Backhoes • 60-100 t, 150 t cranes • Scissor lifts • Self-drive cherry pickers • 5 t, 10 t, 20 t, 35 t, excavators • 10 t rollers • Generators • Compressors • Bulldozers • Ventilation plant • Shaft hoists • Shaft lifts • Road headers • Pumps • Drilling jumbos • TBMs • Frontend loaders • Truck and dogs • Low loader trucks • Light vehicles	Fugitive dusts from: • Clearing of trees and topsoil • Vehicle movements on exposed areas • Windblown dust from exposed areas • Excavation of rock and overburden • Piling • Cut and cover tunnelling • Stockpiling, handling and transport of spoil material • Demolition of low rise buildings and sheds, high rise buildings and carparks, platforms, stations, industrial buildings etc (including blasting, where feasible) Diesel emissions from: • Construction vehicles and plant equipment (mobile and stationary) • Haul vehicles

15.4.3 Emissions estimation

Dust emissions from construction would vary in line with the intensity of construction activities. In general, dust emissions from construction are greatest during periods of significant earth moving activities.

The construction works program was reviewed to determine the phase of construction works that is likely to generate the most emissions from each worksite. The dust emissions from these 'worst-case' scenarios were calculated for each worksite. Emissions were estimated using emission factors in the 'Emission Estimation Technique Manual for Mining version 2.3' (NPI, 2001). The emission factors used in this estimation, under the application of basic controls such as hoardings and water sprays, are presented in **Table 15-16**.

Table 15-16 Emission factors for construction activities

Construction Activity	Unit	TSP	PM_{10}	Controls to be adopted (% Reduction)
Drilling	kg/hole	0.59	0.31	Water sprays (70%)
Blasting	kg/blast	11.7	6.09	Hoardings around worksite (30%)
Excavators / frontend loaders on spoil	kg/tonne*	0.025	0.012	Hoardings and water sprays (65%)
Bulldozers on spoil	kg/hour	1.63	0.33	Hoardings around worksite (30%)
Loading trucks	kg/tonne*	0.0003	0.0001	Hoardings around worksite (30%)
Wheel generated dust	kg/vkt	3.88	0.96	Water sprays (75%)
Trucks dumping spoil	kg/tonne*	0.0120	0.0043	-
Wind erosion	kg/ha/hour	0.4	0.2	-

Source: NPI 2001
Notes:
*1. *of spoil handled*
2. VKT- Vehicle Kilometres Travelled
3. ha- hectare

Assumptions

A number of assumptions were made in estimating the emissions as follows:

- haul distances on unsealed roads for spoil movements and material delivery is assumed to be 400 m per journey
- bulldozers operate at the Victoria Park, Spring Hill, Woolloongabba, Boggo Road and Clapham Rail Yard
- blasting occurs twice per day with blast size of 100 m^2
- drill pattern for blasting is assumed to require 1 drill hole for each 1.5 m^2 blast area
- surface excavation activities would be carried out for 12 hours per day, 6 days a week.

Limitations

The following limitations should also be considered when interpreting the construction air quality assessment:

- the construction scenario assessed is a snapshot of typical activities that could be expected to occur during maximum (ie 'worst-case') worksite activities
- actual emission rates may differ from the estimates in **Table 15-17** and **Table 15-18**

- emission factors are generally long-term averages, whereas actual emissions would vary on a short-term time scale
- estimated dust emission rates are based on an assumption that basic dust emission controls are utilised on many of the dust emitting processes (refer to **Table 15-16**). **Section 15.4.5** identifies mitigation measures to minimise dust nuisance from construction activities.

Worksites

The estimated TSP and PM_{10} emissions in g/s for the various construction activities with controls at each worksite are presented in **Table 15-17** and **Table 15-18**. For each worksite, sources of emissions and construction assumptions have been identified to support the emission estimations and these are identified in *Technical Report No. 7 – Air Quality and Greenhouse Gas Assessment*.

The estimated dust emission rates are entered into the dispersion model to predict TSP and PM_{10} concentrations and dust deposition rates. The predicted TSP and PM_{10} concentrations and dust deposition rates are then compared to the ambient air quality goals.

The worksites expected to generate the highest instantaneous dust emissions are the northern portal (northern section), Woolloongabba, Boggo Road Station (central section), Yeerongpilly Station and southern portal and Clapham Rail Yard (southern section). Dust emissions have been modelled to predict TSP and PM_{10} concentrations and dust deposition rates.

Table 15-17 Estimated TSP emissions (g/s) from worksites

	Northern portal	Woollongabba	Boggo Road Station	Yeerongpilly Station and southern portal	Clapham Rail Yard
Drilling	0.03	0.03	0.03	0.03	-
Blasting	1.31	1.31	1.85	1.31	-
Excavators/ frontend loaders on spoil	1.31	1.31	1.85	1.31	-
Bulldozers on spoil	0.63	0.32	0.40	-	0.45
Loading trucks	0.01	0.03	0.02	0.03	-
Wheel generated dust	-	-	-	0.75	-
Trucks dumping spoil	-	-	-	-	0.56
Wind erosion	0.39	0.23	0.23	0.44	0.93
Total (blasting)	**3.68**	**3.23**	**4.38**	**3.88**	**1.94**
Total (without blasting)	**2.38**	**1.92**	**2.53**	**2.57**	**1.94**

Table 15-18 Estimated PM_{10} emissions (g/s) from worksites

	Northern portal	Woolloongabba	Boggo Road Station	Yeerongpilly Station and southern portal	Clapham Rail Yard
Drilling	0.02	0.02	0.02	0.02	-
Blasting	0.68	0.68	0.96	0.68	-
Excavators/frontend loaders on spoil	0.22	0.63	0.26	0.36	-
Bulldozers on spoil	0.13	0.06	0.08	-	0.09
Loading trucks	0.00	0.01	0.01	0.01	-
Wheel generated dust	-	-	-	0.19	-
Trucks dumping spoil	-	-	-	-	0.20
Wind erosion	0.19	0.12	0.11	0.22	0.47
Total (blasting)	**1.25**	**1.52**	**1.44**	**1.48**	**0.76**
Total (without blasting)	**0.56**	**0.84**	**0.48**	**0.80**	**0.76**

15.4.4 Meteorological and air dispersion modelling results

This section outlines the predicted concentrations of PM_{10} and dust deposition rates for 'worst-case' emissions from construction at the five key worksites:

- Northern portal
- Woolloongabba
- Boggo Road Station
- Yeerongpilly Station and southern portal
- Clapham Rail Yard.

The five worksites were chosen as they will involve the most significant construction periods, intensity of activities, scale of operations and durations. Therefore, these worksites are those with highest potential to cause adverse air quality impacts and have been the focus of the construction air modelling and assessment. Lower air quality impacts would be expected at other worksites for the activities described in **Table 15-15**.

Estimated dust emission rates are based on an assumption that basic dust emission controls are adopted on many of the dust emitting activities (refer to **Table 15-16**). A range of control measures would be implemented at each worksite to minimise the potential for dust nuisance at nearby sensitive receptors (refer to **Section 15.4.5** and **Chapter 24 Draft Outline EMP**).

Northern portal

A contour plot of the predicted maximum increase in PM_{10} concentrations (24 hour average) from construction activities at the northern portal worksite is presented in **Figure 15-12**. PM_{10} concentrations have the potential to exceed the EPP (Air) objective of 50 µg/m^3 in parkland and community areas immediately to the south-east of the worksite.

However, PM_{10} concentrations are expected to be usually below the objective in all residential, education and commercial premises in the locality of this worksite. The predicted dust concentrations are the maximum concentrations expected during construction with greatest potential for air quality impacts at this worksite, ie excavation of the shaft and trough for approximately 10 weeks.

The predicted dust deposition rates at the northern portal worksite have the potential to exceed the air quality guideline of 120 mg/m^2/day in a section of Victoria Park immediately to the south-east of the worksite (refer to **Figure 15-13**). The annual average TSP concentrations meet the air quality objective in the EPP (Air). TSP concentrations (24 hour) have the potential to exceed the dust nuisance goal of 80 $\mu g/m^3$ to the southeast of the worksite (refer to **Figure 15-14**).

Woolloongabba

A contour plot of increases in maximum PM_{10} concentrations (24 hour average) from construction activities at the Woolloongabba worksite is presented in **Figure 15-15**. The results show that PM_{10} concentrations have the potential to exceed the air quality objective of 50 $\mu g/m^3$ in the EPP (Air) at residential areas to the north and south of the worksite. The predicted dust concentrations are the maximum concentrations expected during construction with greatest potential for air quality impacts, ie open excavation for approximately 8 weeks.

The predicted dust deposition rate at residential areas to the north of the worksite has the potential to exceed the nuisance guideline of 120 mg/m^2/day (refer to **Figure 15-16**). The annual average TSP concentrations meet the air quality objective in the EPP (Air). TSP concentrations (24 hour) may exceed the dust nuisance goal of 80 $\mu g/m^3$ to the north and south of the worksite (refer to **Figure 15-17**).

Boggo Road Station

A contour plot of increases in maximum PM_{10} concentrations (24 hour average) at the Boggo Road Station worksite is presented in **Figure 15-18**. PM_{10} concentrations have the potential to exceed the EPP (Air) objective of 50 $\mu g/m^3$ at Dutton Park Primary School and the Ecosciences Precinct. PM_{10} concentrations at the proposed location for the Leukemia Foundation are predicted to comply with the air quality objectives in the EPP (Air). The predicted dust concentrations are the maximum concentrations expected during the construction works with greatest potential for air quality impacts, ie open excavation through centre of the worksite for approximately 7 weeks.

