Air Quality Impact Assessment

Hexham Relief Roads

Australian Rail Track Corporation

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KMH ENVIRONMENTAL

Air Quality Impact Assessment

Hexham Relief Roads

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Glossary and Abbreviations

GLC	Ground Level Concentration as calculated using Ausplume version 6.
$GLC_{(max)}$	The greatest predicted ground level concentration calculated using Ausplume version 6.
$PM_{2.5}$	The fraction of total particulate matter that has an aerodynamic diameter of 2.5 microns or less
PM_{10}	The fraction of total particulate matter has an aerodynamic diameter of 10 microns or less
NOx	Nitrogen oxides
NO_2	Nitrogen dioxide
CO	Carbon monoxide
Total HCs	Total hydrocarbons
PAHs	Polycyclic aromatic hydrocarbons
SO_2	Sulphur dioxide
OEH	Office of Environment and Heritage, NSW
BOM	Bureau of Meteorology
UTM	Universal Transverse Mercator. This is a system for describing position on the earth's surface by identifying coordinates with a zone. The earth's surface is divided into 60 zones.

Executive Summary

The ARTC proposes to develop five Relief Roads (tracks) and associated infrastructure at Hexham in the NSW Hunter Valley (the proposed Project). The proposed Project is located approximately 16km north west of the town of Newcastle.

Key components of the proposed 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 (1,543m long) requiring a minimum standing room of 1,670m; 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 estimated cost of the Project is approximately $90million and it is expected to take approximately 18 months to construct.

The Relief Roads proposed at Hexham aim to provide five holding roads outside of Kooragang Island. Each road will be capable of accommodating a 91 wagon coal train.

It is proposed that these Relief Roads be located between 174.100km and 176.220km chainage.

The project will not only facilitate the re-sequencing moves required when coal volume increases, but will avoid holding back laden coal trains that are affected by failures at coal terminals.

KMH Environmental (KMH) has conducted an air quality assessment on the proposed construction and operation of Relief Roads in Hexham, NSW.

The objective of this assessment is to determine any effects on residents (sensitive receptors) in the Hexham area resulting from the air emissions from locomotives whilst idle at three locations.

There are numerous potential sensitive receptors surrounding this area, including the residents of Hexham, Tarro and Beresfield, Maryland, Sandgate and Tomago. The closest sensitive receptors are located in the Hexham area adjacent to the eastern boundary of this site, and properties in Woodlands Close, Clark Street, Fenwick Street and Shamrock Street. The development is based on the existing rail corridor and runs along the Pacific Highway.

Both the construction and operation phases have been addressed in this assessment.

Construction phase emissions will be managed so as to have no significant impact with the use of normal industry management techniques.

Exhaust stack emissions from mobile locomotives moving into and out of the Relief Roads will not be of sufficient duration to effect measureable impact on any sensitive receptors. Only emission from stationary locomotives has been assessed.

Emission rates for the locomotives were obtained from manufacturer specifications, (as quoted in UHVA ARTC's report for the Air Quality Assessment of Koolbury Rail Loop (produced by PAE Holmes, 2009) and SLR Global Environmental Solutions' report for the Air Quality Impact Assessment of QR National's Train Support Facility have been used.

Existing background levels of pollutants, as measured at the Office of Environment and Heritage (NSW) air quality monitoring station at Beresfield, have been included in the assessment of cumulative impacts.

Additionally, the cumulative impact on background includes proposed Hexham Crossing Loop and QR National's Train Support Facility.

Dispersion modelling was conducted using the Ausplume Gaussian Plume Dispersion Model (version 6.0). Meteorological data was sourced from the Office of Environment and Heritage (NSW) air quality monitoring station at Beresfield.

All predicted ground level concentrations were below NSW OEH Impact assessment criteria.

1. Introduction

The objective of this study is to assess the potential air quality impacts on residents (sensitive receptors) in the Hexham area due to the construction and operation of The Hexham Relief Roads (the proposed Project). The study examined the potential air emissions from locomotives along with the added impacts of two other proposed rail projects within the area, the Hexham Passing Loop (part of the North Sydney Freight Line strategy) and a Train Support Facility proposed by Queensland Rail (QR) National.

The existing background levels of pollutants have been considered in the cumulative impact assessment, which includes additionally the potential impacts from the Hexham Crossing Loop (ARTC) and a Train Support Facility (QR National) projects.

Director-General's Requirements

The Director-General's Requirements (DGRs) identify Air Quality as a key issue for the Environmental Impact Statement.

Table 1 outlines the DGRs relevant to Air Quality and where the DGR is addressed within this EIS.

