Hexham Train Support Facility

Air Quality Assessment

Report Number 630.01858.00300-R1

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Air Quality Assessment

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SLR Consulting Australia Pty Ltd (SLR Consulting) was commissioned by QRNational to prepare an Air Quality Impact Assessment for the proposed Train Support Facility at Hexham. This report presents the results and findings of the air quality assessment, including consideration of both operational and construction activities associated with the proposed project.

EXISTING ENVIRONMENT

A range of air pollutants has been considered including nitrogen dioxide, carbon monoxide, sulphur dioxide and particulate matter. In the absence of site-specific monitoring data, conservative estimates of background concentrations of nitrogen dioxide, sulphur dioxide and particulate matter were developed from data recorded at the NSW Environmental Protection Authority (EPA, formerly the Office of Environment and Heritage) ambient air quality monitoring site at Beresfield. Data from the EPA's monitoring site at Newcastle was used to estimate background concentrations of carbon monoxide.

A limited number of air toxics have also been considered as part of the assessment.

AIR QUALITY ASSESSMENT

Dust generated in association with construction and coal tailing removal activities and impacts of nitrogen dioxide from diesel locomotive exhaust emissions are the most significant sources of air pollutants associated with the proposed project.

The low volume of trains using the Train Support Facility suggests that diesel exhaust emissions associated with on-site activities are unlikely to have a significant impact on local air quality.

Operation of the Train Support Facility is expected to have a minimal impact on air quality at the location of identified nearby sensitive receptors.

Potential adverse impacts from dust emissions during construction and coal tailing removal can be minimised through industry accepted best practice dust mitigation measures.

GREENHOUSE GAS ASSESSMENT

Following a review of the Proposed Train Support Facility, the increase associated with the proposed TSF is not considered significant.

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1 INTRODUCTION

In 2008, SLR Consulting Australia Pty Ltd (SLR Consulting) was commissioned by ADW Johnson Pty Ltd on behalf of QR National (the Proponent) to prepare an Air Quality Impact Assessment (AQIA) for the proposed Train Support Facility (TSF) at Hexham, NSW.

The primary objective of the AQIA was to assess the potential for adverse impacts on local air quality resulting from emissions of criteria pollutants and air toxics attributable to the proposed project. Both construction and operational activities were considered.

A number of air pollutants were considered, including nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter and volatile organic compounds (VOCs).

The AQIA was guided by the NSW Environment Protection Authority (EPA) (formerly the Office of Environment and Heritage (OEH)) document "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (AMMAAP) (EPA, 2005). It was also designed to address the Director-General's requirements for the project with regard to air quality. The DGRs are outlined in **Table 1**.

Table 1 DG Requirements Pertaining to Air Quality Issues

Requirement (summarised)	Relevant Section
Assessment of dust deposition, total suspended particulates, PM_{10} and any other atmospheric pollutants of concern for local, regional and inter-regional air quality from fugitive and point sources	Section 4 and Section 7
Take into account the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2005).	Section 7
Conduct a Greenhouse Gas Assessment (including an assessment of emissions from the disposal/use of extracted coal tailings); taking into account the AGO Factors and Methods Workbook (Australian Greenhouse Office)	Section 8

Since 2008, the AQIA has been revised a number of times to address changes to the Project. In July 2012, the AQIA was submitted to the Department of Planning as part of the QR National Train Support Facility Environmental Assessment. The following comments on the AQIA were subsequently received following the Adequacy Review:

- The background data used for air quality assessment is 2005. This should be updated and the assessment revised.
- The increase in the number of train sets does not seem to have been addressed regarding expected pollutants. Clarification is required on this matter.
- The cumulative impact on increased train sets and the ARTC Relief Road project should also be included.
- Update the GHG assessment to account for the increased activity associated with the Project.

This revision of the Air Quality Impact Assessment and Greenhouse Gas Assessment has been updated to address these comments.

2 PROJECT DESCRIPTION

2.1 Project Overview

QR National currently hauls coal from the Hunter Valley to the Port of Newcastle. They have a secured and forecast growth that will increase train sets from 10 at the present time to 38 trains by 2019. This will drive demand for additional train service capacity. Substantial amounts of rollingstock have been purchased to cope with the growth. Correspondingly the new rollingstock require new provisioning and maintenance facilities. It is of critical importance that new maintenance and provisioning facilities are brought on line in parallel with the delivery of new rollingstock.

The proposed development for the establishment of the Hexham Train Support Facility will provide QR National with the appropriate facilities. Project Application approval is sought for the Hexham Train Support Facility.

The facility will provide a train support facility where:

- The operation of QR National trains can be managed;
- QR National trains can undergo statutory and routine maintenance inspections;
- Locomotives and wagons can be attached/detached from/to QR National trains;
- Locomotives can be provisioned;
- Locomotives and wagons can be serviced;
- Locomotives and wagons can be parked; and,
- Spare parts can be held for locomotives and wagons.

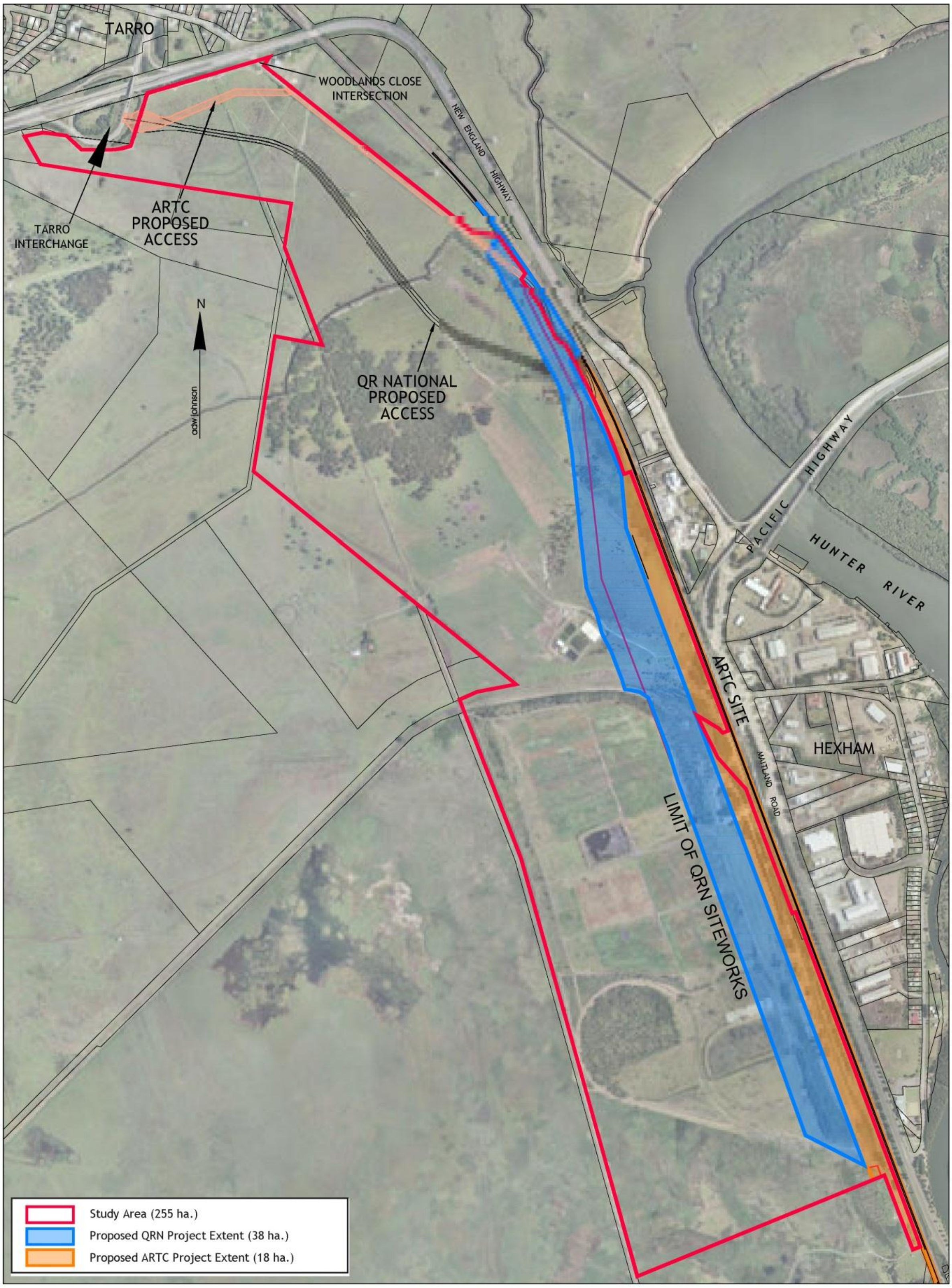
2.2 Project Location

The proposed development site is located parallel to the Pacific Highway at Hexham, NSW. The Hexham study area covers approximately 255 hectares (ha) with the TSF project contained within a 38 ha parcel of land within the study area. See **Figure 1** for an aerial photo of the study area.

In parallel with the application to be made for the TSF, the Australian Rail Track Corporation (ARTC) has confirmed that it will be lodging an application for a Relief Roads Project (5 rail tracks) on a 18 ha site located between the TSF site and the Great Northern Railway (cumulative impact is discussed in **Section 4.1.7**). Refer to **Figure 1**for a plan of the project sites at Hexham.

The site is surrounded by pastoral and wetland areas to the west. Immediately adjoining to the east is the main Northern Rail Line and Pacific Highway and then further to the east is the Hexham Industrial area with some housing and then the Hunter River.

Figure 1 Train Support Facility Project Site and Study Area



2.3 Project Details and Timing

It is currently planned that the TSF will be constructed in a single phase over a period of approximately 20 months. However, consideration is being given to the immediate construction of a provisioning shed and adjacent tracks in order to give relief to the current wait times for existing trains.

The proposed Train Support Facility development is described in more detail as follows:

Preliminary Works

- Construction of a connection to the Tarro Interchange and main vehicle access road to the site;
- Construction of earthworks, drainage, circulating road works and the construction of one provisioning track, a train examination road, two cut out roads and three wagon maintenance roads;
- Minor reshaping and modification to the existing coal reject stockpile will be required to make way for track associated with the TSF. Some 97,500 tonnes will be stockpiled within the former balloon loop site;
- Some filling and grading of the TSF area will be required (some 390,800 tonnes of clean fill will be imported) to ensure site levels can match the adjoining rail network;
- Associated signalling and connections to the down coal road on the Great Northern Line;
- Construction of a Wagon Maintenance Building and wash bay;
- Construction of a Provisioning Facility; and,
- Fuel storage area will initially accommodate 2 x 100,000 litre tanks and will be constructed in such a manner as to allow for future expansion of up to 4 x 100,000 litre tanks of diesel fuel.

Completion Works

- Locomotive Maintenance Roads;
- Wagon storage roads;
- Locomotive Maintenance Shed and wash bay;
- Second Provisioning Facility;
- Turntable; and,
- Administration Offices.

Fuel Storage

It is anticipated that approximately 13 northbound QR National freight trains will be refuelled each day (refuelling takes approximately one hour per train and accounts for approximately 122,200 litres per day (13 x 9,400 litres). There will be two 100,000 litre fuel tanks and B-double fuel deliveries occur approximately three times per day. One 100,000 litre tank will be located at the provisioning facility on PR1, the second will be located at a fuel storage farm on the west side of the site and diesel will be pumped to the provisioning buildings.