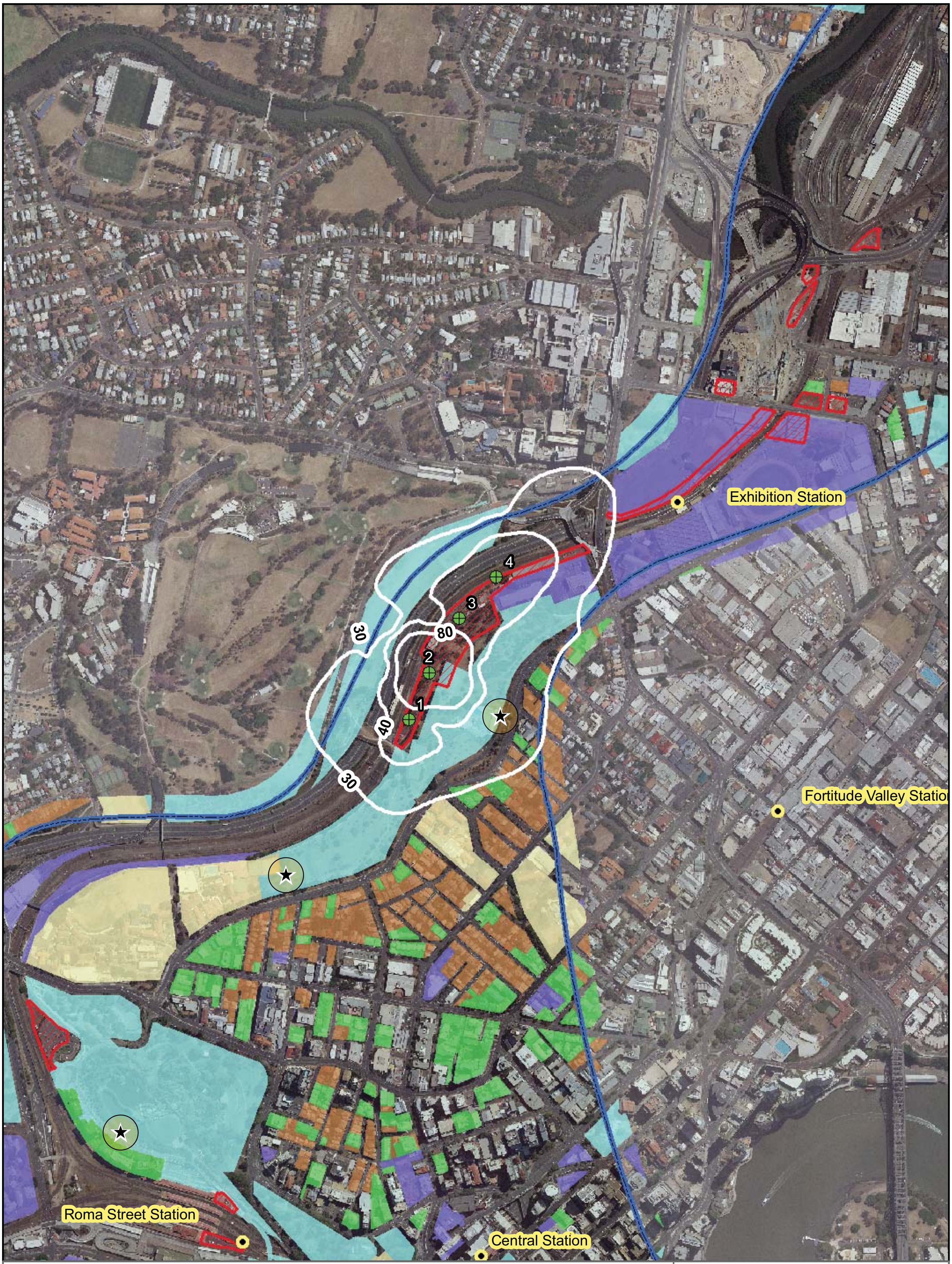
The predicted dust deposition rate has the potential to exceed the guideline of 120 mg/m^2/day at Dutton Park Primary School, the Ecosciences Precinct and at residential areas south of the worksite (refer to **Figure 15-19**).

The annual average TSP concentrations meet the air quality objective in the EPP (Air). TSP concentrations (24 hour average) have the potential to exceed the dust nuisance goal of 80 $\mu g/m^3$ at Dutton Park Primary School and the Ecosciences Precinct (refer to **Figure 15-20**).

Yeerongpilly Station and southern portal

A contour plot of increases in maximum PM_{10} concentrations (24 hour average) at the Yeerongpilly worksite is presented in **Figure 15-21**. Based on these results, PM_{10} concentrations have the potential to exceed the air quality objective of 50 $\mu g/m^3$ in the EPP (Air) at residential areas to the east and north-west of the worksite. The predicted dust concentrations are the maximum concentrations expected during the construction works with greatest potential for air quality impacts, ie excavation in open trough for approximately 10 weeks. The predicted dust deposition rate exceeds the nuisance guideline of 120 mg/m^2/day at residential areas to the east and north-west of the worksite (refer to **Figure 15-22**).

The annual average TSP concentrations meet the air quality objective in the EPP (Air). TSP concentrations (24 hour) have the potential to exceed the dust nuisance goal of 80 $\mu g/m^3$ at residential areas to the east and north-west of the worksite (refer to **Figure 15-23**).



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation
- Indicative Construction Monitoring Points

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-12

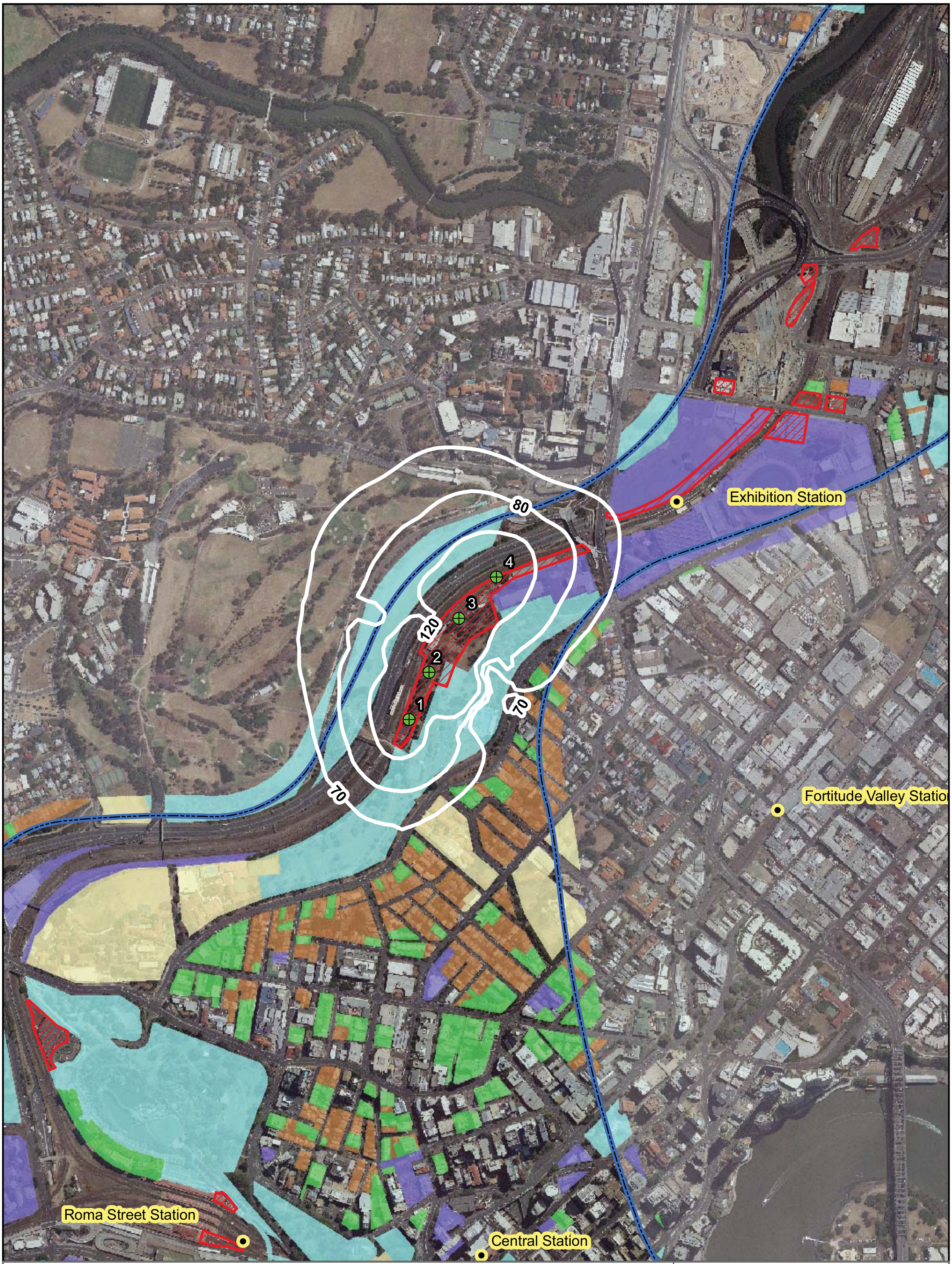
Maximum cumulative PM_{10} concentrations (24 hour average) for Northern Portal (including background of 19 µg/m^3)

0 100 200 300 400 m
1:12,000 at A4
N

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_12_AQ_Pm10_NorthPortal.mxd 08/07/2011 12:33



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-13

Monthly maximum cumulative Dust Deposition rates for Northern Portal (including background of 60 mg/m^2/day)

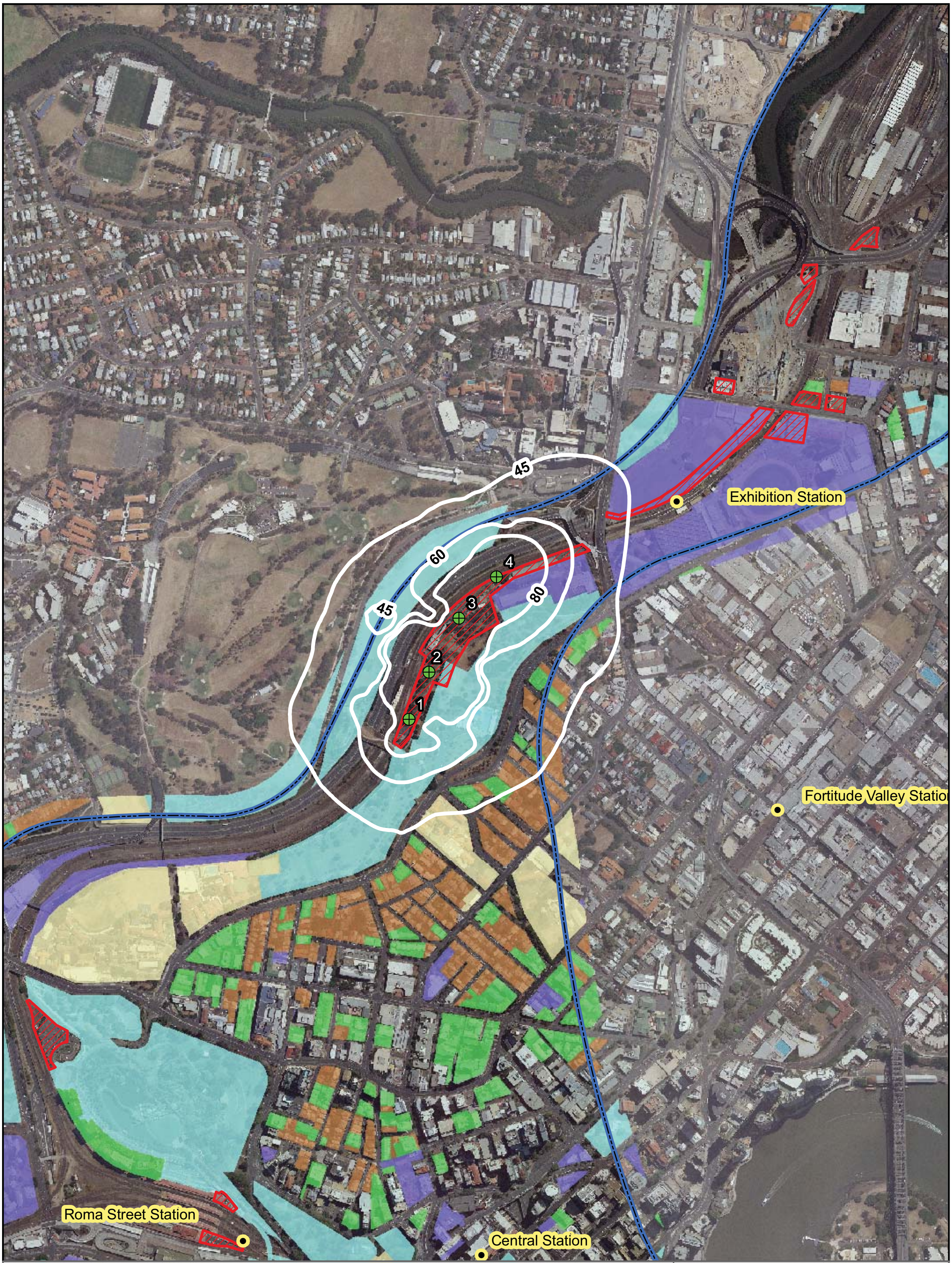
0 100 200 300 400 m

1:12,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_13_AQ_TSP_Deposition_NorthPortal.mxd 08/07/2011 12:34