Table 1: Director-Generals Environmental Assessment Requirements – Air Quality

Director-Generals Requirements	Where addressed
Key issues	
Air Quality – including but not limited to:	
• *air pollutants, including an assessment of dust deposition, total suspended particulates, PM10 and any other atmospheric pollutants of concern for local and regional air quality;*	Section 6 of this report
• *a Scope 1 greenhouse gas assessment (as defined by the Greenhouse Gas Protocol); and*	**Chapter 22 Energy Demand and Greenhouse Gases**
• *taking into account the Australian Greenhouse Office Factors and Methods Workbook (AGO, 2006), and the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005).*	Section 6 of this report

2. Proposal Description

2.1. Overview

Five Up Relief Roads (train lines) to the west of the existing rail lines are proposed to be located adjacent to the Pacific Highway and Hexham Railway Station approximately 16 kilometres north west of Newcastle and 176 kilometres north of Sydney by rail. The existing Down Coal would be removed to make way for the Relief Roads and would be replaced by a new Down Coal that would be constructed to the west and outside of the proposed Relief Roads.

Each Relief Road would have capacity to store a train generally comprising 3 locomotives and up to 91 wagons (1,543m long), requiring a minimum standing room of 1,670 metres. New turnouts, return curves and changes to the existing track formation would also form part of the proposed Project. The tracks would be constructed on a foundation of coarse rock ranging between 600mm and 1,200mm deep. It is estimated that in the order of 110,000 cubic metres of material (comprising gabion rock and ballast) would be required which would be brought onto the site using trucks.

New railway signalling would be required to divert trains off the Up Coal Main, onto the Relief Roads and then back onto the Up Coal Main. This would involve installing electrical cables along the length of the Relief Roads and building a new overhead gantry for signals to control train movements. Some signalling enclosures would also be required to house the electronic control equipment. These would be built on platforms to be above the 1:100 year flood level.

Ancillary infrastructure would include vehicle access tracks, temporary construction compounds and stockpile sites. Land acquisition and the modification to existing rail infrastructure and public utilities would also be undertaken.

Access to the site for construction and for future operations and maintenance will be off the New England Highway as detailed in the traffic study accompanying the EIS.

The estimated cost of the proposed Project is approximately $90 million and it is expected to take approximately 18 months to construct.

2.2. Location

The proposed development is located on the western side of the Hunter River adjacent to Hexham, between 174.100km and 176.220km chainage. The orientation of the tracks is along a north-south axis (approximately).

The proposed site is shown in Figure 1 and Figure 2. The land use in this area is predominantly rural and is dominated by agricultural use. There are a number of townships and industrial areas within a 5km radius of the site.