The fuel storage area will be constructed in such a manner as to allow for future expansion of up to four 100,000 litre tanks of diesel fuel in total. New and used oil will be stored in 5,000 litre tanks. New coolant will be stored in a 5,000 litre storage tank and used coolant will be stored in a 2,000 litre tank at the Locomotive Maintenance Building. A 200 litre drum of petrol will be used for the fuelling of line maintenance vehicles and quad bikes.

All fuels, oil and coolant will be stored in above ground tanks, bunded to ensure that an accidental spillage is contained. All oils and coolant removed off site will be undertaken by licensed recyclers under contract to QR National.

Operational Details

For the operational management of QR National trains running on the Hunter rail corridor, the facility is expected to be open 24 hours per day 7 days per week.

Servicing of locomotives and wagons will be undertaken predominantly during the hours of 0600 to 2200 hours seven days per week, but will also be undertaken to a lesser extent at other times the facility is open to meet the needs of the 24 hour QR National train operation. Servicing can be planned (i.e. preventative) and unplanned (due to failures). During night time hours, the facility will be lit for security reasons.

Car movements can be expected from on-site workers' cars with dedicated employee car parks adjacent the main buildings. Site workers will be predominantly maintenance staff as train drivers will be based at Kooragang Island.

Fuel will be delivered by B-double tankers, with delivery expected to occur during daylight hours. There will also be infrequent road delivery of spare parts, sand and other consumables expected to occur during daylight hours Monday to Friday. Most deliveries will be pallet based, but sand will be in semi-trailer based tankers.

The total employment for the proposed TSF is estimated to be 30 people.

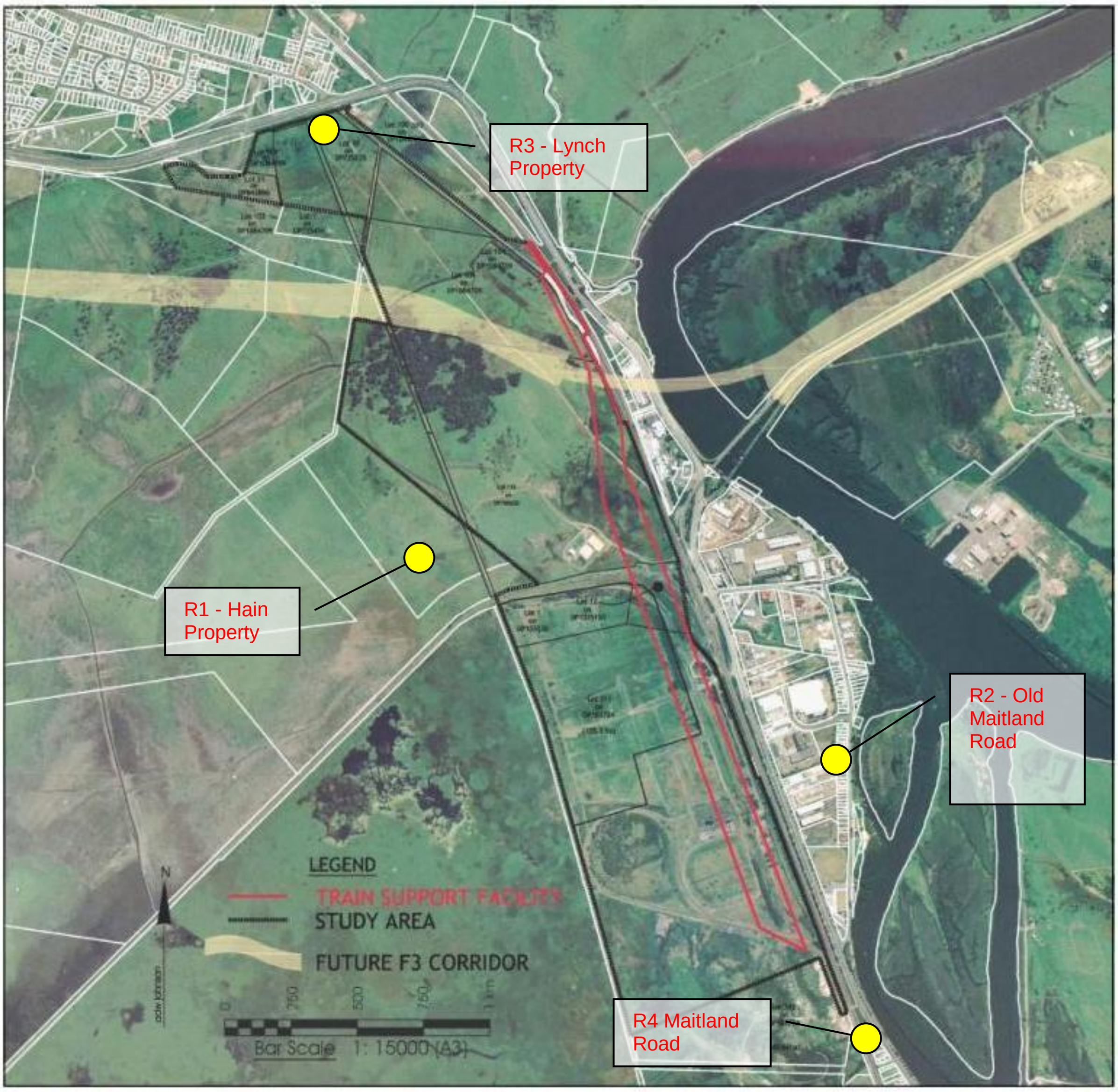
2.4 Sensitive Receivers

The nearest sensitive residential receivers potentially affected by the proposed development are listed in **Table 2** and shown in **Figure 2**.

Table 2 Nearest Sensitive Receivers

Residence ID	Description	Coordinates (UTM)
R1	Hain Property west of site	375,782, 6,367,163
R2	Old Maitland Road east of site	377,349, 6,366,410
R3	Lynch property north of site	375,513, 6,368,840
R4	Maitland Road south-east of site	377,490, 6,365,301

Figure 2 Site Locality and Sensitive Receivers



2.5 Local Topography

The Project Site has an elevation ranging between approximately 2 m AHD to approximately 12 m AHD. The surrounding area is similarly flat. Thus, due to the lack of significant topographic features, flat terrain has been assumed for the purposes of air dispersion modelling.

3 ASSESSMENT CRITERIA

The following sections outline assessment criteria that are relevant to the proposed project. The pollutants considered include particulate matter, nitrogen dioxide, carbon monoxide, sulphur dioxide and select volatile organic compounds.

3.1 Human Health Related Criteria

3.1.1 Particulate Matter

The term “particulate matter” refers to a category of airborne particles typically less than 50 µm in aerodynamic diameter and ranging down to 0.1 µm in size. Particles less than 10 µm are referred to in this report as PM_{10}.

Emissions of PM_{10} are considered an important air quality indicator due to their ability to penetrate into the respiratory system. Potential adverse health impacts associated with exposure to PM_{10} include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NSW EPA’s impact assessment criteria for PM_{10} are summarised in **Table 3**. The 24-hour PM_{10} reporting standard of 50 $\mu g/m^3$ is numerically identical to the equivalent National Environment Protection Measure (NEPM) reporting standard, with the exception that the NEPM reporting standard allows for five exceedences per year. The NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998 to be achieved within 10 years of commencement.

Table 3 EPA Criteria for Particulate Matter as PM_{10}

Pollutant	Averaging Time	Maximum Allowable Concentration ($\mu g/m^3$) [1]
PM_{10}	24 hour	50
	Annual	30

Note 1 The 24-hour NEPM goal allows for a maximum number of allowable exceedences (i.e. five); whereas the EPA guideline does not include this allowance.

An annual goal of 90 $\mu g/m^3$ for the annual average concentration of total suspended particulates (TSP) was recommended by the National Health and Medical Research Council (NHMRC) at their 92nd session in October 1981. It was developed prior to the results from more recent epidemiological studies suggested a relationship between health impacts and exposure to PM_{10} concentrations.

The PM_{10} particle size fraction is typically of the order of 50% of the TSP mass in areas where motor vehicles are not the dominant source of particulate emissions (USEPA, 2001; SKM, 2005), and greater that 50% in areas where vehicle emissions are the main source of particulate matter. The goal for TSP is therefore comparable with an annual PM_{10} goal of approximately 45 $\mu g/m^3$. Thus, the earlier NHMRC goal may be regarded as being not as stringent as the more recent EPA goal of 30 $\mu g/m^3$. As the annual TSP goal is seen to be achieved if the annual PM_{10} goal is satisfied, TSP has not been considered further in this report.

3.1.2 Nitrogen Dioxide

The NSW EPA’s AMMAAP outlines the criteria applicable to nitrogen dioxide (NO_2). These criteria were adapted from NEPC (1998) criteria and are outlined in **Table 4**.

Table 4 EPA Criteria for Nitrogen Dioxide

Pollutant	Averaging Time	Maximum Allowable Concentration (µg/m³)[1]
Nitrogen Dioxide	1 hour	246
	Annual	62

Note 1 Gravimetric concentrations have been derived at 25°C and 1 atmosphere pressure.

3.1.3 Sulphur Dioxide

The NSW EPA's AMMAAP outlines the criteria applicable to sulphur dioxide (SO_2). These criteria were adapted from NHMRC (1996) and NEPC (1998) criteria and are outlined in **Table 5**.

Table 5 EPA Criteria for Sulphur Dioxide

Pollutant	Averaging Time	Maximum Allowable Concentration (µg/m³)[1]
Sulphur dioxide	10 minutes	712
	1 hour	570
	24 hours	228
	Annual	60

Note 1 Gravimetric concentrations have been derived at 25°C and 1 atmosphere pressure.

3.1.4 Carbon Monoxide

The NSW EPA's AMMAAP outlines the criteria applicable to carbon monoxide (CO). These criteria are adapted from World Health Organization (2000) and NEPC (1998) criteria and are summarised in **Table 6**.

Table 6 EPA Criteria for Carbon Monoxide

Pollutant	Averaging Time	Maximum Allowable Concentration (mg/m³)[1]
Carbon monoxide	15 minutes	100
	1 hour	30
	8 hours	10

Note 1 Gravimetric concentrations have been derived at 25°C and 1 atmosphere pressure.

3.1.5 Total Hydrocarbons

The NSW EPA's AMMAAP outlines the criteria applicable to toxic air pollutants. These criteria have been adopted from the Victorian Government Gazette 2001. Criteria relevant to proposed project-related emission sources are presented in **Table 7**.

Table 7 EPA Criteria for Speciated Hydrocarbons

Pollutant	Averaging Period	Maximum Allowable Concentration (mg/m^3)[1]
Benzene	1 hour	0.029
Cyclohexane	1 hour	19
Ethylbenzene	1 hour	8
n-hexane	1 hour	3.2
PAH (as benzo[a]pyrene)	1 hour	0.0004

Note 1 Gravimetric concentrations have been derived at 25°C and 1 atmosphere pressure.

3.2 Criteria Relating to Amenity

3.2.1 Dust Deposition

Presented in **Table 8** are the NSW EPA impact assessment criteria for dust deposition rates based on the potential for nuisance-related complaints.

Table 8 EPA Criteria for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m^2/month	4 g/m^2/month

Note: Dust is assessed as insoluble solids as defined by AS 3580.10.1:2003

4 EXISTING AIR QUALITY ENVIRONMENT

The proposed project site is situated in the Lower Hunter region of New South Wales. This region has a significant industrial base including primary metallurgical works, fertiliser manufacturing and coal fired power generators. Emissions from a substantial motor vehicle fleet also contribute to pollution levels in the region.

4.1 Regional Background Air Quality

In the absence of site-specific monitoring data, estimates of the existing air quality environment for the project site has been derived using data from the EPA monitoring sites at Beresfield and Newcastle.