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-14

Maximum cumulative TSP concentrations (24 hour average) for Northern Portal (including background of 29 µg/m^3)

0 100 200 300 400 m

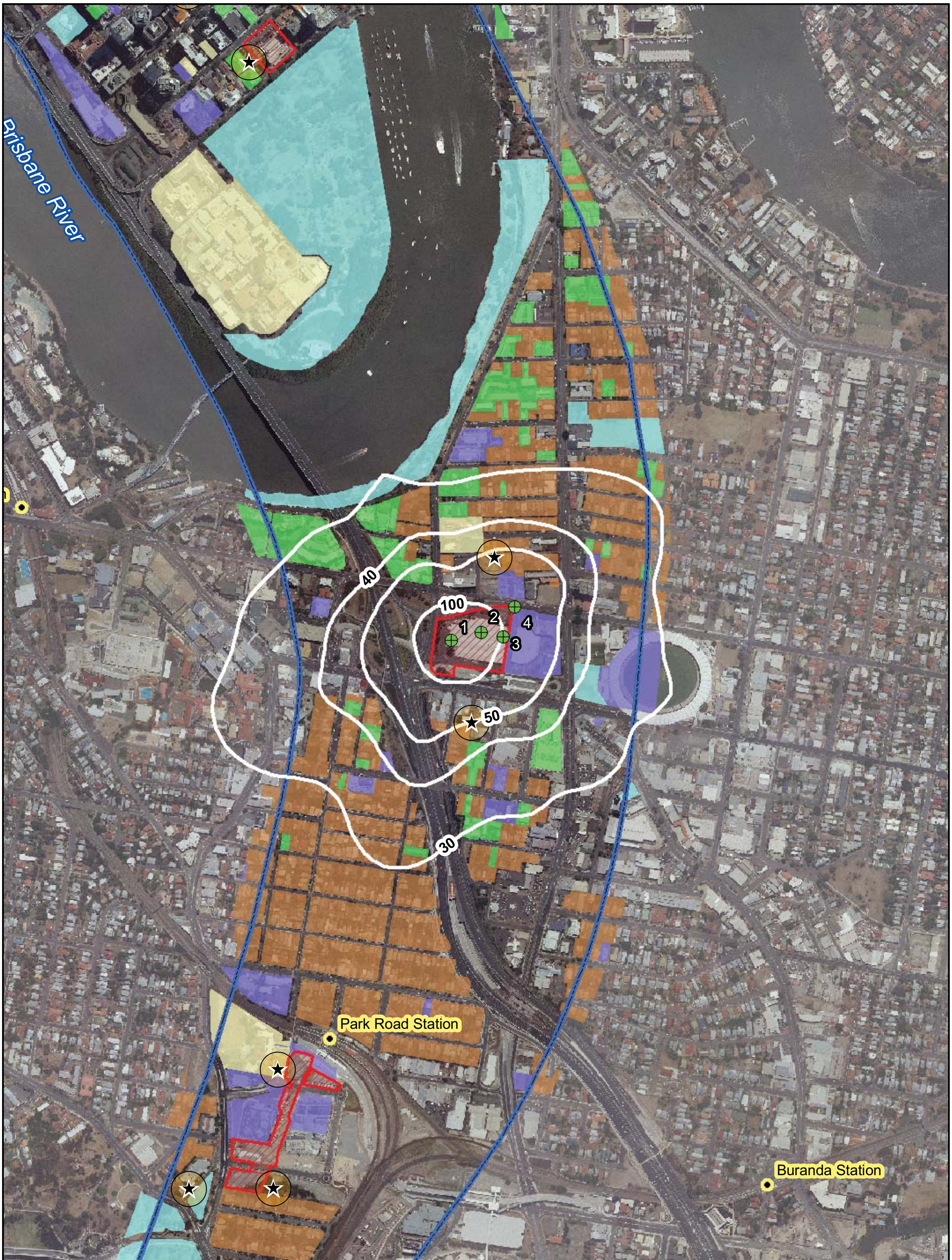
1:12,000 at A4

N

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_14_AQ_TSP_24hr_NorthPortal.mxd 08/07/2011 12:34



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation
- Indicative Construction Monitoring Points

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-15

Maximum cumulative PM10 concentrations (24 hour average) for Woolloongabba (including background of 19 μg/m^3)

0 100 200 300 400 m

1:12,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_15_AQ_Pm10_Woolloongabba.mxd 08/07/2011 12:35

LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-16

Monthly maximum cumulative Dust Deposition rates for Woolloogabba (including background of 60 mg/m^2/day)

0 100 200 300 400 m

1:12,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_16_AQ_TSP_Depsotion_Woolloongabba.mxd 08/07/2011 12:36

LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-17

Maximum cumulative TSP concentrations (24 hour average) for Woolloongabba (including background of 29 µg/m^3)

0 100 200 300 400 m

1:12,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_17_AQ_TSP_24hr_Woolloongabba.mxd 08/07/2011 12:36

LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation
- Indicative Construction Monitoring Points

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-18

Maximum cumulative PM_{10} concentrations (24 hour average) for Boggo Road (including background of 19 µg/m^3)

0 50 100 150 200 m

1:6,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_18_AQ_Pm10_Boggo_Rd.mxd 08/07/2011 12:37

LEGEND
- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-19

Monthly maximum cumulative Dust Deposition rates for Boggo Road (including background of 60 mg/m^2/day)

0 50 100 150 200 m

1:6,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_19_AQ_TSP_Deposition_Boggo_Rd.mxd 08/07/2011 12:37

LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-20

Maximum cumulative TSP concentrations (24 hour average) for Boggo Road (including background of 29 µg/m³)

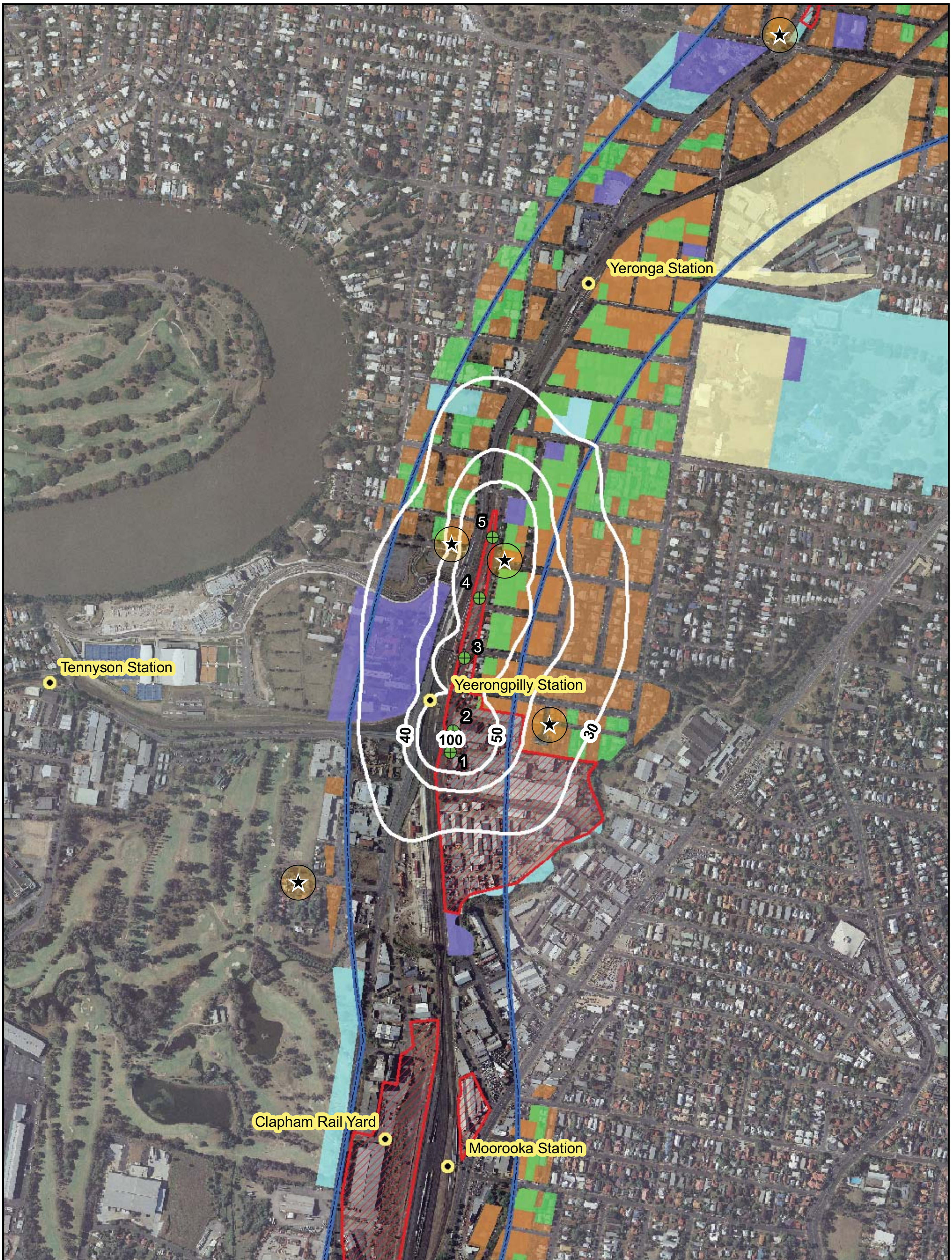
0 50 100 150 200 m

1:6,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_20_AQ_TSP_24hr_Boggo_Rd.mxd 08/07/2011 12:38



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation
- Indicative Construction Monitoring Points

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-21

Maximum cumulative PM_{10} concentrations (24 hour average) for Yeerongpilly (including background of 19 µg/m^3)