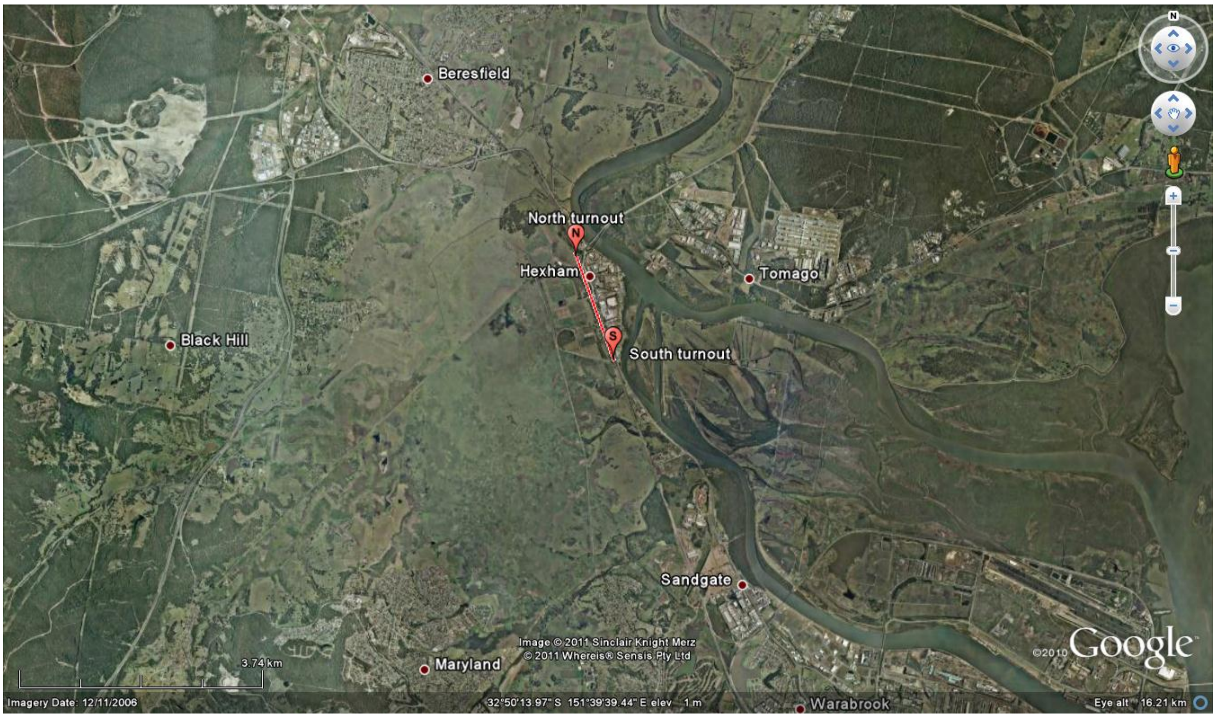

Figure 1: **Overview of the proposed location – Hexham** Image Source: Google Earth Pro

Figure 2: **Closer detail of location of proposed development** Image Source: Google Earth Pro

2.3. Sensitive Receivers

Twenty-four sensitive receptors have been identified in the vicinity of the proposed Hexham Relief Roads, including residential premises and workplaces (which are largely industrial). Twenty-four (24) specific locations were included in the dispersion model to represent impact at all of these sensitive receptors. The residential addresses within the Hexham area (Clark Street, Fenwick Street and

Shamrock Street) are further away from the emission source than the below sensitive receptors and therefore impact at these residential sites will be lower than the impact at these sensitive receptors.

Table 2: Sensitive receptors included in the dispersion model

Sensitive Receptors	Coordinates (UTM)		
	Zone	m E	m S
SR1	56 H	377067.49 m E	6366771.88 m S
SR2	56 H	377274.34 m E	6366100.62 m S
SR3	56 H	376855.32 m E	6367335.01 m S
SR4	56 H	377368.86 m E	6366841.26 m S
SR5	56 H	377889.75 m E	6367126.59 m S
SR6	56 H	378329.54 m E	6367517.14 m S
SR7	56 H	379009.47 m E	6367047.38 m S
SR8	56 H	378207.86 m E	6367944.41 m S
SR9	56 H	379120.77 m E	6367882.15 m S
SR10	56 H	380202.26 m E	6367372.25 m S
SR11	56 H	380886.52 m E	6366638.96 m S
SR12	56 H	376604.18 m E	6367686.72 m S
SR13	56 H	375513.93 m E	6368815.59 m S
SR14	56 H	373962.90 m E	6368289.23 m S
SR15	56 H	374720.99 m E	6368769.50 m S
SR16	56 H	375761.51 m E	6367142.85 m S
SR17	56 H	373548.71 m E	6366432.18 m S
SR18	56 H	373125.16 m E	6367257.98 m S
SR19	56 H	374531.29 m E	6367257.98 m S
SR20	56 H	377256.94 m E	6362224.35 m S
SR21	56 H	378010.59 m E	6364146.47 m S
SR22	56 H	378662.59 m E	6363748.24 m S
SR23	56 H	378868.88 m E	6363263.93 m S
SR24	56 H	379184.64 m E	6362396.78 m S