The Beresfield monitoring site is located approximately 3 km north-northwest of the project site and is classified as semi-rural. It was commissioned in 1993 and is located in the Francis Greenway High School, on Lawson Avenue, Beresfield.

The EPA maintains a monitoring site in Newcastle which is located approximately 13 km southeast of the project site. The site was commissioned in 1992 and is located in the Newcastle Sports Ground, off Dumaresq Street, Newcastle.

The parameters that are currently measured at the Beresfield and Newcastle monitoring sites are summarised in **Table 9**. For the purposes of this assessment, estimates of background concentrations of criteria pollutants were derived from the Beresfield monitoring site for 2011, with the exception of carbon monoxide for which the Newcastle data set was used.

Table 9 Parameters Measured at the Beresfield and Newcastle Monitoring Sites

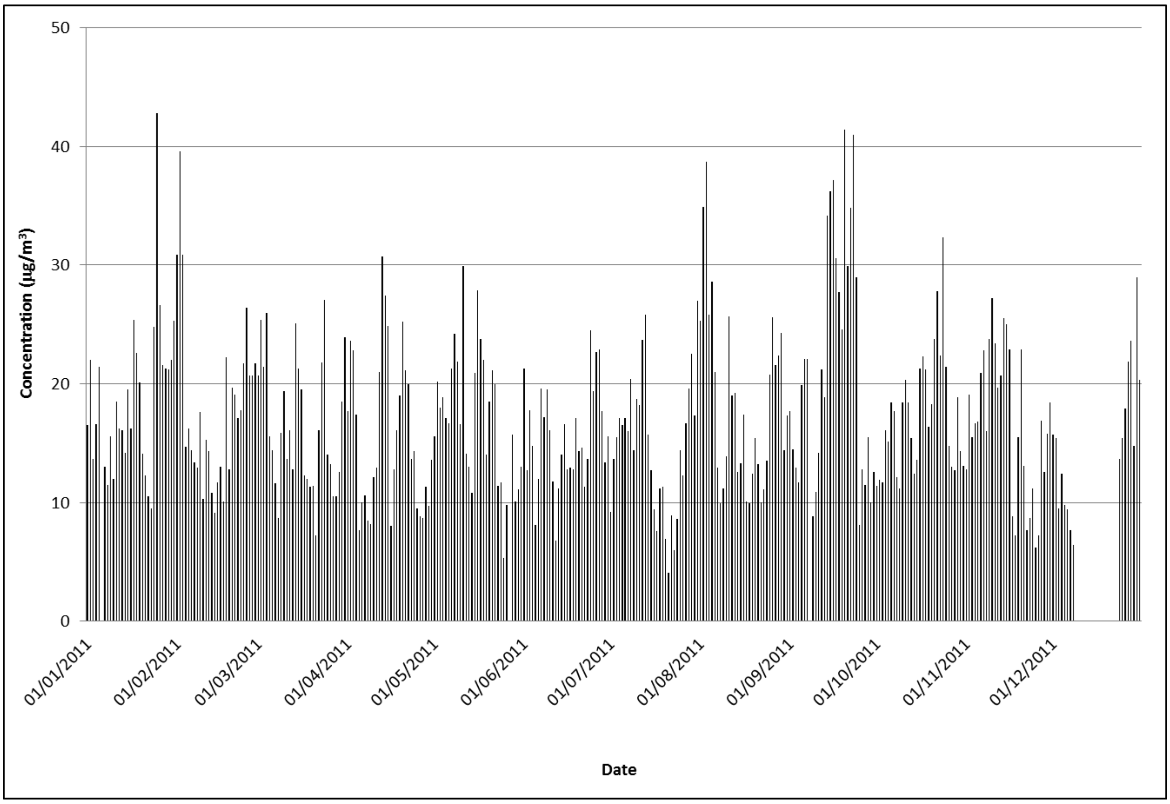
Parameter	Beresfield	Newcastle
Ozone	✓	✓
Oxides of Nitrogen	✓	✓
Sulphur Dioxide	✓	✓
Particulate Matter as PM_{10}	✓	✓
Particulate Matter as $PM_{2.5}$	✓	✓
Carbon Monoxide	-	✓
Meteorology	✓	✓

4.1.1 Particulate Matter

Presented in **Figure 3** is a time-series plot of the 24-hour average PM_{10} concentrations recorded at the Beresfield monitoring site during 2011.

The maximum recorded 24-hour average concentration of PM_{10} was 42.8 µg/m^3 on 25th January. The annual average concentration of PM_{10} for 2011 was 17.2 µg/m^3.

Figure 3 24-hour Average PM_{10} Concentrations Recorded at Beresfield in 2011



Note: The EPA standard for PM_{10} (24-hour average) is 50 µg/m^3. During 2011 there were no recorded exceedences of this value at Beresfield.

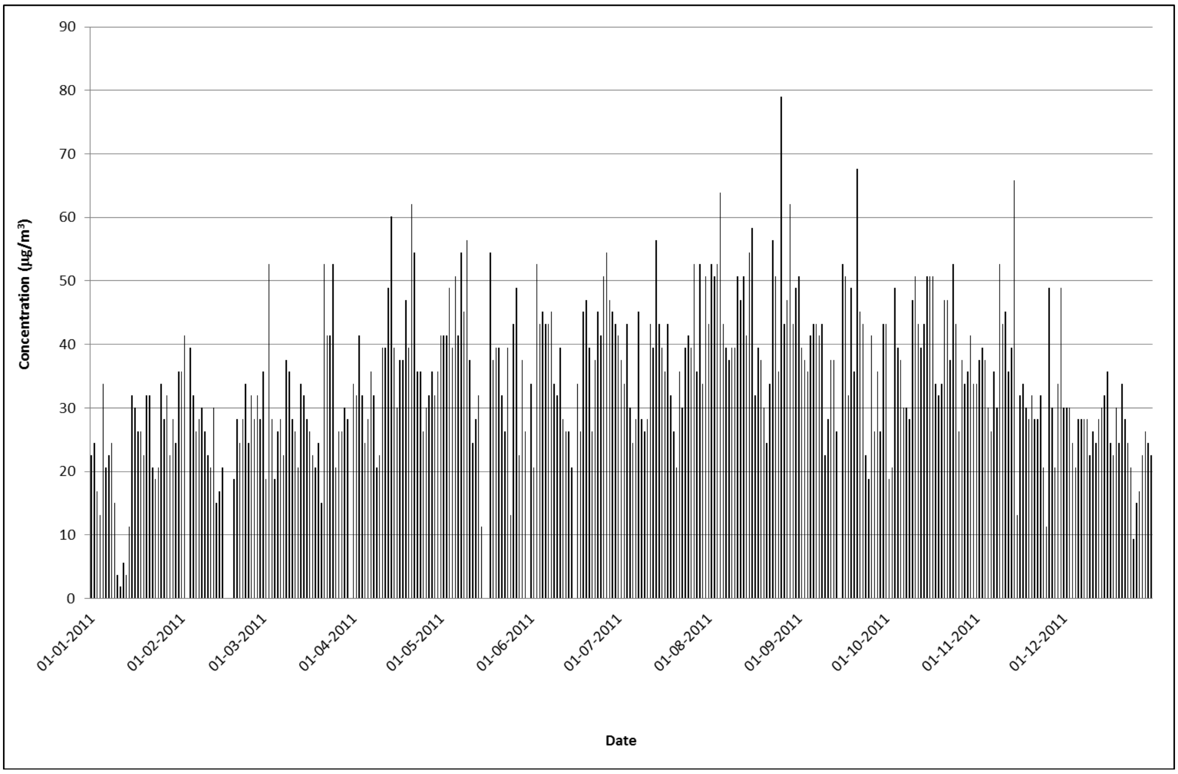
4.1.2 Nitrogen Dioxide

The majority of nitrogen dioxide in the atmosphere is attributable to anthropogenic sources, mainly the burning of fossil fuels, although 80% of nitrogen dioxide in cities can come from motor vehicle exhaust. Other sources include petrol and metal refining, other manufacturing industries and food processing. At Hexham, the majority of the nitrogen dioxide in the atmosphere is likely to be attributed to vehicular emissions and industrial sources.

Presented in **Figure 4** is a time-series plot of the daily maximum 1-hour average NO_2 concentrations recorded at the Beresfield monitoring site during 2011.

The maximum daily maximum 1-hour concentration of nitrogen dioxide was 79.0 µg/m^3 (42 ppb) on 26th August. The annual average concentration was reported to be 33.6 µg/m^3(18 ppb) in 2011.

Figure 4 Daily Maximum 1-Hour Average NO_2 Concentrations Recorded at Beresfield in 2011



Note: The EPA standard for NO_2 (1-hour average) is 0.120 ppm (246 µg/m^3 at 25°C and 1 atmosphere pressure). During 2011 there were no recorded exceedences of this value at Beresfield.

4.1.3 Sulphur Dioxide

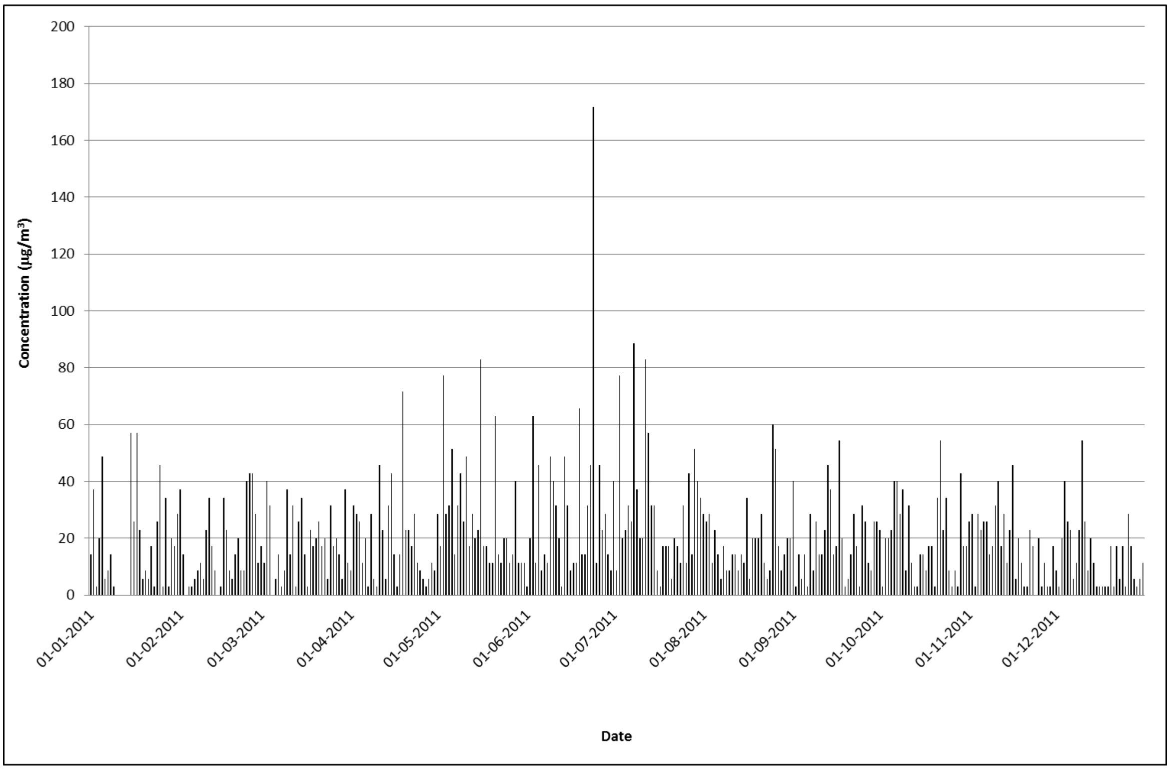
Approximately 99% of ambient sulphur dioxide is attributable to anthropogenic sources. The main source of sulphur dioxide is industrial activities which process materials which contain sulphur, e.g. electricity generation from coal, oil or gas combustion. Certain mineral ores also contain sulphur which is released as sulphur dioxide during processing. Sulphur dioxide is also present in motor vehicle emissions, although concentrations of sulphur dioxide in ambient air from motor vehicles have been reduced in more recent times due to the introduction of low sulphur fuels.