0 100 200 300 400 m

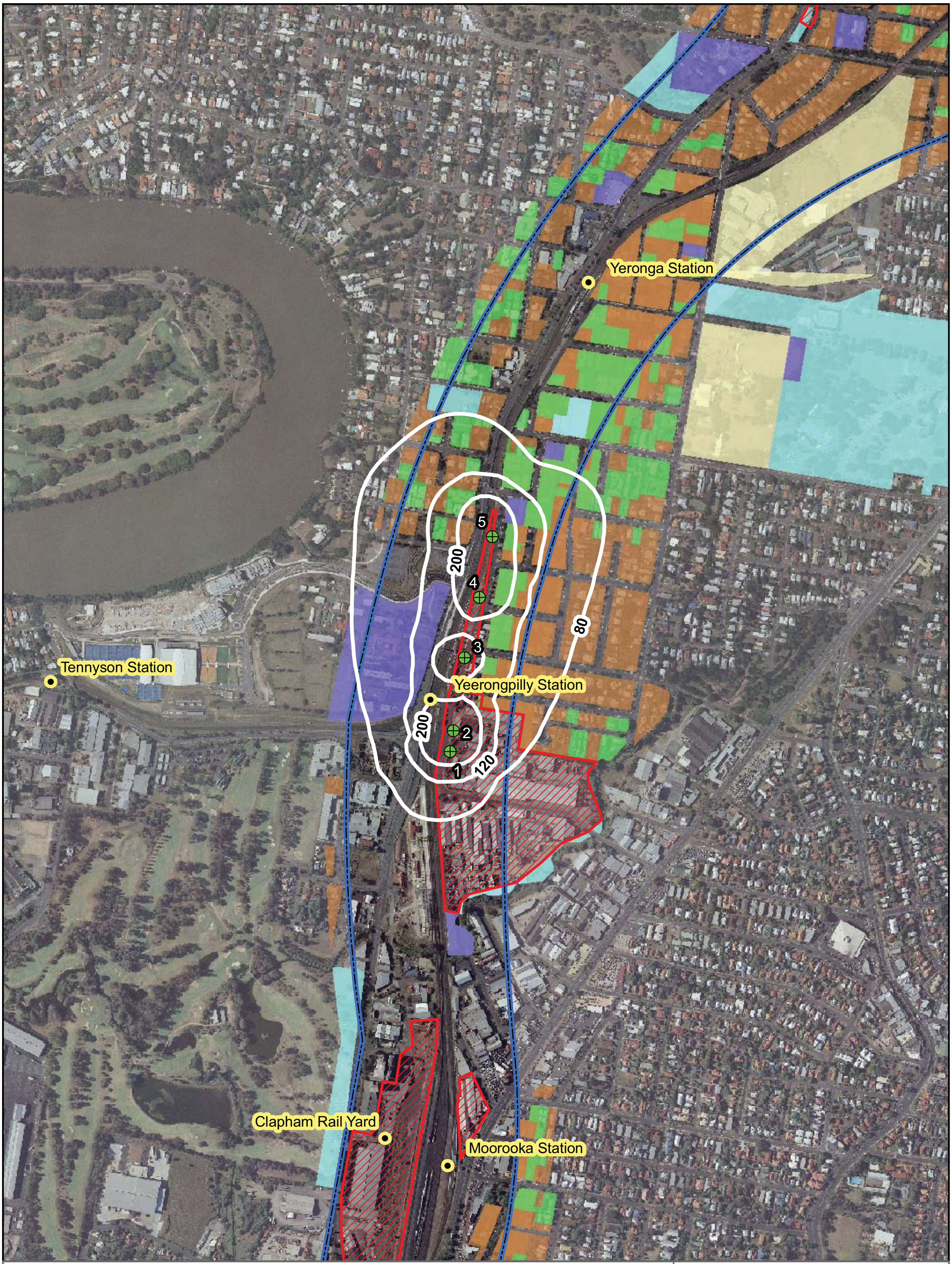
1:12,000 at A4

N

CrossRiverRail

SKM aurecon
CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_21_AQ_Pm10_Yeerongpilly.mxd 08/07/2011 12:42



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-22

Monthly maximum cumulative Dust Deposition rates for Yeerongpilly (including background of 60 mg/m^2/day)

0 100 200 300 400 m

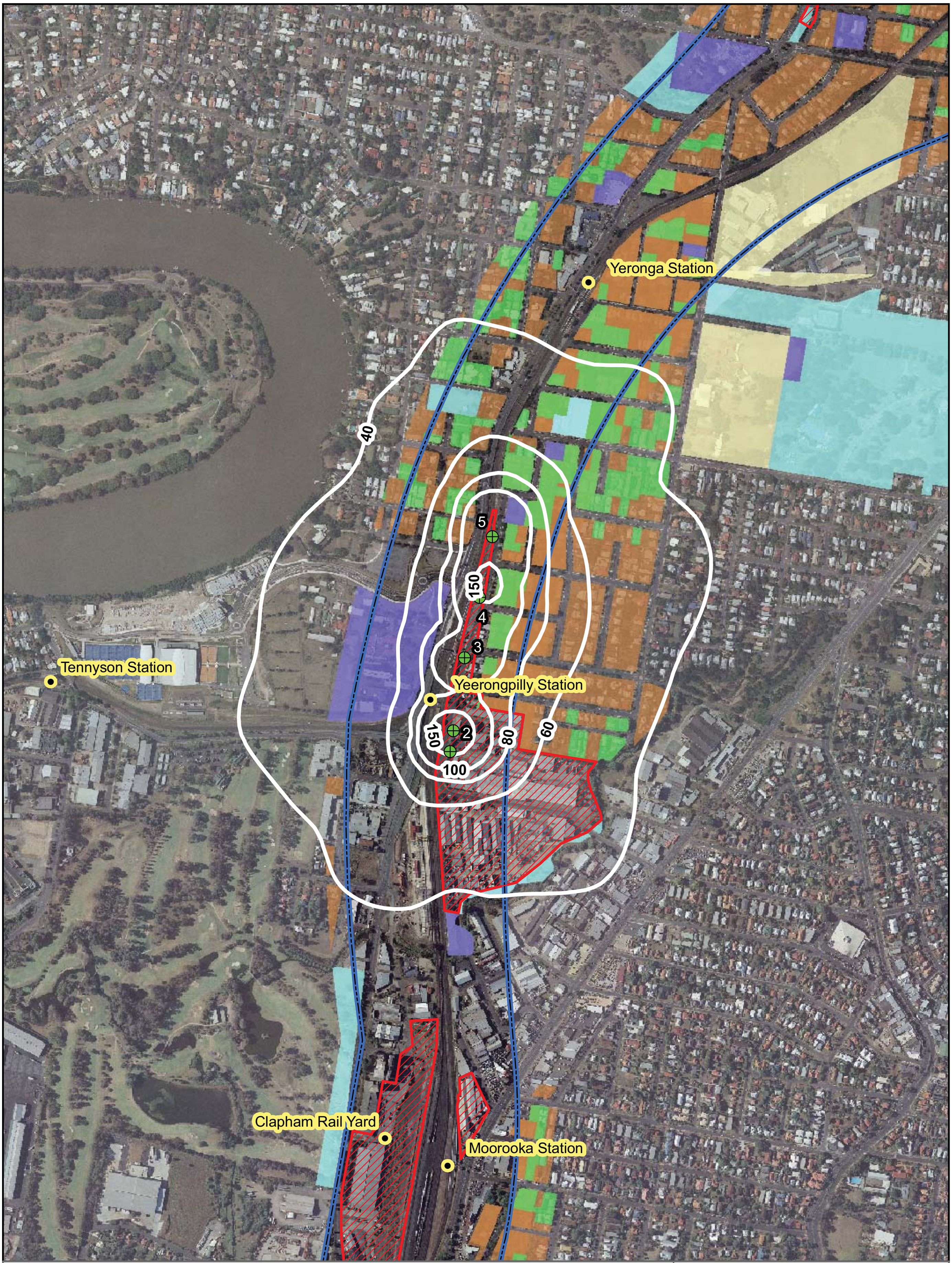
1:12,000 at A4

N

CrossRiverRail

SKM aurecon
CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_22_AQ_TSP_Deposition_Yeerongpilly.mxd 08/07/2011 12:39



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-23

Maximum cumulative TSP concentrations (24 hour average) for Yeerongpilly (including background of 29 μg/m^3)

0 100 200 300 400 m

1:12,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_23_AQ_TSP_24hr_Yeerongpilly.mxd 08/07/2011 12:40

Clapham Rail Yard

A contour plot of increases in maximum PM_{10} concentrations (24 hour average) from the Clapham Rail Yard worksite is presented in **Figure 15-24**. The predicted PM_{10} concentrations during construction activities with the greatest potential for air quality impacts, ie earthworks over approximately 36 weeks, subject to rail operations requirements and safety constraints, comply with the air quality objective of 50 µg/m^3 in the EPP (Air).

The predicted dust deposition rates at sensitive receptors are likely to be within the guideline level of 120 mg/m^2/day (refer to **Figure 15-25**) at parkland to the northwest of the worksite.

The annual average TSP concentrations meet the air quality objective in the EPP (Air). TSP concentrations (24 hour) are predicted to exceed the dust nuisance goal of 80 µg/m^3 at parkland to the northwest of the worksite (refer to **Figure 15-26**).

Human health risk

Exposure to ambient air pollution has been linked to a number of health impacts mainly related to the respiratory tract and pulmonary functions. The ambient air quality goals established in the EPP (Air) have been set to protect human health and wellbeing.

Particles generated through construction works, such as excavation and materials handling are predominantly due to the crushing or abrasion of rock and most of the emissions will be larger than $PM_{2.5}$ (ultra-fine particles), which are of most concern in terms of health impacts. This has been studied extensively in the mining industry. A 1986 study by the State Pollution Control Commission (SPCC) concluded that in the mining areas of the Hunter Valley, NSW where particulate emissions are dominated by excavation of materials (similar to construction) $PM_{2.5}$ was less than 5% of total dust (TSP) emissions (SPCC 1986).

The predicted TSP and PM_{10} concentrations during construction are generally below the ambient air quality goals in the EPP (Air). During peak construction periods the predicted PM_{10} concentrations exceed the ambient air quality goal of 50 µg/m^3 (24 hour average) at sensitive receptors in close proximity to some of the worksites. Given the short duration of the peaks in construction activities (up to 10 weeks in duration) and background monitoring data in Brisbane recording regular exceedances of the 24 hour PM_{10} ambient air quality goal, the potential for an increase in human health risk due to the construction of the Project at nearby sensitive receptors is considered to be low.