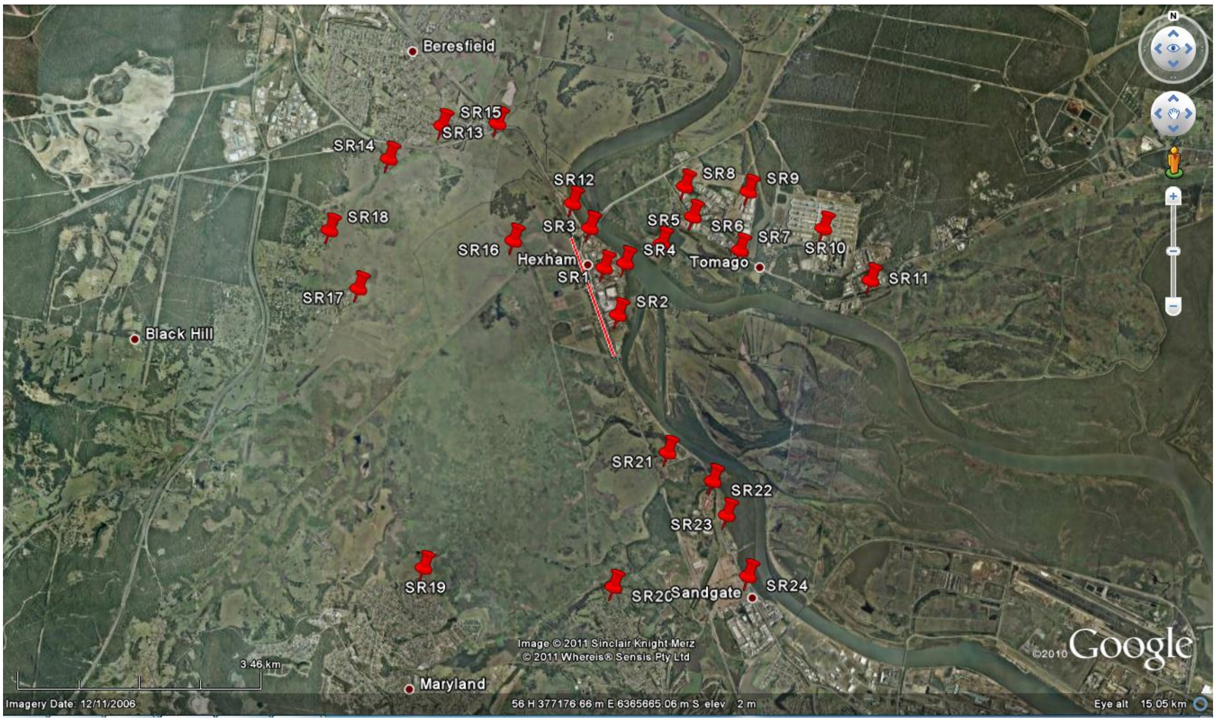

Figure 3: **Sensitive receptors included in the dispersion model** Image Source: Google Earth Pro

3. Assessment Criteria

Dispersion modelling results have been compared to ground level concentration criteria defined in the NSW Department of Environment and Conservation's 2005 Publication *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. The substances identified as possible pollutants from locomotives, their impact assessment criteria and the sources of the criteria are presented in Table 3 below.

Table 3: Assessment criteria

Substance	Impact Assessment Criteria (µg/m³)			
	15min Averaging Time	1hr Averaging Time	24hr Averaging Time	Annual Average
1,3-Butadiene	-	40	-	-
Benzene	-	29	-	-
Carbon monoxide (CO)	100	30	-	-
Nitrogen Dioxide (NO_2)	-	246	-	62
Particulate Matter ≤10.0 µm (PM_{10})	-	-	50	30
Particulate Matter ≤2.5 µm ($PM_{2.5}$)	-	-	25	-
Polycyclic Aromatic Hydrocarbons	-	0.4	-	-
Sulphur Dioxide (SO_2)	-	570	228	60

4. Modelling Parameters

4.1. Locomotives

Table 4 below lists the locomotives that operate in the Hunter Valley and their power ratings. Emission rates for the 81 and 90 class locomotives have been used due to the prevalence of these trains on this railway line.

Table 4: Locomotives operating in the Hunter Valley

Locomotive Class	Power rating, kW (hp)
81	2,500 (3,300)
82	2,425 (3,250)
90	3,030 (4,060)
92	3,370 (4,500)
G	2,830 (3,800)

4.2. Emission Sources and Rates

It is assumed that the only emission sources from the trains during operations are the exhaust points on the top of locomotives. It is assumed that there are three locomotives in each train. The dispersion modelling is based on a conservative basis which assumes five trains idle continuously (i.e. 24 hours per day) in the Relief Roads. In reality this will not happen as trains would move in and out of the Relief Roads, but has been represented as a worst-case scenario.

Dust emissions from moving wagons are not included in this report, due to the low speed train movements entering the relief roads. Any particulate matter generated via train movement will be insignificant. The erosion of dust from wagons is unlikely at the site, as any surface dust would have been removed prior as any loaded trains would have been subjected to the combined effects of the travel speed and prevailing wind before arriving at this location. Therefore the modelling in this report is only addressing emissions from idle locomotives.

This also applies to the crossing loop, however the emission is based on an estimate that there will be one train idle for an entire hour, every hour, to account for the higher traffic rates.

Exhaust vent details are given in Table 5 below:

Table 5: Locomotive exhaust parameters

Locomotive Exhaust Vents	
Diameter (mm)	300
Height from ground level (m)	4.3
Distance from front of locomotive (m)	2
Exit velocity (m/s)	15
Temperature at exit (°C)	200

Emissions data from manufacturer specifications, (as quoted in PAEHolmes' report for the Air Quality Assessment of ARTC Koolbury Rail Loop, 2009) have been used; (see Table 6 below). An additional level of conservatism has been applied by using the highest emission rate from each class of locomotive for each pollutant.