At Hexham, the main source of sulphur dioxide is likely to be motor vehicle emissions and industrial activities.

Presented in **Figure 5** is a time series plot of the daily maximum 1-hour average concentrations of SO_2 recorded at Beresfield during 2011.

The maximum daily maximum 1-hour average concentration of sulphur dioxide was 171.6 µg/m^3 (60 ppb) on 24th June. The annual average concentration was reported to be 4.9 µg/m^3 (2 ppb) in 2011 and the maximum 24-hour average reported in 2011 was 34.3 µg/m^3 (12 ppb).

Figure 5 Daily Maximum 1-Hour Average SO_2 Concentrations Recorded at Beresfield in 2011



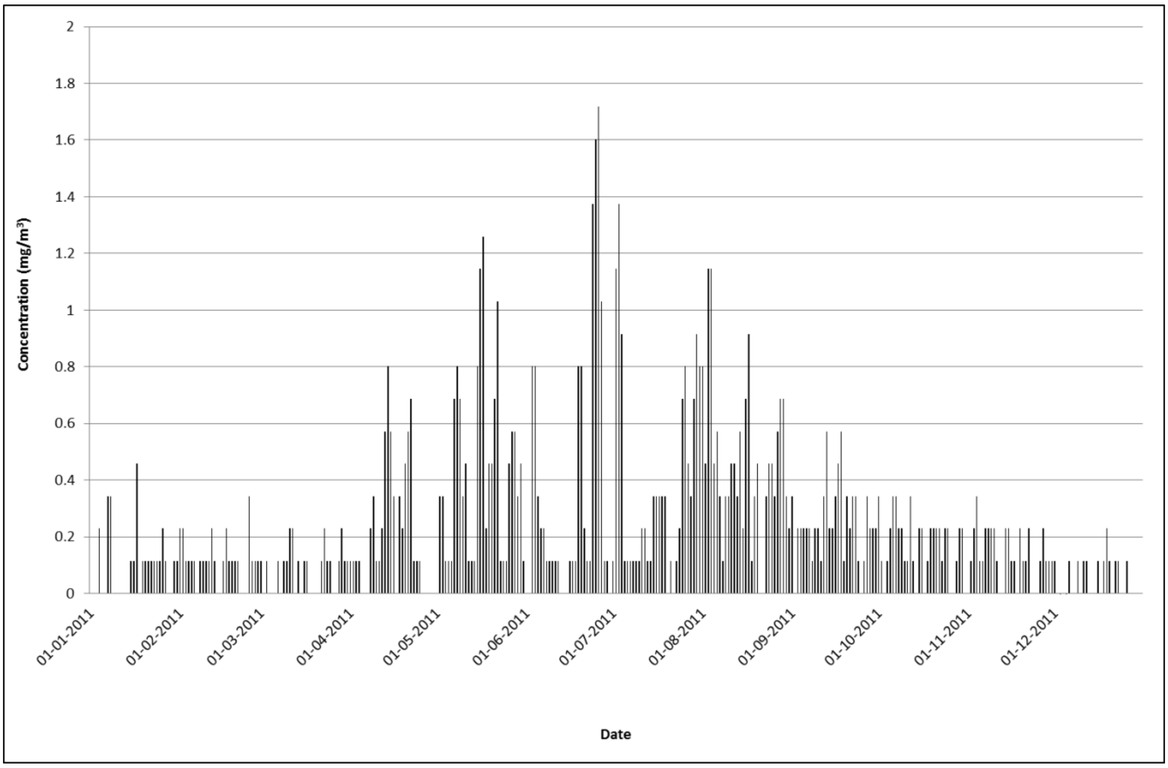
Note: The EPA standard for SO_2 (1-hour average) is 0.20 ppm (570 µg/m^3 at 25°C and 1 atmosphere pressure). During 2011 there were no recorded exceedences of this value at Beresfield.

4.1.4 Carbon Monoxide

Presented in **Figure 6** is a time series of the daily maximum 8-hour average concentration of carbon monoxide as recorded at the Newcastle monitoring site for 2011.

The maximum daily maximum 8-hour concentration of CO was 1.7 mg/m^3 (1.5 ppm) on 26th June. The annual average was reported to be 0.2 mg/m^3 (0.2 ppm) in 2011.

Figure 6 Daily Maximum 8-Hour Average CO Concentrations Recorded at Newcastle in 2011



Note: The EPA standard for CO (8-hour average) is 9 ppm (10 mg/m^3 at 25°C and 1 atmosphere pressure). During 2011 there were no recorded exceedences of this value at Newcastle.

4.1.5 Volatile Organic Compounds

Due to the limited availability of ambient monitoring data for air toxics, background concentrations of benzene, cyclohexane, ethylbenzene, n-hexane and PAH (as benzo[a]pyrene) were not able to be estimated. It is anticipated based on the nature of the surrounding land use however, that current ambient ground-level concentrations of these air toxics are well below the relevant criteria. Reporting of air quality impact assessment results in relation to these air toxics will necessarily focus on worst-case estimates of incremental contribution to ground-level concentrations.

4.1.6 Dust Deposition

In the absence of relevant monitoring data, an estimate of background dust deposition data for the Newcastle region has been adopted. Typical background dust deposition rates for a semi-rural industrial area can be assumed to be approximately 2 g/m^2/month.

4.1.7 Regional Background Air Quality Environment for Assessment Purposes

Based on the data and discussion above, the regional background air quality concentrations adopted for this assessment are presented in **Table 10**. It is noted that 15-minute and 1-hour average CO data are not readily available from the Newcastle monitoring site and regional background concentrations have not been assumed in this assessment.

Table 10 Background Pollutant Concentrations Assumed for Assessment Purposes

Air Quality Indicator	Averaging Period	Units	Regional Background Levels Assumed
PM_{10}	24-Hour	µg/m^3	42.8
	Annual	µg/m^3	17.2
Nitrogen dioxide	1-hour	µg/m^3	79.0
	Annual	µg/m^3	33.6
Sulphur dioxide	1-hour	µg/m^3	171.6
	24-Hour	µg/m^3	34.3
	Annual	µg/m^3	4.9
Carbon monoxide	15-minute	mg/m^3	N/A
	1-hour	mg/m^3	N/A
	8-hour	mg/m^3	1.7
Dust deposition	Annual	g/m^2/month	2.0

4.2 Incremental Impact of ARTC

The ARTC proposes to develop five Relief Roads (tracks) and associated infrastructure adjacent to the Project Site.

Key components of the proposed Relief Roads Project comprise:

- five Up Relief Roads (train lines) to the west of the existing Up Main, Down Main and Up Coal including:
  - the removal of the existing Down Coal (located to the west of the Up Coal);
  - the construction of five new train lines (tracks) for the Relief Roads;
  - the construction of a new Down Coal to the west and outside of the proposed Relief Roads;
  - each Relief Road to accommodate trains generally comprising two or three locomotives and up to 91 wagons (1,543 m long) requiring a minimum standing room of 1,670 m; and
  - new turnouts return curves and associated track changes;
- installation of new signal infrastructure for the five Relief Roads including signal location cases, huts and gantries;
- earth and civil works of approximately 265,000 cubic metres, including cut to fill, track formation, drainage and minor structures;
- ancillary infrastructure including vehicle access tracks, temporary construction compounds and stockpile sites;
- land acquisition and the upgrading of existing rail infrastructure and public utilities as required; and
- access road from Tarro Interchange to Woodlands Close.

The ARTC also propose a Hexham Crossing Loop. This is located north of Hexham and the five Relief Roads, and will provide a nominal 1,570 m clear standing room to accommodate a 1,500 m long train. The track is unidirectional running only in an Up direction (trains to Newcastle); therefore stationary locomotives will only be located at the southern end of the loop.

The purpose of the crossing loop is to reduce potential delays on the rail network caused by the competition for train paths on the shared passenger and freight line. During the operational phase, a conservative approach has been applied to the modelling; estimating approximately 80 trains will idle on a daily basis. It has been assumed that there will be trains constantly idle throughout every hour of the day.

Dispersion modelling by KMH Environmental was undertaken for the ARTC and Crossing Loop (*'Air Quality Impact Assessment - Hexham Relief Roads', dated 27 April 2012).* The maximum incremental ground level concentrations presented in the KMH report at the sensitive receptor locations considered in this AQIA for both ARTC projects are detailed in **Table 11**.

It is noted that the ARTC Relief Roads project modelled a range of different scenarios, which considered the following:

- One train sitting idle for all hours (365 days a year, 24 hours per day);
- Two trains sitting idle for all hours (365 days a year, 24 hours per day);
- Three trains sitting idle for all hours (365 days a year, 24 hours per day); and
- Five trains sitting idle for all hours (365 days a year, 24 hours per day).

For the purposes of determining conservatively high background concentrations, the model results for five trains sitting idle have been included.

Table 11 ARTC Relief Roads Modelling Results at Sensitive Receptor Locations – 2012

Pollutant	**Units**	**Averaging Time**	**Maximum Predicted Increment**			
			R1	**R2**	**R3**	**R4**
NO_2	µg/m^3	1-Hour	70	78	51	110
		Annual	1	2	0	4
CO	mg/m^3	15 min	0.051	0.057	0.037	0.080
		1 hr	0.020	0.027	0.015	0.056
PM_{10}	µg/m^3	24-hr	0	1	0	0
		Annual	0	0	0	0
SO_2	µg/m^3	1 hr	12	13	8	18
		24-hr	1	2	0	6
		Annual	0	0	0	1

5 EMISSION INVENTORY

The emissions inventory is limited to the construction and operation of the Train Support Facility. Sources associated with the construction phase of the proposed facility are listed and their emissions qualitatively assessed in **Section 6.1**. Atmospheric emissions associated with the operational phase of the train support facility, identified and quantified as part of the study, are documented in **Section 6.2.**

5.1 Construction Phase

Based on information provided by the Proponent, dust generating construction related activities at the proposed site may include (but may not be limited to):

- Road construction;
- Importing fill (approximately 1000 m^3 per day);
- Loading and unloading of trucks;
- Excavating;
- Use of backhoes;
- Movement of trucks on unpaved roads; and
- Wind erosion of stockpiles and exposed areas.

Due to the irregularity and short duration of the emission sources during this phase, the impact is not expected to have long-term health or ecological impacts beyond the proposed site boundaries. However, as these sources can result in high short-term releases of particulate matter during construction, control measures should be put in place during this phase. The control techniques for fugitive dust sources generally involve watering, minimisation of disturbed areas, chemical stabilisation, wind sheltering and source activity management.

5.2 Operational Phase

Air pollutant emission sources associated with the day-to-day operation of the proposed Train Support Facility include:

- Refuelling of locomotives with diesel;
- Refuelling and emptying of storage tanks;
- Storage of fuels;
- Locomotive exhaust;
- Maintenance operations which includes (but not limited to);
    - Oil and grease removal;
    - Wagon and locomotive cleaning; and
    - Wagon and locomotive repairs.
- Vehicles; and,
- Site based equipment including (but not limited to):
    - Wagon placement tractor;
    - Forklift;
    - Compressor;
    - Trucks; and,

- Quad bikes.