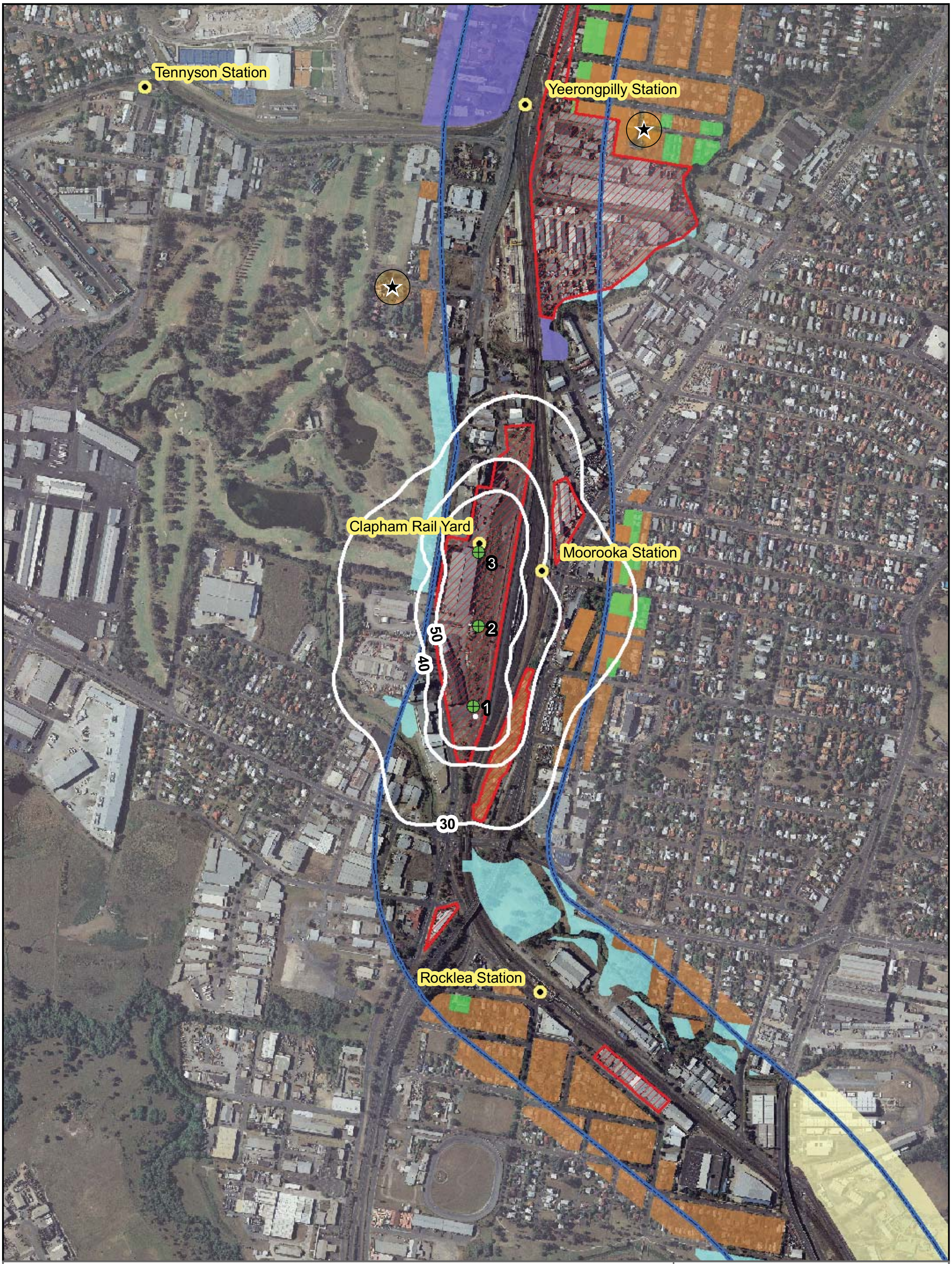
15.4.5 Mitigation measures for construction

The following section identifies mitigation measures which have been regularly and successfully applied to similar large scale construction projects in order to minimise the potential for nuisance dust impacts during construction.

Management measures for dust nuisance impacts

To minimise the possibility of complaints from construction activities, a system would be established as part of the Environmental Management Plan (EMP) that addresses the following (refer to **Chapter 24 Draft Outline EMP**):

- effective management of dust generation
- effective monitoring of impacts
- effective communication with the local community on issues associated with construction activities
- a clearly identified point of contact should the community have comments or complaints
- a well defined process to ensure that any issues are dealt with promptly and to a satisfactory level
- a well defined system of recording any incidents or complaints.



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation
- Indicative Construction Monitoring Points

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-24

Maximum cumulative PM_{10} concentrations (24 hour average) for Clapham Rail Yard (including background of 19 µg/m^3)

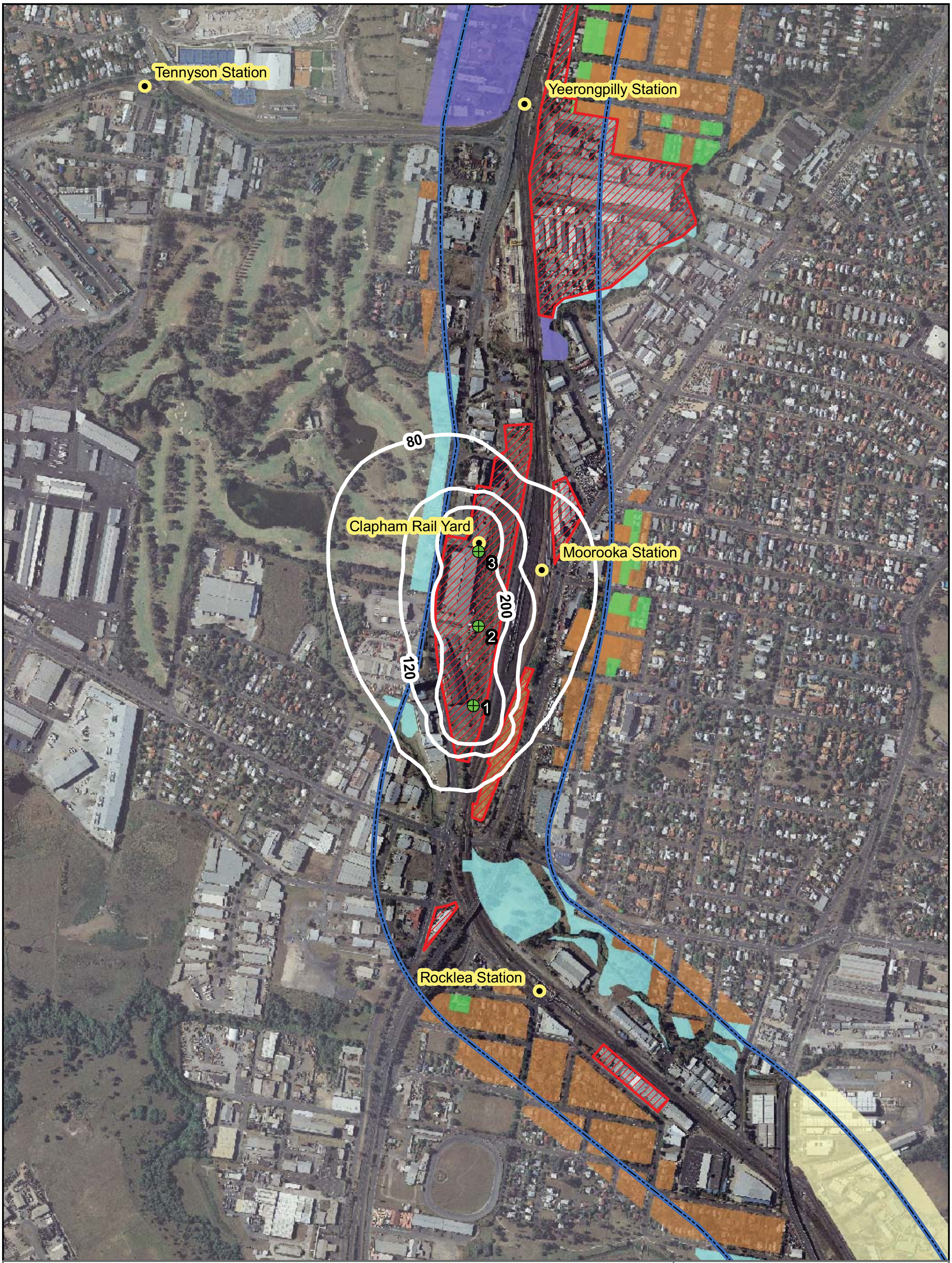
0 100 200 300 400 m

1:12,000 at A4

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_24_AQ_Pm10_Clapham.mxd 08/07/2011 12:40



LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-25

Monthly maximum cumulative Dust Deposition rates for Clapham Rail Yard (including background of 60 mg/m^2/day)

0 100 200 300 400 m

1:12,000 at A4

N

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_25_AQ_TSP_Deposition_Clapham.mxd 08/07/2011 12:41

LEGEND

- Study Corridor
- Station
- Track
- Sources
- Worksites
- Community
- Detached Dwelling
- Education
- Multiple Unit Dwelling
- Open Space, Parks & Recreation

CROSS RIVER RAIL
ENVIRONMENTAL IMPACT STATEMENT

Figure 15-26

Maximum cumulative TSP concentrations (24 hour average) for Clapham Rail Yard (including background of 29 μg/m^3)

0 100 200 300 400 m

1:12,000 at A4

N

CrossRiverRail

SKM aurecon CRR JOINT VENTURE

K:\Cross River Rail\600 Environment\619 GIS\SKM\Spatial\ArcGIS\Air_Quality\20110602_Report_Figures\Fig_15_26_AQ_TSP_24hr_Clapham.mxd 08/07/2011 12:41

The requirements for monitoring particulates adjacent to the main worksites is included in **Chapter 24 Draft Outline EMP**. Management measures which would be implemented at all worksites as part of the EMP are outlined in **Chapter 24 Draft Outline EMP** and include:

- monitoring meteorological conditions at worksites and spoil placement sites, particularly wind speed and direction and where necessary take measures to avoid impacts of dust or odour on adjacent properties
- conducting demolition activities using appropriate dust controls, such as water sprays
- handling excavated spoil within enclosed worksheds, where possible. Worksheds would cover the excavated areas and would allow access and egress of trucks and truck loading operations and stockpiling of excavated tunnel material
- installing truck wheel wash stations in worksites where space allows
- where space constraints do not allow for the implementation of wheel wash stations, for example the ventilation shaft and emergency access building, Roma Street and Albert Street north worksites, additional washing and sweeping of road spaces would be implemented
- providing adequate ventilation during underground construction works. Dust collected from the filtration system would be disposed of appropriately
- covering trucks transporting excavated material, to minimise wind blown dust during transport
- cleaning down loaded trucks prior to exiting worksites, to ensure loose material is not tracked onto the adjacent road network
- ensuring sealed access roads into worksites are kept relatively dust free by regular sweeping and washing, wherever needed.

Mitigation for workers exposed to contaminated land during construction is described in **Chapter 8 Land Contamination** and includes measures to limit the exposure of workers to potential contaminants in soil and/or water, for example through the wearing of personal protective equipment and the control of dust during construction.

Management measures for odour impacts

Reasonable and practicable measures to address the potential impact of odour on adjacent properties would be implemented as part of the EMP. These include:

- identifying and determining the potential for odour impacts at off-site sensitive receptors
- conducting works with odorous soils when wind directions are unlikely to affect sensitive receptors
- covering odorous, excavated soil stockpiled either on a worksite or a spoil placement site to reduce odour impacts.

Management measures for diesel exhaust emissions

The effects of diesel exhaust emissions would be minimised by the following measures:

- avoiding queuing of the construction traffic vehicle fleet in the streets adjacent to the worksites which would in turn minimise the amount of exhaust emissions generated during the construction works
- marshalling and queuing for trucks and worksite vehicles away from residential areas and other sensitive receptors, where possible
- directing exhaust emissions from mobile and stationary plant away from the ground and sensitive receptors, where possible
- minimising the use and intensity of use of diesel engines

- for stationary plant and equipment, ensuring all diesel motors are fitted with emission control measures and are regularly maintained to manufacturers' specifications.

Adjacent development projects

There are a number of locations where construction works for adjacent development projects could coincide with Project construction, for example the redevelopment of RNA Showgrounds, sites within the Brisbane CBD and Bowen Hills Urban Development Area. Adjacent developments have the potential to cause cumulative impacts on air quality from the excavation and movement of spoil and operation of construction equipment. Dust control measures would be required for these worksites and to avoid or minimise the potential for a cumulative increase in dust nuisance.

Monitoring of dust emissions for the Project and nearby development projects would be required, with regular reporting on changes in air quality at nearby sensitive receptors (refer to **Chapter 23 Cumulative Impacts**). A coordinated approach to managing the potential for cumulative construction impacts, for example construction dust and vehicle emissions, will be needed.