Table 6: 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)
NO_x	0.97	90 Class (RIC)
NO_2*	0.19	Derived from NO_x
PM_{10}	0.013	81 Class (Lilley, 1996)
SO_2	0.032	90 Class (RIC)
$PM_{2.5}$**	0.012	Derived

* NO_2 has been calculated as 20% of NO_x levels as a conservative approach for modelling purposes.
** Emission rates for $PM_{2.5}$ from locomotives are based on the assumption that 98% of PM_{10} is less than 2.5 microns.

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 7 below.

Table 7: Relative contributions of toxic organic substances to total hydrocarbon emissions

NPI Substance	Line Haul Locomotive Emission Factors (g/L)	% of Total Hydrocarbons
1,3-Butadiene	0.31	7.3
Benzene	0.35	8.2
Polycyclic Aromatic Hydrocarbons	0.0017	0.040
Total Volatile Organic Compounds	4.27	100

4.3. Modelling Scenarios

Four scenarios were modelled. These are:

- five trains have been modelled 24 hours per day to demonstrate worst possible impact; and
- three, two and one train(s) have been modelled 24 hours per day to demonstrate impact under differing operational capacities.

When interpreting the results of the dispersion modelling, consideration should be given to the frequency of the weather conditions likely to result in maximum concentrations of pollutants at ground level. In conjunction with this, the worst case emissions (i.e. five locomotives idling simultaneously) would need to coincide with the worst case weather conditions in order to achieve the predicted results at ground level.

4.4. Background Concentration of Contaminants

4.4.1. Beresfield air quality monitoring station

Existing background concentrations of pollutants have been included in this assessment for applicable parameters.

These parameters are shown in Table 8 along with the highest ranked background concentration. The 100th percentile result has been used in all cases.

Table 8: Beresfield background concentrations 2006

Parameter	Background Concentration (100th percentile, µg/m³)
Nitrogen dioxide (hourly average)	67.7
Sulphur dioxide (hourly average)	107
PM_{10}	Hourly average : 163 24 hour average: 58 Annual average: 21
$PM_{2.5}$	Hourly average : 259 24 hour average: 31 Annual average: 6.8

The Beresfield air quality monitoring site is located at Francis Greenway High School, on Lawson Avenue, Beresfield. It is situated in a residential area to the north-west of Newcastle and is at an elevation of 14 metres.

Beresfield is approximately 4.5km north-west of the Project site and would have air quality that is representative of the Project area.

The most recent complete data set available for Beresfield is for 2006 and was supplied by the Office of Environment and Heritage.

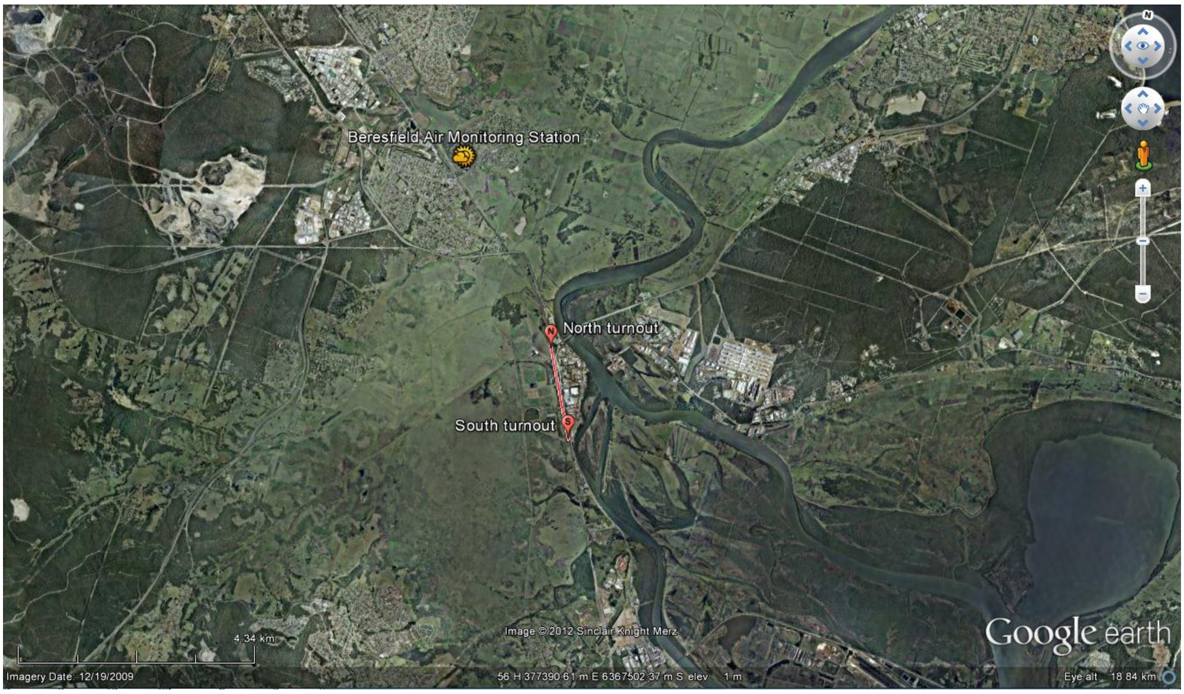

Figure 4: Location of Beresfield monitoring station Image Source: Google Earth Pro