5.2.1 Fuel Storage

Based on information provided by QRNational, the site of the Train Support Facility will initially contain two 100,000 litre diesel fuel storage tanks. One of the tanks will be located at the provisioning facility and the second will be located at a fuel storage farm on the west side of the site. Diesel will then be pumped from this second storage tank to the provisioning buildings. The fuel storage farm will be designed to allow for future expansion of up to four 100,000 litre storage tanks.

Emission rates of VOCs associated with the storage of fuels on site are presented in **Table 12** and were derived using the following:

- The proposed fuel usage is 122,200 L per day. For the purpose of this assessment it is assumed 122,200 litres of diesel per day will be displaced on site.
- The site will operate 7 days a week;
- A maximum of 12,410,000 litres of diesel per year will be stored;
- A maximum of 40,000 litres of fuel oil will be stored (conservative estimate);
- Table 1, Table 2 and Appendix F.1 of the Australian Government document: *NPI Emission Estimation Technique Manual for Fuel and Organic Liquid Storage Version 3.0 January 2008*.

Table 12 Emission Rates for Air Toxics Associated with Fuel Storage

Pollutant	Diesel (g/s)	Fuel Oil (g/s)
Total VOCs	7.81E-04	8.28E-07
Benzene	1.38E-04 (18%)	1.51E-07 (18%)
Cyclohexane	4.59E-05 (5.9%)	-
Ethylbenzene	4.92E-05 (6.3%)	1.61E-08 (1.9%)
n-Hexane	7.55E-05 (9.7%)	2.47E-07 (30%)

5.2.2 Fuel Tank Refilling

For the purposes of the current assessment it has been assumed that truck refuelling of the storage tanks will involve Stage 1 Vapour Recovery. Based on information provided in Table 2 of the Australian Government document: *NPI Emission Estimation Technique Manual for Aggregated Emissions from Service Stations November 1999*, the ratio of emissions associated with tank breathing/emptying and tank filling (using submerged filling and vapour recovery) is 3 to 1. In the absence of additional information, this ratio of tank breathing to tank refuelling has been assumed to be applicable to diesel fuel.

Emission rates of VOCs associated with fuel storage refuelling on site are presented **Table 13**.

Table 13 Emission Rates for Air Toxics Associated with Fuel Storage Refilling

Pollutant	Diesel (g/s)	Fuel Oil (g/s)
Total VOC	2.60E-04	2.76E-07
Benzene	4.59E-05 (18%)	5.02E-08 (18%)
Cyclohexane	1.53E-05 (5.9%)	-
Ethylbenzene	1.64E-05 (6.3%)	5.38E-09 (1.9%)
n-Hexane	2.52E-05 (9.7%)	8.25E-08 (30%)

5.2.3 Exhaust from Diesel Locomotives

Emissions data from manufacturer specifications, (taken from PAEHolmes' report for the Air Quality Assessment of ARTC Koolbury Rail Loop, 2009) have been used; (see **Table 14**). An additional level of conservatism has been applied by using the highest emission rate from each class of locomotive for each pollutant.

To determine the contribution of individual toxic organic compounds relative to emissions of total hydrocarbons, the relative emission factors quoted in NPI's *Emission Estimation Technique Manual for Railway Yard Operations* (June 2008) were used. These are shown in **Table 15** below.

Source characteristics used in relation to exhaust from locomotives within the yard are summarised in **Table 16**.

Table 14 Estimated Emission Rates for Idling Diesel Locomotives

Pollutant	Emission Rate (kg/hr)	Source
CO	0.11	81 Class (Lilley, 1996)
Total hydrocarbons	0.042	90 Class (RIC)
NOx	0.97	90 Class (RIC)
NO_2*	0.19	Derived from NOx
PM_{10}	0.013	81 Class (Lilley, 1996)
SO_2	0.032	90 Class (RIC)

Table 15 Speciation of Hydrocarbon Emissions

NPI Substance	Line Haul Locomotive Emission Factors (g/L)	% of Total Hydrocarbons
Total Volatile Organic Compounds	4.27	100
1,3-Butadiene	0.31	7.3
Benzene	0.35	8.2
Polycyclic Aromatic Hydrocarbons	0.0017	0.04

Table 16 Locomotive Source Characteristics[1]

Parameter	Units	Value
Number of outlets per train	-	2
Distance between outlets	m	1.5
Height of exhaust above ground	m	3.9
Stack Diameter	m	0.22
Exit velocity (Switch cycle)	m/s	17
Exit velocity (Line haul cycle)	m/s	48.7
Average Exit Velocity	m/s	32.9
Exhaust gas temperature	°C	422

Note (1) Based on information for the 2400/2470 class of locomotives provided in the Jilalan Rail Yard Upgrade Project EIS, Connell Wagner, 2007.

The 2400 class of locomotive is an older, less efficient class of locomotive than the 5000 class currently used by QRNational on Hunter Valley hauls and therefore the assessment is considered conservative.

It is proposed that there will be 38 train sets using the site by 2019. To account for this, for the purposes of estimating worst-case impacts from diesel locomotive exhaust emissions it has been assumed that three locomotives based on worst-case emission rates listed in **Table 14** are emitting continuously from stationary locations along the site.

It is also noted that the background environment detailed in **Section 4.1.7** considers five locomotives emitting continuously on the ARTC Relief Roads site. It is considered that the incorporation of eight locomotives (ARTC and QR National projects combined) operating continuously is a very conservative position, and adequately considers the cumulative impacts of the two developments.

5.2.4 Breathing and Refuelling of Storage Tanks

The estimated emissions from fuel storage and refuelling of storage tanks were combined and modelled as a single volume source. Emissions from these sources were assumed to occur 24 hours per day, 365 days per year.

6 METEOROLOGICAL AND DISPERSION MODELLING

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component.

The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading. Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Oke, 2003; Sturman and Tapper, 2006).

Spatial variations and diurnal and seasonal changes in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. Atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area.

6.1 Dispersion Model

The pollutant dispersion modelling carried out in this assessment utilises the Ausplume Gaussian Plume Dispersion Model software developed by EPA Victoria, Version 6.0.

Ausplume is the approved dispersion model for use in the majority of applications in NSW. Default options specified in the Technical Users Manual (EPA Victoria, 2000) have been used, as per NSW EPA AMMAAP.

6.2 TAPM Simulation of Atmospheric Stability and Mixing Layer Depth

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of flow due to the frictional drag of the earth's surface, or as result of the heat and moisture exchanges that take place at the surface (Stull, 1997; Oke, 2003). During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence and the passage of frontal systems.

Radiative flux divergence during the night usually results in the establishment of ground-based inversions and the erosion of the mixing layer. Nighttimes are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential. The mixed layer thus ranges in depth from a few metres (i.e. stable or neutral layers) during nighttimes to the base of the lowest-level elevated subsidence inversion during unstable, daytime conditions.

For elevated releases, the highest ground level concentrations frequently occur during unstable, daytime conditions when the plume is 'brought to ground'. In contrast, the highest concentrations for ground level non-wind dependent releases would occur during weak wind speeds and stable (night-time) atmospheric conditions.

Meteorological parameters such as atmospheric stability class and mixing height are not routinely recorded and need to be derived or simulated. The Air Pollution Model (TAPM) was used during the course of this study to generate these parameters in order to support the description of the meso-scale atmospheric dispersion potential and to provide the necessary input to the atmospheric dispersion simulations undertaken for the proposed development.

6.3 Meteorological Data

The Air Pollution Model (TAPM) software, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was used to simulate the meteorology of the area. TAPM is a prognostic model which may be used to predict three-dimensional meteorological data, with no local data inputs required.

The model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations. TAPM is often used to drive the regulatory Ausplume model where insufficient on-site meteorology data is available, and as such is considered suitable for use in this assessment.

Additionally TAPM may assimilate wind observations so that they can optionally be included in a model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values.

To provide concurrent observations with the background PM_{10} data used in the assessment, TAPM was used to generate a 2011 meteorological data set, using the data assimilation option to incorporate observations from the Bureau of Meteorology site at Newcastle Nobbys, located approximately 15 km southeast of the project site.

6.3.1 Wind Speed and Direction Data

A summary of the 2011 annual wind behaviour for the project site presented as a wind rose is included in **Appendix A**. This wind rose is representative of the meteorological input file used in the assessment, and displays occurrences of winds from all quadrants.

The annual wind rose indicates the prevailing wind direction is from the northwest quadrant. Calms are infrequent, occurring approximately 1.4% of the time. Winds for the dominant quadrant are mild in nature, having wind speed range between 1.5 m/s and 5.5 m/s.

The seasonal variation in wind behaviour at the site is also presented in **Appendix A**. The seasonal wind roses indicate that:

- In summer, light winds are present from the east-southeast (approximately 14% of the time);
- In autumn there is slightly prevailing wind direction, light winds are present from the west-northwest (approximately 8% of the time);
- In winter, light to moderate winds are present from the west-northwest (approximately 28% of the time); and
- In spring there is no prevailing wind direction.

6.3.2 Atmospheric Stability

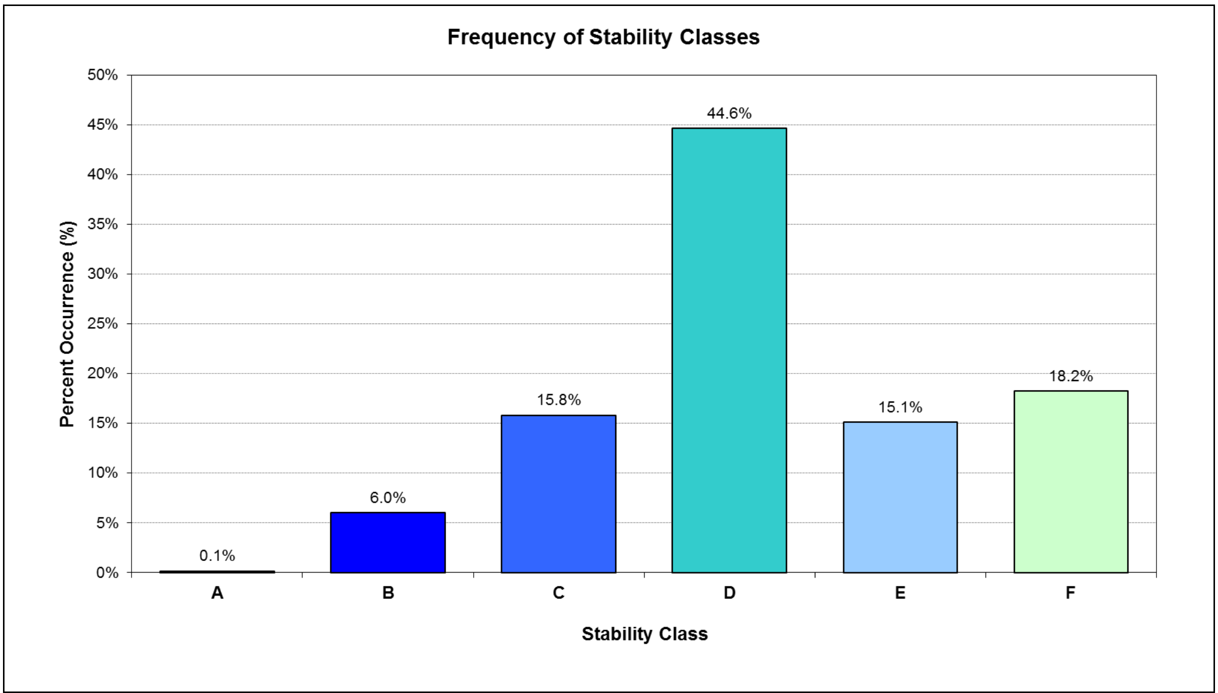
Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, “A” to “F”, to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

As indicated by **Figure 7**, the TAPM results indicate that the Pasquill-Gifford atmospheric stability class "D" was the most prevalent throughout the year. This is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing. A neutral atmosphere neither enhances nor inhibits mechanical turbulence and as a result, the vertical and lateral diffusion of a given atmospheric pollutant may be expected to be of a small to moderate scale.