15.4.6 Air quality monitoring during construction

Regular monitoring of TSP, PM_{10} and dust deposition levels at the nearest sensitive receptors adjacent to worksites and locations representative of the work space would provide a basis for compliance with appropriate criteria. Monitoring requirements are outlined in **Chapter 24 Draft Outline EMP**.

Indicative dust monitoring locations around the main worksites are shown in **Figure 15-12, Figure 15-15, Figure 15-18, Figure 15-21** and in Appendix 3 of *Technical Report No 7 – Air Quality and Greenhouse Gas Assessment*. Descriptions of proposed dust monitoring locations are provided in **Table 15-19**.

Table 15-19 Indicative dust monitoring locations

Worksite (refer to Figure 15-12, Figure 15-15, Figure 15-18, Figure 15-21)	Indicative Dust Monitoring Locations
Northern portal	• Victoria Park, adjacent to Brisbane Girls Grammar School • Gregory Terrace, adjacent to Centenary Aquatic Centre
Roma Street	• Adjacent to apartment complex, Roma Street Parkland
Albert Street	• Albert Street, western side opposite southern shaft, at 3rd floor level • Albert Street, western side opposite northern shaft, at street level
Woolloongabba	• Transport and Main Roads (TMR)/DERM monitoring station (existing) • Reid Street, adjacent to Chalk Hotel car parking
Boggo Road	• Dutton Park State School, adjacent boundary to worksite • Maldon Street, adjacent to Multiple Sclerosis headquarters • Rawnsley Street, at selected residence
Ventilation shaft	• Fairfield Road, western side north of Venner Road, at selected residence • Railway Parade, north of Bledisloe Street, at selected residence
Yeerongpilly Station and southern portal	• Crichton Street, east of realignment of Wilkie Street, at selected residence • Olive Street, at selected residence • Bow Street – Park Lane residential area, at selected residence • Allawah Street, near Palomar Road, at selected residence
Swanbank spoil site	• If required, off Cummer Road

Olfactory (smell) inspections for potential odour generating activities would be conducted on a daily basis.

Monthly reporting on the findings of the air quality monitoring program and results of odour monitoring would be carried out by site personnel. Further details are provided in **Chapter 24 Draft Outline EMP**.

15.4.7 Summary

This section has provided an assessment of potential air quality impacts during construction. The key findings show that predicted TSP and PM_{10} concentrations are generally below the ambient air quality goals in the EPP (Air). However, when ambient PM_{10} concentrations are added to Project concentrations, there is the potential for exceedances of the PM_{10} goal for a very small number of sensitive receptors.

Mitigation measures are proposed for managing potential dust and odour nuisance, including the establishment of monitoring, communication and complaints systems. Further details are provided in **Chapter 24 Draft Outline EMP**. With mitigation measures in place during the construction phase, the residual effects of construction related dust are predicted to be low over the short term.

15.5 Operation phase air quality impacts

15.5.1 Introduction

This section provides an assessment of potential air quality impacts during operation of the Project. The approach to this assessment was to:

- identify the sources of air emissions during operation
- examine the key factors that influence emissions from identified sources
- evaluate the likely changes to emission sources due to the Project
- relate the likely changes in emission sources to potential air quality impacts at local and regional scales, taking account of existing background levels and relevant air quality objectives
- outline appropriate mitigation measures to ensure air quality objectives are not exceeded.

15.5.2 Sources of air emissions

The Project would influence three key air emission sources, as follows:

- motor vehicles
- trains and railways
- tunnel and station ventilation.

Motor vehicles

The Project would result in changes to motor vehicle use and emissions at both local (near train stations) and regional scales. These changes would arise from changes to the availability and access to rail services.

Air emissions from motor vehicles vary depending on a number of factors. The main influences on air emissions from traffic include the type of vehicles comprising the fleet, the age of the vehicles, speed of traffic flow and the road gradient. In general, congested roads with numerous intersections (requiring stop start conditions) would generate higher emissions than a free flowing road with no intersections. Roads with a higher percentage of heavy vehicles typically generate higher emissions. For some air pollutants, such as carbon monoxide, higher vehicle speeds generally result in lower emissions, due to more complete combustion. However, oxides of nitrogen emissions generally increase with speed.

Trains and railways

The Project would influence train movements in the Brisbane area, including suburban and interurban passenger trains and diesel powered freight and coal trains (refer to **Chapter 5 Transport**).

Brisbane's suburban and interurban passenger trains are comprised of Electric Multiple Units (EMUs) powered by electricity supplied from the grid by overhead wires. No direct emissions are associated with the EMUs, however indirect emissions are caused by the off-site generation of electricity.

Freight and coal trains operating within the Brisbane area are diesel-electric 2300 Series locomotives. These locomotives use diesel fuelled electricity generators to power traction engines. Emissions from diesel-electric locomotives are similar to emissions from other diesel fuelled vehicles, consisting predominantly of CO, Volatile Organic Compounds (VOC's) and NO_x.

Tunnel and station ventilation

Minor quantities of particulate matter emissions would be generated in underground tunnels, mainly due to train brake pad wear, vaporisation of metals due to sparking, wear of steel due to friction between wheels and rail, and recirculation of particulates from tunnel walls. Most of these emissions would be exhausted out ventilation shafts in very low concentrations, well below all air quality standards. Vented air is likely to comprise minor concentrations of CO_2, VOCs and NO_x as well as ash and soot particulates.

During events such as station or train fires, tunnel and station ventilation systems would be used to exhaust the air to the surface.

15.5.3 Regional effects of motor vehicles

Changes to motor vehicle use have the potential to affect air quality on a regional scale. Network traffic statistics for South East Queensland have been estimated and used to predict the change in emissions with, and without, the Project.

Table 15-20 shows the estimates of daily Vehicle Kilometres Travelled (VKT) with and without the Project (further details are provided in **Chapter 5 Transport**). Overall, this data shows that the Project would result in a 0.4% decrease in VKT in 2021 and a 0.9% decrease in VKT in 2031. The VKT are generally predicted to decrease for both modes of travel, except in 2031 where a slight increase in VKT is predicted for highway traffic with the Project. Overall, the Project is predicted to provide a 2 million VKT reduction per day in urban traffic by 2031.

Table 15-20 Network traffic statistics with and without the Project

Mode of travel	Daily (24 hour) vehicle kilometres travelled			
	2021		2031	
	With Project	Without Project	With Project	Without Project
Urban	29,613,808	29,830,844	39,645,335	41,599,168
Highway	40,849,822	40,928,773	48,220,090	47,031,197
Total	**70,463,629**	**70,759,617**	**87,865,425**	**88,630,365**

The network traffic statistics and derived exhaust emission factors have been used to estimate total vehicle emissions for South East Queensland. Emission rates from vehicles were estimated from the Transport and Main Roads Emission Factor Calculator v1.1, and the calculations assumed no grade correction, no seasonal correction and 8% overall heavy vehicles.

Details of the network emission estimation calculations for 2021 and 2031 are provided in *Technical Report No.7 – Air Quality and Greenhouse Gas Assessment*. The calculations show that emissions of all identified pollutants would be approximately 0.4% lower with the Project in 2021, compared to the scenario without the Project. By 2031, it is estimated that emissions of all pollutants would be approximately 0.8% lower compared to the without Project scenario.

As detailed in **Chapter 5 Transport,** although only small percentage changes in road network volumes and performance on a typical weekday are forecast with the Project in operation in the Brisbane metropolitan area, overall cumulative benefits are significant. By 2031, the reduction in private vehicle use associated with the Project (compared to without the Project) is forecast to reach 275 million vehicle kilometres per annum. A comparison of total vehicle trips (average weekday) in the Brisbane metropolitan area shows that there would be almost 30,000 fewer road vehicle trips on the network with the Project in operation, compared to the scenario without the Project in 2031.

Changes to motor vehicle use within the study corridor

Traffic volumes crossing selected major links and the CBD cordon within and surrounding the study corridor are examined in **Chapter 5 Transport.** Two way traffic volumes in the morning peak period would be less with the Project than without the Project. The reduction in vehicle trips and corresponding reductions in road vehicle emissions across the CBD cordon is predicted to be 2,300 vehicles by 2031 during the morning peak period. Changes in road traffic volumes in the morning peak period for specific state controlled road links were also examined. A small reduction in road traffic volumes on state controlled roads in, and immediately surrounding the study corridor in the morning peak period is forecast. This reduction in traffic would produce localised air quality benefits on the affected roadways.

15.5.4 Regional effects of train movements

The Project would facilitate an increase in train movements on Brisbane's rail network. Depending on the type of trains and the travel routes, there is the potential for an increase in regional emissions. Projected train movements with and without the Project have been examined to assess the potential change in air emissions due to increased train movements.

Table 15-21 shows projected weekly train movements with and without the Project, and split by rail line and train type (further details are provided in **Chapter 5 Transport)**. The train types include electric and diesel-electric units.

Table 15-21 Predicted train volumes per week

	Trains per week (both directions)		
	Demand	**Without Project**	**With Project**
2021			
North Coast (E)	264	264	264
Salisbury – Tennyson (E)	172	24	172
Tennyson – Port (IM)	78	3	78
Tennyson – Port (Coal)	197	197	197
2031			
North Coast (E)	322	16	322
Salisbury – Tennyson (E)	209	24	209
Tennyson – Port (IM)	94	3	94
Tennyson – Port (Coal)	232	198	232

Source*:* Systemwide*,* 2010

Note: E = Electric, IM = Intermodal (freight)

As noted in **Section 15.5.2**, there are no significant direct emissions to air associated with electric trains. Minor particulate matter emissions arise from brake pad wear, vaporisation of metals and friction between the wheels and rails.

Coal trains would have the highest potential to cause adverse air quality impacts compared with the suburban passenger, interurban passenger and freight trains. The majority of particulate matter emissions from coal trains are due to erosion of the top of the coal in the wagons. The emissions are generally in the PM_{10} size range. Surface erosion usually results from the movement of air across the load surface, which is influenced by the speed of the train and local wind conditions. Other contributing factors are the coal type and moisture content, train vibration and the profile of the coal load in the wagon.

There are various measures to minimise particulate emissions from coal trains. Typically, these measures include profiling the coal load in the wagon to reduce exposure to wind, and spraying the surface of loaded coal wagons with a polymer sealant after loading to prevent dust lift off.

In 2021, the 'without Project' scenario would cater for train demand on the North Coast line and coal trains travelling from Tennyson to the Port of Brisbane. It would not be able to meet the predicted demand of electric trains travelling from Salisbury to Tennyson, and freight trains travelling from Tennyson to the Port. Under the 'with Project' scenario, the demand would be satisfied, significantly increasing electric train movements from Salisbury to Tennyson and freight movements from Tennyson to the Port by 148 and 75 trains per week respectively. Coal train volumes would remain the same.

By 2031, the 'without Project' scenario would see the volume of freight trains per week decrease due to constraints on rail capacity by the increase in passenger trains. At the same time, demand on all lines would be increased. The 'with Project' scenario would meet the demand, allowing an increase of trains on all lines. Coal trains are predicted to increase by 34 trains per week.