4.4.2. Hexham Crossing Loop

ARTC's proposed Hexham Crossing Loop has been included in this assessment by inclusion of the expected emission sources in the Ausplume modelling. The basis for predicting emission from this development is identical to the basis applied for the Relief Roads.

The proposed project site is located north of Hexham and the five Relief Roads, and will provide a nominal 1570m clear standing room to accommodate a 1500m 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 location is shown in Figure 5.

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.

It is assumed that the management of construction will be conducted according to standard industry procedures and that fugitive emissions will be negligible.

The basis for modelling this development is identical to the basis developed for the Relief Roads, as shown in Sections 4.1 and 4.2. Again, it has been assumed that trains will be idle in the crossing loop for the entire hour, every hour (worst case scenario).

The emission rates used are shown in the Hexham crossing loop are shown in Table 9.

Table 9: Estimated emission rates for idling diesel locomotives at the crossing loop

Pollutant	Emission rate (kg/hr)	Source
CO	0.163	81 Class (Lilley, 1996)
Total hydrocarbons	0.042	90 Class (RIC)
NO_2	0.292	90 Class (RIC)
PM_{10}	0.013	81 Class (Lilley, 1996)
SO_2	0.048	90 Class (RIC)
$PM_{2.5}$*	0.012	Derived

* Emission rates for $PM_{2.5}$ from locomotives are based on the assumption that 98% of PM_{10} is less than 2.5 microns.

Table 10: Estimated Coordinates of proposed North and South points along the Hexham Crossing Loop

Location	m E	m S
North	376606.86	6367509.46
South	375629.80	6368910.23

The three locomotives from the Hexham Crossing loop development were applied in the modelling for the project; the location of the crossing loop and specific source points can be seen in Figure 4.