Table 17 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

Figure 7 Annual Atmospheric Stability Class Distribution for the Project Site, 2011.

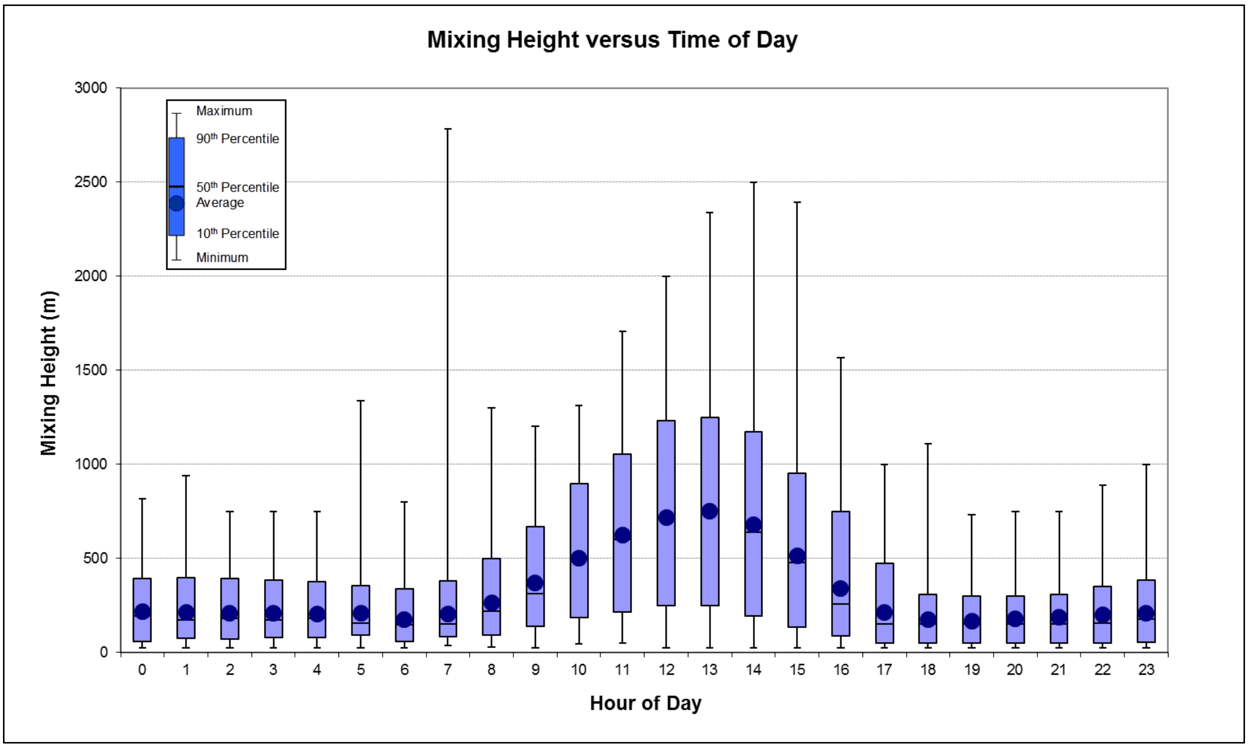


6.3.3 Mixing Height

Diurnal variation in maximum and average mixing depths predicted by TAPM at the project site is illustrated in **Figure 8**.

The project site, as would be expected, an increase in the mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occurs in the mid-day, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

Figure 8 Mixing Heights for the Project Site, 2011



7 AIR QUALITY IMPACT ASSESSMENT

The AQIA comprises an analysis of compliance with emission limits and ambient air quality goals and the evaluation of the likelihood of impacts on human health and welfare and other aspects of the biophysical environment as a result of atmospheric emissions due to the proposed development.

7.1 Construction

As noted in **Section 5.1**, the construction phase of the Project will comprise a series of different operations including land clearing, topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, compaction, etc. Each of these operations has its own duration and potential for dust generation. The potential for dust generation varies significantly from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. This is in contrast to most other fugitive dust sources where emissions are either relatively steady or follow a discernible annual cycle.

Due to the irregularity and short duration of the emission sources during this phase, the impact is not expected to have long-term health or ecological impacts beyond the Project boundaries. However, as these sources can result in high short-term releases of particulate matter during operation, control measures should be put in place during this phase. The control techniques for fugitive dust sources generally involve watering, minimisation of exposed areas, chemical stabilisation, wind sheltering and source activity management.

7.1.1 Dust Management and Mitigation

The following procedures and requirements should be followed during the life of the project to minimise the impact of dust generated in association with the proposed development:

- Watering of roads and sealing of roads where possible;
- Wind breaks composed of earth banks and other screens to protect areas by reducing capacity of the wind to raise dust;
- Trucks entering and leaving the site should be well maintained in accordance with the manufacturer's specification to comply with all relevant regulations. Fines may be imposed on vehicles which do not comply with smoke emission standards. Truck movement should be controlled on site and restricted to designated roadways. Truck wheel washes or other dust removal procedures (including covering of loads) should be installed to minimise transport of dust offsite if necessary; and,
- If necessary, modifying construction activities during periods of high wind.

The following are general, basic procedures which are designed to control dust and other emissions from construction operations and on-site equipment. The aim of these procedures is to minimise off-site dust nuisance and air quality impacts. Consideration should be given to adopt measures appropriate to the proposed project.

- Activities carried out on site should be such as to ensure that all equipment used and all facilities erected are designed and operated to control the emission of smoke, dust, fume and other objectionable matter into the atmosphere.
- Precautions to be taken include spraying of earthworks, roads and other surfaces as necessary with water or other suitable liquids, providing dust suppression equipment to any onsite materials batching plant, sealing of temporary haul roads and the modification of operations during high or unfavourable wind conditions.
- Working areas and access roads should be stabilised as soon as practicable to prevent or minimise windblown dust.
- All disturbed areas should be stabilised as soon as practicable to prevent or minimise windblown dust.

- All unsealed trafficable areas be kept sufficiently damp during working hours to minimise windblown or traffic generated dust emissions. Continued use of water on dirt roads helps the formation of a crust so that dust is not as easily generated.
- Water sprays, sprinklers and water carts may be employed if needed to adequately dampen stockpiles, work areas and exposed soils to prevent the emissions of dust from the site. Water carts and other equipment will be available to enable watering at least at an hourly rate of 2 litres per square metre.
- Stockpiles and handling areas should be maintained in a condition which minimises windblown or traffic generated dust. Areas that may be inaccessible by water carts should be kept in a condition which minimises windblown or traffic generated dust using other means.
- All equipment for dust control will be kept in good operating condition. The equipment will be operable at all times with the exception of shutdowns required for maintenance. Construction equipment will be properly maintained to ensure exhaust emissions comply with relevant regulatory requirements.
- If visible smoke can be seen from any equipment (while working on a construction site) for longer than 10 seconds duration, the equipment should be taken out of service and adequately repaired or tuned so that smoke is no longer visible for periods longer than 10 seconds.
- Cleared vegetation, demolition materials and other combustible waste material should not be burnt on site.
- Silt should be removed from behind filter fences and other erosion control structures on a regular basis, so that collected silt does not become a source of dust.
- No dust, soil or mud should be deposited from any vehicle on public roads. Where wheel washing facilities are provided on construction works area, all drivers of construction vehicles shall utilise the wheel wash prior to leaving the works area and entering public roads.
- Any dust soil or mud deposited on public roads by sub-contractors construction activities and vehicle movements should be removed immediately and disposed of appropriately
- Hire agreements should contain provisions to stand down equipment which has excessively smoky exhaust.

7.2 Operational

7.2.1 Particulate Matter as PM_{10}

Presented in **Table 18** are the predicted highest 24-hour average PM_{10} concentrations at the identified four sensitive receptor sites, incorporating the 24-hour average regional background concentration as described in **Section 4.1.1**, the incremental increase due to emissions from ARTC as described in **Section 4.2**, and the 100th percentile incremental increase predicted for the Hexham TSF at each location. The NSW EPA goal for the 24-hour average ground level concentration of PM_{10} is 50 µg/m^3.

Also presented in **Table 18** are the results for the annual average concentration of PM_{10}. The NSW EPA goal for the annual average ground level concentration of PM_{10} is 30 µg/m^3.

The cumulative results of dispersion modelling indicate that no exceedences of the NSW EPA criteria for 24-hour average or annual average ground-level concentrations of PM_{10} will occur at any of the sensitive receptor locations as a result of activities associated with the operation of the Train Support Facility. Emissions from the ARTC and Hexham TSF Projects are predicted to have a negligible impact compared to existing regional background levels.

Table 18 Results of Dispersion Modelling for Particulate Matter as PM_{10}

Pollutant	Averaging Period	Receptor	Regional Background (µg/m³)	Increment by ARTC (µg/m³)	Increment by Hexham TSF (µg/m³)	Total Impact (µg/m³)	EPA Criteria (µg/m³)
PM_{10}	24-hours	R1	42.8	0	0.04	42.8	**50**
		R2	42.8	1	0.04	43.8	
		R3	42.8	0	0.04	42.8	
		R4	42.8	0	0.04	42.8	
	Annual	R1	17.2	0	0.006	17.2	**30**
		R2	17.2	0	0.007	17.2	
		R3	17.2	0	0.004	17.2	
		R4	17.2	0	0.004	17.2	

7.2.2 Nitrogen Dioxide

For the 1-hour averaging period, percentage conversions of 10% to 20% are typically applied for receptors in close proximity to major roads, while percentage conversions of 30% are considered conservative for receptors downstream of power station plumes (Bofinger et al 1986).

The degree to which the chemical transformation of oxides of nitrogen to nitrogen dioxide has occurred after emission from the source depends on a number of factors including temperature, sunlight, the amount of ozone present, and the distance downstream of the source. Thus the conversion of oxides of nitrogen to nitrogen dioxide is not instantaneous. On this basis, a NO_2 percentage conversion of 30% is considered appropriate for this assessment and has been applied to the predicted incremental increases associated with the Train Support Facility.

Presented in **Table 19** are the predicted the highest 1-hour average NO_2 concentrations at the four sensitive receptor sites incorporating the maximum 1-hour average regional background concentration as described in **Section 4.1.2,** the incremental increase due to emissions from ARTC as described in **Section 4.2**, and the 100th percentile incremental increase predicted for the Hexham TSF. The NSW EPA goal for the 1-hour average ground level concentration of nitrogen dioxide is 246 µg/m^3. Also presented in **Table 19** are the results for the annual average concentrations of NO_2. A NO_2 conversion rate of 100% has been assumed for the annual average. The NSW EPA goal for the annual average ground level concentration of nitrogen dioxide is 62 µg/m^3.

The maximum cumulative results of the dispersion modelling suggest that no exceedences of the relevant NSW EPA goals for ambient concentrations of NO_2 will occur at any of the sensitive receptor locations as a result of activities associated with the operation of the Train Support Facility.