Table 15-22 quantifies the relative contribution of rail emissions to 'other mobile sources', as well as all sources in South East Queensland (EPA 2003). Current rail emissions as a percentage of all sources emissions have then been derived for NO_x, PM_{10} and VOCs. From this analysis, it is clear that rail emissions are a small contributor to total emissions in South East Queensland. Therefore, the predicted changes to train movements due to the Project are unlikely to affect regional air quality. GHG emissions are presented in **Section 15.6.**

Table 15-22 Percentage contribution of rail emissions to South East Queensland emissions

	NO_x	PM_{10}	VOC
Rail emissions as a percentage of "other mobile sources"	6.3%	1.7%	0.5%
Emissions from "other mobile sources" as a percentage of all sources	9.3%	3.5%	1.5%
Rail emissions as a percentage of all sources	0.6%	0.1%	0.01%

Source*:* EPA *(*2003*)*

15.5.5 Underground rail stations

A review of literature relating to air quality in underground rail stations was conducted. Various studies of subway systems around the world show that concentrations of dust, both $PM_{2.5}$ and PM_{10}, CO and CO_2 in underground railstations are generally higher than the aboveground ambient air quality (Johansson and Johansson 2003, Aarnio et al. 2005, Invernizzi et al. 2008).

In a study of an underground station in Stockholm, Johansson and Johansson (2003) found that the concentrations of PM_{10} and $PM_{2.5}$ closely followed train traffic intensity with consistently high levels during week days and slight decreases on weekends. Similarly, a study in Seoul by Kwon et al (2008) found that levels of CO_2 can be linearly correlated with the number of passengers using the station.

Across the studies reviewed, subway dust was found to include iron oxide, copper, zinc, manganese, chromium and VOCs. $PM_{2.5}$ dust sampled in the London Underground consisted of approximately 67% iron oxide from wheels and rails, approximately 1-2% quartz from ceramic brake pads, traces of other materials and the remainder consisting of volatile matter (Seaton et al 2005).

A study by Grass et al (2010) conducted in the subway system of New York City found that concentrations of steel composites, such as iron, manganese and chromium in subway air were significantly higher than the aboveground ambient air. The toxicology results of subway workers with high exposure to subway air were compared with bus drivers and suburban office workers found no significant increase in health impacts. A similar study in Stockholm (Gustavsson et al. 2008) examined the incidence of lung cancer as a result of exposure to subway air particles, but did not find any discernible variation.

The typical particulate matter concentrations in underground rail tunnels, from the studies reviewed above, were as follows:

- average PM_{10} and $PM_{2.5}$ concentrations on platforms in Seoul, Korea of 129±21 µg/m^3 and 105±14 µg/m^3 respectively (Kwon et al 2008)
- average, weekday, daytime PM_{10} concentrations of up to around 470 µg/m^3 and corresponding average $PM_{2.5}$ concentrations of up to around 260 µg/m^3 (Johansson and Johansson 2003).

The above data cannot be directly correlated with the EPP (Air) objectives, due to differing averaging times and measurement circumstances, although the data provides an indication of the maximum particulate levels that might be experienced in underground rail stations. The diverse range of particulate matter concentration is likely to be the result of differing local circumstances. This includes differences in aboveground ambient air quality, materials used (track, wheel and brake), station ventilation performance, the frequency of train movements, the number of passengers using the platform and the presence of platform screen doors. However, these studies highlight the potential for elevated particulate matter concentrations in underground rail tunnels and at stations.

The air quality objectives in the EPP (Air) for particulate matter have been set for the protection of human health, though these objectives are related to ambient air quality. In the absence of relevant indoor air quality standards or objectives, time-weighted average exposure limits for workplaces have been examined to assess the significance of potential in-tunnel concentrations. The time-weighted average is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week.

Time-weighted average exposure limits are presented in **Table 15-23**. The inspirable fraction, comprising airborne particles of dust that can be taken in through the nose or mouth during breathing, is related to airborne particles with equivalent aerodynamic diameters less than approximately 100 microns (similar to TSP). The respirable fraction relates to particles less than approximately 10 microns (or PM_{10}).

Table 15-23 Relevant time weighted average exposure limits

Pollutant	Time-weighted average exposure (8-hour working day, 5-day working week)
Particulate matter – inspirable fraction[1] Inspirable dust is airborne particles of dust that can be taken in through the nose or mouth during breathing.	10 mg/m^3 (or 10,000 µg/m^3)
Particulate matter – respirable fraction[2] Respirable dust is that fraction of inspirable dust composed of fine particles which can reach the lower bronchioles and alveolar regions of the lung.	3 mg/m^3 (or 3,000 µg/m^3)

Notes:
1. *NOHSC exposure limits (NOHSC 1995)*
2. *Value noted by the ACGIH 2005 (American Conference of Industrial Hygienists) has been referenced in absence of specific goals in Australia*

The typical in-tunnel particulate matter concentrations discussed above are below both the inspirable and respirable work place limits shown in **Table 15-23**. This suggests that the health of individuals at underground stations would not be adversely affected. A suitable impact mitigation measure would be to operate the underground rail system such that the time that individuals who occupy stations is minimised to the maximum extent practicable.

Finally, the presence of platform screen doors at underground platforms would physically separate air in the rail corridor from air in the rail stations. Combined with effective station ventilation systems, this barrier is likely to reduce the exposure to users from dusts and other contaminants.

15.5.6 Station ventilation

Air within the tunnel and stations would be exhausted to the surface by ventilation systems at the underground stations and at the ventilation shaft between the Yeerongpilly and Boggo Road stations. Cross sections and long sections of each station and figures showing the ventilation shaft and emergency access building are provided in **Volume 2 Reference design drawings**.

Ventilation at stations would be powered by four 60 m^3/s fans operating out of shafts at each end of the platform. These shafts would draw and exhaust air from louvered inlets on the roof of stations, above the station plaza. The ventilation shaft would use two bi-directional 60 m^3/s fans running in either exhaust or supply mode. Air would be drawn and exhausted from an 8.5 m high ventilation stack located at the ventilation and emergency access building. It is estimated that average velocity of exhaust air would be in the range of 10 – 15 m/s. Contaminants in exhaust air would be similar to station and tunnel air quality, however these are likely to be at lower concentrations, due to the increased volume of air.

The proposed location for the ventilation outlet at Boggo Road Station is sited to the north of the station into the Boggo Road busway. The ventilation outlet would be located approximately 80 m from Dutton Park State School. The ventilation outlet air would contain small quantities of particulates at low concentrations due to the large volumes of exhaust air. Given the low concentrations of particulates, the ventilation system is unlikely to have air quality impacts on the surrounding environment, including Dutton Park State School.

The tunnel ventilation system would draw fresh air through the entrance of the tunnel, pass it through the tunnel, and discharge it through ventilation shafts into the surrounding outdoor air. In the event of an emergency, such as a fire in either the stations or tunnels, fumes would be emitted through the ventilation shafts. The design and location of the ventilation shafts at stations would ensure sensitive receptors were not affected and suitable emergency plans would be in place in these circumstances.

15.5.7 Thermal impacts

The tunnel ventilation system would be designed to prevent the build up of hot air in the tunnel. The system would draw fresh air through the entrance of the tunnel, pass it through the tunnel, and discharge it through ventilation shafts into the surrounding outdoor air. The ventilation shafts would be used to adjust the rate of air flow through the tunnels, and ensure air from the tunnels is well dispersed and diluted into the outdoor air. With continual air flow, there is unlikely to be an increase in in-tunnel temperatures significantly above ambient temperatures. In-tunnel air temperature and thermal comfort would be considered further at the detailed design phase.

15.5.8 Air quality summary

This section has provided an assessment of the potential air quality impacts during Project operations. The key findings of this assessment were as follows:

- predicted changes to motor vehicle use and emissions are unlikely to affect regional air quality
- predicted changes to train movements and emissions are unlikely to affect regional air quality.

During operations, there are not expected to be any potential impacts resulting from dust or emissions in terms of human health. Any dust issues associated with coal train movements would continue to be addressed by QR National.

The potential for air quality impacts from the operation of the Project at a local scale is also expected to be remote. This is due to the proposed design and location/positioning of air vents and car parks and pick up and drop off facilities of the upgraded and/or new rail stations, being separated as much as possible from surrounding sensitive receptors.

Particulate matter concentrations are likely to comply with work place limits. The risk to individuals, both commuters and workers, within the tunnel environment is very low due to design elements including ventilation, station platform screens and doors. In addition to the individual health risks being very low, the standard working shift of approximately 8 hours limits the occupancy time for workers within the tunnel environment.

During operation, minor beneficial residual effects are predicted on air quality over the medium term through reductions in motor vehicle use (in comparison to the Project not proceeding) and GHG emissions, as a result of changed network performance on the South East Queensland road network.

15.6 Greenhouse gas emissions

15.6.1 Introduction

The potential GHG and climate change impacts of the Project have been assessed by:

- estimating the direct and indirect GHG emissions resulting from the construction and operation of the Project
- identifying mitigation measures to reduce GHG emissions.

15.6.2 GHG methodology

A preliminary GHG inventory has been prepared for the construction and operation of the Project in alignment with the requirements of the National Greenhouse and Energy Reporting System. GHG emissions attributable to the Project have been considered in terms of two ‘scopes’ of emission categories:

- Scope 1: direct emissions from sources within the study corridor
- Scope 2: indirect emissions from the generation and consumption of electricity produced outside of the study corridor.

Scope 3 emissions or indirect emissions that are a consequence of the Project but not from sources owned or controlled by the Project have not been estimated for this assessment.

The National Greenhouse Accounts (NGA) Factors (DCCEE 2010b) were used in the preparation of the GHG inventory. The relevant emission factors are presented in **Table 15-24**.

Table 15-24 GHG factors

Emission Source	Scope	Emission Factor
Diesel Fuel	1	2.70 t CO_2-e/kL
Unleaded Petrol	1	2.38 t CO_2-e/kL
Electricity from grid (QLD)	2	0.89 kg CO_2-e/kWh

Source*:* National Greenhouse Accounts (NGA) Factors (DCCEE 2010b)

For the purposes of this assessment, the efficiency of the road network was assumed to be reflected in a comparison of projected VKT with and without the Project.

The GHG emissions from vehicles were determined using the following assumptions:

- the breakdown of Queensland vehicle fleet (ABS 2009)
  - 76% passenger cars
  - 20% light commercial vehicles
  - 1% light rigid trucks
  - 2% heavy rigid trucks
  - 1% articulated trucks
- fuel consumption rates per kilometre were derived from the Green Vehicle Guide (DIT 2010) and the Survey of Motor Vehicle Use (ABS 2008 c)
- the assumed fuel mix by vehicle type is
  - passenger cars is 95% petrol and 5% diesel
  - light commercial vehicles is 60% petrol and 40% diesel
  - light rigid trucks, medium rigid trucks and articulated trucks are 100% diesel.

15.6.3 GHG emissions

Construction

The main sources of GHG emissions for the construction of the Project are:

- direct CO_2 emissions from fuel combustion in construction equipment
- indirect CO_2 emissions due to consumption of electricity.

Estimates of diesel and electricity usage for the construction of the Project are presented in **Table 15-25** along with the corresponding GHG emission estimates.