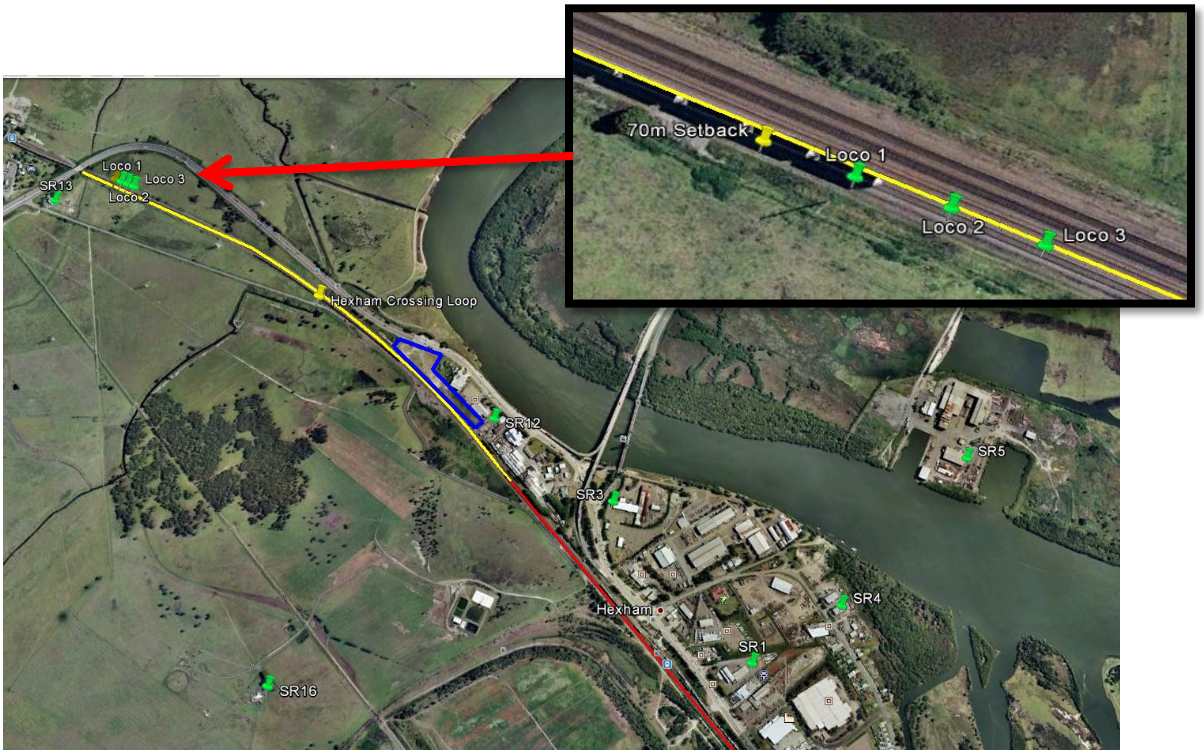

Figure 5: The location of the three locomotives applied to the modelling Image Sourced: Google Maps Pro

4.4.3. QR National Train Support Facility

QR National proposed Train Support Facility has been included in the cumulative background by using the highest predicted ground level concentrations reported in SLR Global Environmental Solutions' report for the Air Quality Impact Assessment of QR National's Train Support Facility 2011.

The highest (100th percentile) ground level concentrations found for this site are shown in Table 11. The results reported by SLR have been used and NO_2 has been adjusted to the conservative estimate used throughout this assessment (i.e. 20% of NO_x is assumed to be NO_2).
The QR National Train Support Facility is located on the former Coal and Allied land and other adjoining land owned by QR National off Maitland Road at Hexham. It will operate 7 days per week. The facility is anticipated to be 3 km in length and will be located parallel to the Pacific Highway at Hexham, immediately to the west of the Relief Roads.

The purpose of this facility is to provide a service centre and associated yard 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;
- spare parts can be held for locomotives and wagons;
- refuelling of diesel engines; and
- fuel storage.

The GLC_{max} calculated for QR National Train Support Facility was applied as background data for the modelling of the Relief Roads as shown in Table 11.

Table 11: (GLC_{max}) for QR National Train Support Facility

Substance	(GLC_{max}) for QR National Train Support Facility (µg/m³)			
	15mins Averaging Time	1hr Averaging Time	24hr Averaging Time	Annual Average
Carbon monoxide	2.2	2.2	-	-
Nitrogen Dioxide (NO_2)	-	38.8*	-	5.7*
Particulate Matter ≤10.0 µm	-	-	3.3	0.3
Particulate Matter ≤2.5 µm	-			
Sulphur Dioxide	-	0.6	0.5	0.2

* NO_2 assumed to be 20% of NO_x.

Source: SLR Global Environmental Solutions

4.5. Meteorological Data

Site specific meteorological data was sourced from the Office of Environment and Heritage (OEH) air quality monitoring station in Beresfield. This site is approximately 4.5kms north-west of the proposed site and is considered sufficiently similar to be a good representation of the atmospheric conditions at the proposed site. The location of this air monitoring station is shown in Figure 4.

Data from this monitoring station was supplemented with data from the Williamtown Airport.

The data set is 99% complete and all seasons are well represented.

The meteorological file was compiled in accordance with NSW Department of Environment and Conservation's 2005 Publication *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.*

4.5.1. Prevalent weather conditions

The climate in this area is typical of the lower Hunter Valley. The summer is warm and is the wettest period of the year. The winters are cooler and relatively dry. The meteorological data used for the dispersion modelling was sourced from the Beresfield Air Monitoring Station (Office of Environment and Heritage), shown in Figure 6. The data set used is from 2006 and is the most current full data set available.

This monitoring station is considered to be a good representation of atmospheric conditions at the proposed site because it is within close proximity and shares similar topography.