Table 19 Results of the Dispersion Modelling for Nitrogen Dioxide

Pollutant	Averaging Period	Receptor	Regional Background (µg/m³)	Increment by ARTC (µg/m³)	Increment by Hexham TSF (µg/m³)	Total Impact (µg/m³)	EPA Criteria (µg/m³)
NO_2	1-hour	R1	79.0	70	2	151	**246**
		R2	79.0	78	2.5	159	
		R3	79.0	51	2.6	133	
		R4	79.0	110	2.7	192	
	Annual	R1	33.6	1	0.1	34.7	**62**
		R2	33.6	2	0.2	35.8	
		R3	33.6	0	0.1	33.7	
		R4	33.6	4	0.1	37.7	

7.2.3 Sulphur Dioxide

Presented in **Table 20** are the predicted the highest 1-hour average SO_2 concentrations at the four sensitive receptor sites incorporating the maximum 1-hour average regional background concentration as described in **Section 4.1.2,** the incremental increase due to emissions from ARTC as described in **Section 4.2**, and the 100th percentile incremental increase predicted for the Hexham TSF. Also presented in **Table 20** are the results for the 10-minute average, 1-hour average, 24-hour average and annual average ground-level concentrations of SO_2. The NSW EPA goal for the 10-minute average ground level concentration of sulphur dioxide is 700 µg/m^3. The goal for the 1-hour average concentration of sulphur dioxide is 570 µg/m^3. The goal for the 24-hour average concentration of sulphur dioxide is 228 µg/m^3. The goal for the annual average concentration of sulphur dioxide is 60 µg/m^3.

The maximum cumulative results predicted by the dispersion modelling suggest that no exceedences of the relevant NSW EPA goals for the ground level concentrations of SO_2 will occur at any of the sensitive receptor locations as a result of activities associated with the operation of the Train Support Facility.

Table 20 Results of the Dispersion Modelling for Sulphur Dioxide

Pollutant	Averaging Period	Receptor	Regional Background (µg/m^3)	Increment by ARTC (µg/m^3)	Increment by Hexham TSF (µg/m^3)	Total Impact (µg/m^3)	EPA Criteria (µg/m^3)
SO_2	10-minutes	R1	145.6	17.2	0.3	163.1	**700**
		R2	145.6	18.6	0.4	164.6	
		R3	145.6	11.4	0.4	157.4	
		R4	145.6	25.8	0.4	171.8	
	1-hour	R1	171.6	12	0.2	183.8	**570**
		R2	171.6	13	0.3	184.9	
		R3	171.6	8	0.3	179.9	
		R4	171.6	18	0.3	189.9	
	24-hours	R1	34.3	1	0.1	35.4	**228**
		R2	34.3	2	0.1	36.4	
		R3	34.3	0	0.1	34.4	
		R4	34.3	6	0.1	40.4	
	Annual	R1	4.9	0	0.01	4.9	**60**
		R2	4.9	0	0.02	4.9	
		R3	4.9	0	0.01	4.9	
		R4	4.9	1	0.01	5.9	

7.2.4 Carbon Monoxide

Presented in **Table 21** are the predicted highest 15-minute, 1-hour and 8-hour average CO concentrations at the four sensitive receptor sites, incorporating the maximum 1-hour average regional background concentration as described in **Section 4.1.2,** the incremental increase due to emissions from ARTC as described in **Section 4.2**, and the 100th percentile incremental increase predicted for the Hexham TSF.

The NSW EPA criterion for 15-minute average ground level concentrations of CO is 100 mg/m^3, the criterion for 1-hour average concentrations of CO is 30 mg/m^3 and the goal for 8-hour average concentrations of CO is 10 mg/m^3.

There are no 15-minute or 1-hour average background concentrations readily available from the Newcastle monitoring station, nor does the ARTC assessment report present 8-hour average concentrations predicted as a result of emissions from the Hexham Relief Roads and Hexham Crossing Loop Projects. However, the cumulative concentrations presented in **Table 21** based on the information that is available are far below EPA guideline levels. This suggests that exceedences of the relevant NSW EPA criteria for CO due to cumulative impacts are very unlikely to occur.

Table 21 Results of the Dispersion Modelling for Carbon Dioxide

Pollutant	Averaging Period	Receptor	Regional Background (mg/m^3)	Increment by ARTC (mg/m^3)	Increment by Hexham TSF (mg/m^3)	Total Impact (mg/m^3)	EPA Criteria (mg/m^3)
CO	15-minutes	R1	N/A	0.05	0.001	0.05	**100**
		R2	N/A	0.06	0.001	0.06	
		R3	N/A	0.04	0.001	0.04	
		R4	N/A	0.08	0.001	0.08	
	1-hour	R1	N/A	0.02	0.0008	0.02	**30**
		R2	N/A	0.03	0.001	0.03	
		R3	N/A	0.02	0.001	0.02	
		R4	N/A	0.06	0.001	0.06	
	8-hours	R1	1.7	N/A	0.0003	1.7	**10**
		R2	1.7	N/A	0.0004	1.7	
		R3	1.7	N/A	0.0004	1.7	
		R4	1.7	N/A	0.0004	1.7	

7.2.5 Total Hydrocarbons

Presented in **Table 22** are the results of the dispersion modelling for the maximum predicted ground-level concentrations of total hydrocarbons at the four sensitive receptor sites.

There are no ambient air quality criteria for total hydrocarbons, but criteria are set for some of the individual compounds that comprise total hydrocarbons emitted from diesel engines, also shown in **Table 22**. The results of the modelling show that even if the worst case assumption that all VOCs emitted from the site are in the form of either benzene, cyclohexane, ethylbenzene or n-hexane, the relevant EPA criterion is not predicted to be exceeded. As shown in **Table 15**, PAHs make up only 0.04% of the total VOC emissions from the engine emissions, hence no exceednaces of the PAH criterion is predicted either (i.e. 0.04% of 0.0004 mg/m^3 = 1.6×10^{-7} mg/m^3 which is far below the guideline of 0.0004 mg/m^3).

Table 22 Results of the Dispersion Modelling for Total Hydrocarbons (mg/m^3)

Pollutant	Averaging Period	Receptors	Increment by Hexham TSF (mg/m^3)	Speciated VOC Criteria (mg/m^3)
Total Hydrocarbons	1-hour	R1	0.0003	Benzene = 0.029 Cyclohexane = 19 Ethylbenzene = 8 n-hexane = 3.2 PAH (as benzo[a]pyrene) = 0.0004
		R2	0.0004	
		R3	0.0004	
		R4	0.0004	

7.2.6 Amenity

Consistent with the assumptions outlined in Connell Wagner (2007), based on the nature of the emission sources, it has been assumed that all of TSP is in the form of PM_{10}. As the contribution of on-site emission sources associated with the operational phase of the Train Support Facility to ground-level concentrations of PM_{10} are minimal, it is reasonable to expect that dust deposition resulting from activities associated with the operation of the Train Support Facility will not have a significant impact on local amenity.

7.3 Adverse Air Quality Impact Minimisation Measures

Consideration of the following may aid in minimising the potential for adverse impacts from the Train Support Facility operational sources:

- Minimise any non-essential idling of locomotives;
- Identify and expeditiously repair locomotives with excessive smoke;
- Incorporate the usage of low sulphur diesel fuel where available;
- Minimise fuel spillage; and,
- Exhaust emissions associated with low exit velocities have the highest potential for adverse ground-level impacts.

8 GREENHOUSE GAS ASSESSMENT

The DGR's for the Project require the following to be performed in relation to greenhouse gas (GHG) emissions:

- Conduct a Greenhouse Gas Assessment; taking into account the AGO Factors and Methods Workbook (Australian Greenhouse Office).

This GHG assessment has been performed with reference to the Australian Department of Climate Change and Energy Efficiency (DCCEE) document "*National Greenhouse Accounts Factors*" (July, 2012).

This assessment considers the impact of the proposed Project and compares this predicted impact to that currently experienced as a result of the current Kooragang facility operations.

Activity data for the following have been obtained from the Proponent for the period 1 September 2011 to 31 August 2012:

- Total Electricity Consumption (kilowatt-hours [kWh]); and,
- Total Diesel Consumption (litres [L]).

Data have been sourced from the Proponent provided spreadsheet 'Kooragang Fuel Usage Electricity usage Sep 11 to Aug 12'.

There was no available information regarding the use of Oil and Greases on the site, or the volume of waste that is transferred to landfill. These sources have not been considered within this assessment.

The historical construction project description indicated that Coal Rejects were to be removed from site. This is no longer the case. The construction of the facility is limited to:

- Construction of a connection to the Tarro Interchange and main vehicle access road to the site;
- Construction of earthworks, drainage, circulating road works and the construction of one provisioning track, a train examination road, two cut out roads and three wagon maintenance roads;
- Minor reshaping and modification to the existing coal reject stockpile will be required to make way for track associated with the TSF. Some 97,500 tonnes will be stockpiled within the former balloon loop site;
- Some filling and grading of the TSF area will be required (some 390,800 tonnes of clean fill will be imported) to ensure site levels can match the adjoining rail network;
- Associated signalling and connections to the down coal road on the Great Northern Line;
- Construction of a Wagon Maintenance Building and wash bay; and
- Construction of a Provisioning Facility.

The construction of the TSF is short term in nature and it is anticipated that GHG emissions during the operation of the facility will be higher than those generated during construction. Therefore the assessment of the construction of the TSF has not been considered any further within this GHG assessment.

8.1 Activity Data

8.1.1 Electricity Consumption

To assess the GHG impact of the proposed Hexham Train Support Facility, activity data for the current site operations has been sourced from the above referenced spreadsheet for the period 1 September 2011 to 31 August 2012. A total of 19,316 kWh of electricity was purchased during this period.

It is proposed that QR Operations will increase from 11 train sets (associated with the current Kooragang facility) to 38 train sets at the Hexham facility. Therefore approximately 3.4 times more trains will be serviced at the new facility.

For the purposes of being conservative, it has been estimated that the consumption of purchased electricity will be in the order of 3.4 times more than that currently used at the current Kooragang facility. Therefore, following Project construction, the TSF electricity consumption is anticipated to increase to 65,676 kWh per annum.

8.1.2 On-Site Diesel Consumption

Activity data for the current activities at the Kooragang faciltiy with respect to diesel consumption have been sourced from the above referenced spreadsheet for the period 1 September 2011 to 31 August 2012. This indicates that a total of 120,833 L of diesel was combusted for transport purposes during this period.

As previously discussed, 3.4 times more trains will be serviced at the Hexham facility than are currently serviced at the Kooragang Facility.

For the purposes of being conservative, it has been estimated that the consumption of diesel will be in the order of 3.4 times more than that currently used at the current Kooragang facility. Therefore, following Project construction, diesel consumption associated with the operation of the TSF is anticipated to increase to be 410,834 L/year.

8.1.3 Summary of Activity Data

A summary of activity data related to the current (Kooragang) and proposed operations at Hexham is provided in **Table 23**.

Table 23 Summary of Project Related Activity Data Relevant to GHG Emissions (Current and Proposed Operations)

Activity	Quantity for Project Operations	
	Current	Proposed
Annual Electricity Consumption (kWh)	19,316	65,676
Annual Diesel Consumption, on-site operations (L)	120,833	410,834

8.2 Direct and Indirect Emissions (Emissions Scope)

National Greenhouse and Energy Reporting Regulations 2008 defines Scope 1 and Scope 2 emissions as follows:

Division 2.5 Meaning of emissions, production and consumption: section 10

2.23 Meaning of *emissions*, *production* and *consumption*

(2) ***Emissions*** of greenhouse gas, in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of one of the following:

(a) an activity, or series of activities (including ancillary activities) that constitute the facility (***scope 1 emissions***);

(b) 1 or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility (***scope 2 emissions***).