Table 15-25 GHG during construction of the Project

Emission Source	Value	Units	GHG Emissions (t CO_2-e)
Excavation of tunnels, shafts and caverns			
Electricity Consumption[1]	196,250,000	kWh	174,663
Diesel Fuel Consumption[1]	8,125	kL	21,922
Site preparation, surface works and station construction			
Electricity Consumption[1]	275,026,000	kWh	244,773
Diesel Fuel Consumption[1]	78,235	kL	211,089
Total			**652,447**

Source: 1. AECOM, March 2011b

The construction of the Project is estimated to result in approximately 0.65 Mt CO_2-e of GHG emissions, or approximately 0.13 Mt CO_2-e per year, based on a five and a half year construction period. The annual GHG emissions during construction of the Project represent 0.02% of and 0.10% of Australia's and Queensland's 2008 GHG emissions, respectively.

Operations

The most significant GHG emissions associated with the operation of the Project would be generated as a result of electricity consumption from trains and the stations.

It has been estimated that each 3-car train unit would consume approximately 152 kWh per journey. This is based on an approximate travel time through the Project network of 19 minutes. Consumption scales up to 304 kWh and 456 kWh per 6 and 9-car trains, respectively. **Table 15-26** shows the estimated electricity consumption for train journeys through the Project.

Table 15-26 Train electricity consumption

Year	Train Journeys/Day	Train Journeys/year	Electricity Consumption (kWh/year)
2021	634	231,410	70,348,640
2031	1,106	403,690	122,721,760

Electricity use within underground and aboveground stations has been estimated for peak, off-peak and station close periods for weekdays and weekends in both summer and winter. The estimates took into account electricity use for station ventilation, tunnel ventilation, air conditioning, fire services, hydraulics, vertical transport and lighting. The estimated annual electricity consumption is:

- 1,511,379 MWh in aboveground rail stations
- 8,373,893 MWh in underground rail stations.

The estimated electricity consumption and associated GHG emissions during operation of the Project are presented in **Table 15-27**.

Table 15-27 Operation energy consumption and associated GHG emissions estimate

Location/Device	Electricity Consumption (kWh/year)	Greenhouse Gas Emissions (t CO_2-e/year)
Bowen Hills Station	1,511,379	1,345
Ekka Station	1,511,379	1,345
Roma Street Station	8,373,893	7,453
Albert Street Station	8,373,893	7,453
Gabba Station	8,373,893	7,453
Boggo Road Station	8,373,893	7,453
Yeerongpilly Station	1,511,379	1,345
Stations Sub-total	**38,029,709**	**33,846**
Trains (2021)	70,348,640	62,610
Trains (2031)	122,721,760	109,222
Total (2021)	**108,378,349**	**96,456**
Total (2031)	**160,751,469**	**143,068**

During operation, the Project is estimated to result in approximately 0.09 Mt CO_2-e of GHG emissions per year in 2021, and 0.14 Mt CO_2-e per year in 2031. The annual GHG emissions during operation of the Project in 2021 and 2031 represent 0.01% and 0.06% of Australia's and Queensland's 2008 GHG emissions, respectively. In 2031, the annual emissions would represent 0.02% and 0.14% of Australia's and Queensland's 2008 GHG emissions, respectively.

Changes to road network performance

The Project would affect the GHG emissions from Brisbane's vehicle fleet by providing additional capacity for freight and passenger rail services. Additional train services may alleviate demand for both private and heavy vehicle travel, reducing VKT (in comparison to the Project not proceeding) and improving the efficiency of traffic flow for vehicles using the road network.

Traffic forecasts were prepared using the Project transport model which is based on data as supplied by the Department of Transport and Main Roads. The projected VKT on the South East Queensland road network with and without the Project is presented in **Table 15-28**.

Table 15-28 Average weekday travelled (VKT) data for Brisbane with and without the Project

Year	Speed Limit	Without Project (AWDT)			With Project (AWDT)		
		Total VKT	% Urban	% Hwy	Total VKT	% Urban	% Hwy
2009	40	106,388	100%	0%	-	-	-
	50	1,285,841	100%	0%	-	-	-
	60	22,255,079	100%	0%	-	-	-
	70	5,281,425	2%	98%	-	-	-
	80	7,145,413	4%	96%	-	-	-
	90	951,506	4%	96%	-	-	-
	100	16,152,709	3%	97%	-	-	-
	TOTAL	**53,178,362**	**-**	**-**	**-**	**-**	**-**
2021	40	170,482	100%	0%	166,460	100%	0%
	50	1,496,338	100%	0%	1,480,441	100%	0%
	60	27,484,565	100%	0%	27,342,410	100%	0%
	70	6,798,433	4%	96%	6,758,493	3%	97%
	80	11,282,017	4%	96%	11,250,552	3%	96%
	90	1,459,540	0%	100%	1,460,702	0%	100%
	100	22,096,790	0%	100%	22,032,619	0%	100%
	TOTAL	**70,788,165**	**-**	**-**	**70,491,676**	**-**	**-**
2031	40	214,876	100%	0%	207,860	100%	0%
	50	1,702,984	100%	0%	1,654,556	100%	0%
	60	32,933,220	100%	0%	32,551,831	100%	0%
	70	7,877,904	6%	94%	7,756,129	5%	95%
	80	14,954,745	9%	91%	14,673,710	8%	92%
	90	1,778,637	10%	90%	1,787,879	9%	91%
	100	29,167,999	16%	84%	29,233,459	12%	88%
	TOTAL	**88,630,365**	**-**	**-**	**87,865,425**	**-**	**-**

Notes:
AWDT = average weekday travelled
Annual = AWDT x 330

The estimated daily fuel consumption with and without the Project is presented in **Table 15-29**.

Table 15-29 Estimated daily (AWDT) fuel consumption with and without the Project

Year	Without Project		With Project	
	Unleaded Petrol (kL)	Diesel (kL)	Unleaded Petrol (kL)	Diesel (kL)
2009	3,809.1	791.4	-	-
2021	4,955.7	1,074.8	4,931.4	1,071.0
2031	6,370.5	1,314.9	6,254.0	1,315.3

Note:
AWDT = average weekday travelled

The difference in GHG emissions as a result of changed network performance on the South East Queensland road network due to the Project is presented in **Table 15-30.** The Project is predicted to reduce GHG emissions from changes in road network performance by:

- 22.5 kt CO_2-e in 2021
- 91.1 kt CO_2-e in 2031.

The predicted reduction in GHG emissions of 91.1 kt CO_2-e represents approximately 0.8% of Queensland's transport GHG emissions in 2008 (11 Mt CO_2-e).

Table 15-30 Greenhouse gas emissions (t CO_2-e) from change in road network performance

Year	GHG Emissions – Without Project		GHG Emissions – With Project		Difference in Annual GHG Emissions
	AWDT	Annual	AWDT	Annual	
2009	11,202	3,696,798	-	-	-
2021	14,696	4,849,683	14,628	4,827,212	-22,471
2031	18,711	6,174,784	18,436	6,083,721	-91,063

Notes:
AWDT = average weekday travelled
Annual = AWDT x 330

The Project aligns with the Queensland Government's policies to reduce GHG emissions from the transport sector by improving traffic flows to reduce emissions.

15.6.4 Greenhouse gas mitigation measures

Minimising emissions

The gas emissions from the construction of the Project would be minimised through:

- maintaining construction equipment and haul trucks in good working order so fuel efficiency of equipment is maximised
- procurement of energy efficient construction equipment
- use of appropriately sized equipment for construction activities
- minimising waste from construction
- substituting high energy intensity building materials, where possible, for materials that have a lower energy intensity.

Minimising emissions from operation

Aspects of the reference design which reduce energy demand and reduce GHG emissions include:

- pressure differentials, platform screen doors and targeted cooling are proposed to improve air conditioning efficiency
- tunnelling between Boggo Road Station and Yeerongpilly instead of surface track widening allows reduced energy use from straighter track alignment between Boggo Road and Yeerongpilly.

The GHG emissions from the operation of the Project would be minimised through:

- energy efficient design of ventilation systems to minimise power requirements
- improved specification for new rolling stock to reduce energy demands
- a review of annual energy use to identify potential energy efficiency opportunities to reduce GHG emissions.

Queensland Rail is expected to manage and operate the Project infrastructure and provide the operating passenger trains in accordance with its current network operations. Queensland Rail would be required to estimate and report annual GHG emissions under the National Greenhouse and Energy Reporting System.

Renewable energy and greenhouse gas offsets

There are further opportunities to reduce GHG emissions from the Project through:

- purchasing energy from renewable electricity sources
- providing GHG offsets.

The proponent would produce an offset for a proportion of GHG emissions generated from the construction and operation of the Project. The plan would be prepared prior to commencement of permanent construction works.

15.6.5 GHG emissions - summary

The Project aligns with the Queensland Government's policies to reduce GHG emissions from the transport sector by improving traffic flow for reduced emissions and provides more opportunities to streamline freight deliveries.

In addition to improving existing traffic flows and streamlining freight deliveries, the Project also provides an additional efficient public transport option and experience for people living within the Project catchment area. This additional option may lead to a greater number of people choosing to commute on public transport rather than driving motor vehicles. The Project would therefore have beneficial impacts on reducing GHG emissions per head of population and change traditional commuter mindsets.

15.7 Summary

Existing air quality within the study corridor is generally good with concentrations of most pollutants well below the air quality goals. Air quality is considered to be mainly influenced by regional air emissions. Circumstances where exceedances are identified in the corridor relate to:

- regional sources of PM_{10}, such as controlled burns or dust storms, which typically result in one or two exceedances of the goal being recorded each year
- $PM_{2.5}$ levels in Brisbane, which occasionally exceed the ambient air quality goals in the EPP (Air)
- the dispersion meteorology, which is characterised by winds from the northeast during summer and spring, and winds from the southwest during autumn and winter.

15.7.1 Construction

During construction, air quality impacts would be primarily generated from dust during earth moving activities and diesel emissions from construction vehicles. Dust emissions during construction would vary depending on the intensity of construction activities. In general, dust emissions from construction would be greatest during periods of significant earth moving operations and during adverse weather conditions, such as high winds after an extended period of no rainfall.

Worksites predicted to generate the highest dust emissions are located at the northern portal, Woolloongabba, Boggo Road Station, Yeerongpilly Station and Clapham Rail Yard. Dust emissions modelled to predict TSP and PM_{10} concentrations indicate that air quality objectives may be exceeded over very small areas near to each of these worksites.

A range of controls would be implemented during the construction phase as part of a construction dust management plan (refer to **Chapter 24 Draft Outline EMP**). This would ensure dust and vehicle emissions are kept to a practicable minimum when working in the vicinity of residential properties and other sensitive locations. Dust monitoring and careful management during construction would minimise the likelihood of dust emission incidents.

15.7.2 Operation

At the local and regional scales, train operations and changes in motor vehicle use are not predicted to adversely impact on air quality.

The operation of underground train stations is not predicted to adversely affect the health of individuals. The risk to individuals, both commuters and workers, within the tunnel environment is very low due to design elements including ventilation, station platform screens and doors.

The main GHG emissions released during operation would be generated via electricity consumption from trains and stations. The Project would result in a small reduction in traffic emissions on roads within the study corridor as well as across the metropolitan network.

The Project provides an additional efficient public transport option and experience for people living within the catchment area. This may lead to a greater number of people choosing to commute on public transport as an alternative to motor vehicles and therefore have modest positive impacts on reducing GHG emissions.