Meaning of production

(3) ***Production*** of energy, in relation to a facility, means 1 of the following:

(a) the extraction or capture of energy from natural sources for final consumption by or from the operation of the facility or for use other than in the operation of the facility;

(b) the manufacture of energy by the conversion of energy from 1 form to another form for final consumption by or from the operation of the facility or for use other than in the operation of the facility.

Meaning of consumption

(4) ***Consumption*** of energy, in relation to a facility, means the use or disposal of energy from the operation of the facility including own-use and losses in extraction, production and transmission.

The Australian Government Department of Climate Change and Energy Efficiency (DCCEE) National Greenhouse Accounts Factors Workbook (DCCEE, 2012) has been used to define the methodology for estimating Scope 3 emissions in this assessment. The definition of Scope 3 emissions is defined as follows:

- Various emission factors can be used to calculate scope 3 emissions. For ease of use, this workbook reports specific 'Scope 3' emission factors for organisations that:

  (a) burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or

  (b) consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the T&D network.

8.3 Greenhouse Gas Calculation Methodology

Quantification of potential Project emissions has been undertaken in relation to both carbon dioxide (CO_2) and other non-CO_2 greenhouse gas emissions.

For comparative purposes, non-CO_2 greenhouse gases are awarded a "CO_2-equivalence" (CO_2-e) based on their contribution to the enhancement of the greenhouse effect. The CO_2-e of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO_2 greenhouse gases are contained within the Intergovernmental Panel on Climate Change (IPCC), (1996) document "*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*".

The GWPs of relevance to this assessment are:

- methane (CH_4): GWP of 21 (21 times more effective as a greenhouse gas than CO_2); and,
- nitrous oxide (N_2O): GWP of 310 (310 times more effective as a greenhouse gas than CO_2).

The short-lived gases such as carbon monoxide (CO), nitrogen dioxide (NO_2), and non-methane volatile organic compounds (NMVOCs) vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

The greenhouse gas emissions associated with the current and proposed Project have been assessed in terms of direct (Scope 1) emission potential, indirect (Scope 2) emission potential and significant upstream/downstream (Scope 3) emission potential.

A summary of the current and potential Project GHG emission sources is provided in **Table 24**.

Table 24 Summary of Potential Project Greenhouse Gas Emissions

Project Component	Direct Emissions	Indirect Emissions	
	Scope 1	**Scope 2**	**Scope 3**
Diesel	Emissions from the combustion of diesel at the Project in both mobile and fixed plant and equipment	N/A	Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project Site.
Electricity	N/A	Emissions associated with the consumption of purchased electricity at the Project Site.	Estimated emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed at the Project Site and the electricity lost in delivery in the transmission and distribution network.

N/A = Not applicable

8.3.1 Scope 1 (Direct) Emissions

On-Site Diesel Usage

The primary fuel source at the Project Site is diesel. Diesel consumption for all mobile and fixed equipment, including idling trains is calculated as presented in **Table 23**.

Annual Scope 1 emissions of CO_2 and other GHG from diesel combustion have been estimated using emission factors contained in **Table 25** (DCCEE, 2012).

Table 25 Fuel Combustion Emission Factors – fuel used for transport purposes

Fuel Combusted	Energy Content Factor (GJ/kL)	Emission Factor (kg CO_2-e/GJ)		
		CO_2	**CH_4**	**N_2O**
Diesel Oil	38.6	69.2	0.1	0.2

Source: Table 3, DCCEE (2012)

Scope 1 emissions of CO_2-e from the combustion of diesel fuel are presented in **Table 26** for the current operations and proposed operations at the Project site.

Table 26 Calculated Emissions from Diesel Combustion (tonnes) SCOPE 1

Source	Emissions (tonnes CO_2-e)
Current Operations	324
Proposed Operations	1,102

8.3.2 Scope 2: Indirect Emissions through the Consumption of Purchased Electricity

Scope 2 GHG emissions associated with the Project relate to the consumption of purchased electricity. The NGA Factors provides Scope 2 emission factors for the consumption of purchased electricity by each state of Australia. State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

The emission factor for Scope 2 (0.88 kg CO_2-e/kWh as per Table 5 of the NGA Factors) covers emissions from fuel combustion at power stations associated with the consumption of purchased electricity in New South Wales.

Annual Scope 2 emissions of CO_2-equivalent (CO_2-e) from the consumption of purchased electricity for operations at the Project Site are presented in **Table 27**.

Table 27 Scope 2 GHG Emissions – Purchased Electricity

Year	Consumption Rate (kWh/year)	Total Emissions (t CO_2-e year)
Current Operation	19,316	17.0
Proposed Operation	65,676	57.8

Source: Table 5, DCCEE (2012)

- **Scope 3: Other Indirect Emissions**

Extraction, Production and Transport of Fuel Burned for the Generation of Electricity and Electricity Consumed in the Transmission and Distribution System

The NGA Factors provides Scope 3 emission factors for the consumption of purchased electricity by each state. State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

The NSW Scope 3 emission factor (0.17 kg CO_2-e/kWh) covers both the emissions from the extraction, production and transport of fuels used in the production of the purchased electricity (i.e. fugitive emissions and stationary and mobile fuel combustion emissions) and also the emissions associated with the electricity lost in transmission and distribution on route to the customer.

Annual Scope 3 emissions of CO_2-equivalent from the consumption of purchased electricity for operations at the Project Site are presented in **Table 28**.

Table 28 Scope 3 GHG Emissions – Purchased Electricity

Year	Consumption Rate (kWh/year)	Total Emissions (t CO_2-e year)
Current Operation	19,316	3.3
Proposed Operation	65,676	11.2

Source: Table 45, DCCEE (2012)

Extraction, Production and Transport of Diesel Consumed at the Project

Scope 3 GHG emissions attributable to diesel used onsite at the Project Site relate to its extraction, production and transport. These emissions are associated with:

- diesel consumed by plant and equipment; and
- diesel consumed by idling trains.

The annual emissions of CO_2 and other GHG from this source have been estimated using Table 4 of the NGA Factors. The calculated Scope 3 diesel combustion related emissions are presented in **Table 29**.

Table 29 Scope 3 Diesel Combustion Related GHG Emissions

Year	Consumption (kL/year)	Energy Content (GJ/kL)	Emission Factor (kg CO_2 – e/GJ)	Total Emissions (t CO_2-e year)
Current Operation	120.8	38.6	5.3	24.7
Proposed Operation	410.8	38.6	5.3	83.9

8.4 Greenhouse Gas Calculation Results

Calculated Scope 1 and Scope 2 emissions of greenhouse gas resulting from the emissions sources outlined above for current operations (September 2011 to August 2012), and the proposed operations are presented in **Table 30**.

Table 30 Summary of Scope 1 and 2 GHG Emissions

Source	Emissions (tonnes CO_2-e)	
	Current Operations	**Proposed Operations**
Scope 1		
Diesel Combustion (on-site)	324	1,102
Scope 1 Subtotal	**324**	**1,102**
Scope 2		
Electricity Consumption	17.0	57.8
Scope 2 Subtotal	**17.0**	**57.8**
Scope 3		
Diesel	24.7	83.9
Electricity	3.3	11.2
Scope 3 Subtotal	**28.0**	**95.1**
Total Scope 1, 2 and 3	**369.0**	**1,254.9**

8.4.1 Scope 1 Emissions Estimations

Direct (Scope 1) GHG emissions (CO_2-e) resulting from the operation of the proposed Hexham TSF are estimated to be 1,102 tpa, an increase of approximately 778 tpa on current Kooragang operations.

8.4.2 Scope 2 Emissions Estimations

Indirect (Scope 2) GHG emissions (CO_2-e) resulting the operation of the proposed Hexham TSF are estimated to be 57.8 tpa, an increase of approximately 40.8 tpa on current Kooragang operations.

8.5 Comparison with National and State GHG Emissions

The estimated annual emissions associated with the modified Project are presented in **Table 31**.

Table 31 GHG Emissions Estimated to Result from Hexham TSF Operation

Emission Scope	Estimated Emissions (t CO_2-e/annum)
1	1,102
2	57.8
3	95.1
TOTAL	**1,254.9**

Emissions of GHG in NSW were reported to be 161 Mt in 2009, 27% of the Australian total GHG emissions of 545.8 Mt. Comparison of the emissions attributable to the Project with NSW and Australia emission totals is presented in **Table 32**.

Table 32 Comparison of Modified Project GHG Emissions with State and National Totals 2007

Emission Scope	Estimated Emissions (tCO_2-e/annum)	Percentage of NSW 2009 GHG Emission Total	Percentage of Australian 2009 GHG Emission Total
Scope 1	1,108	<0.001	<0.001
TOTAL (1, 2 and 3)	1,254.9	<0.001	<0.001

It is clear from the values presented in the preceding sections that the principal source of GHG emissions during the operational phase of the Project is the onsite usage of diesel although the totals are negligible when compared to NSW and Australian emissions totals.

9 DISCUSSION AND CONCLUSION

SLR Consulting Australia Pty Ltd (SLR Consulting) has been commissioned by QRNational to conduct an Air Quality Impact Assessment of the proposed Train Support Facility at Hexham, NSW.

In relation to the findings of the air quality assessment we note the following:

- The assessment has considered both operational and construction activities relating to the proposed project.
- A range of air pollutants has been considered including nitrogen dioxide, carbon monoxide, sulphur dioxide, and particulate matter. Air toxics associated with fuel storage and diesel exhaust from locomotives has also been considered.

- Dust generated in association with construction and coal tailing removal activities and impacts of nitrogen dioxide from diesel locomotive exhaust emissions are the most significant sources of air pollutants associated with the proposed project.
- Operation of the Train Support Facility is expected to have a minimal impact on air quality at the location of the sensitive receptors.
- The cumulative impact of the Train Support Facility and adjacent ARTC operations are expected to have a minimal impact on air quality at the location of the sensitive receptors.
- The low volume of trains using the Train Support Facility suggests that diesel exhaust emissions associated with on-site activities are unlikely to have a significant impact on local air quality.
- Impacts from dust emissions during construction can be minimised through the implementation of industry accepted best practice dust mitigation measures.
- As described within **Section 8**, with regard to the NSW and Australian greenhouse gas emissions, the increase associated with the proposed TSF is not considered significant.

10 RECOMMENDATIONS

10.1 Operational Dust Mitigation

Operational dust levels are predicted to be below the relevant guidelines at the closest residential receivers.

However, the following procedures and requirements should be followed during the life of the project to minimise the impact of dust generated in association with the proposed development:

- Watering of roads and sealing of roads where possible;
- Wind breaks composed of earth banks and other screens to protect areas by reducing capacity of the wind to raise dust; and
- Trucks entering and leaving the site should be well maintained in accordance with the manufacturer's specification to comply with all relevant regulations. Fines may be imposed on vehicles which do not comply with smoke emission standards. Truck movement should be controlled on site and restricted to designated roadways. Truck wheel washes or other dust removal procedures (including covering of loads) should be installed to minimise transport of dust offsite if necessary.

10.2 Construction Dust Mitigation

Dust mitigation during the construction phase of the project is considered essential.

It is recommended that the basic procedures (as detailed in **Section 7.1.1**), which are designed to control dust and other emissions from construction operations and on-site equipment are followed.

11 REFERENCES

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Appendix A

Windrose