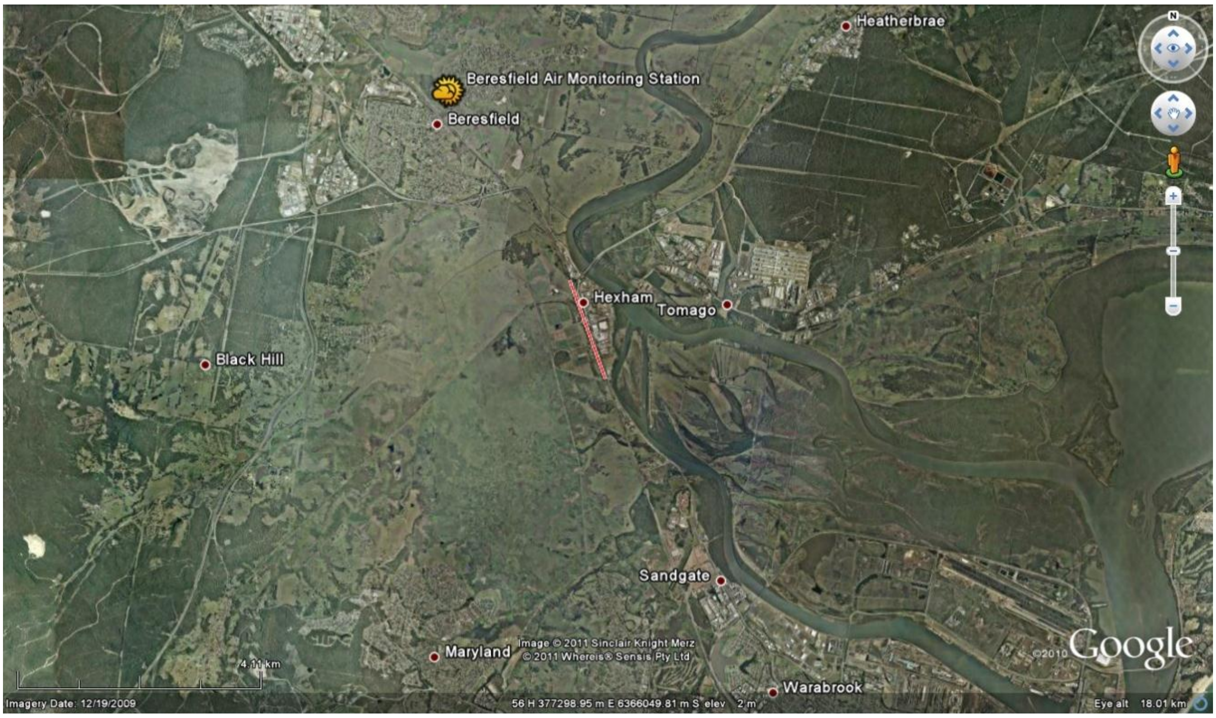

Figure 6 **Location of Beresfield Air Monitoring Station** Image Source: Google Earth Pro

4.5.2. Temperature profile

The seasonal temperature ranges are shown in Figure 7.

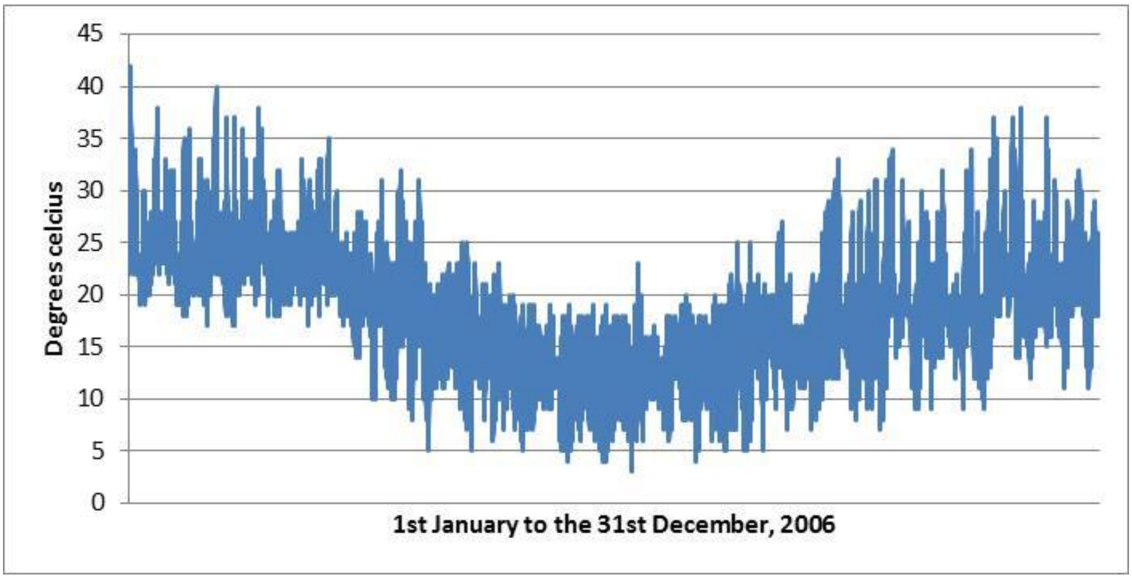

Figure 7: **Annual temperature profile**

4.5.3. Wind speed and direction

Figure 8 shows the average wind speed and direction for the each season and the annual average.

The summer months are dominated by stronger winds that tend from between easterly, south easterly and southerly directions. This reverses during autumn months, which are dominated by north westerly winds at speeds that are similar to those found in the summer but are less variable in direction. This trend continues during winter with the trend being towards somewhat calmer stable breezes originating from a north westerly direction. The breeze then picks up during the spring to become highly variable in both speed and direction.

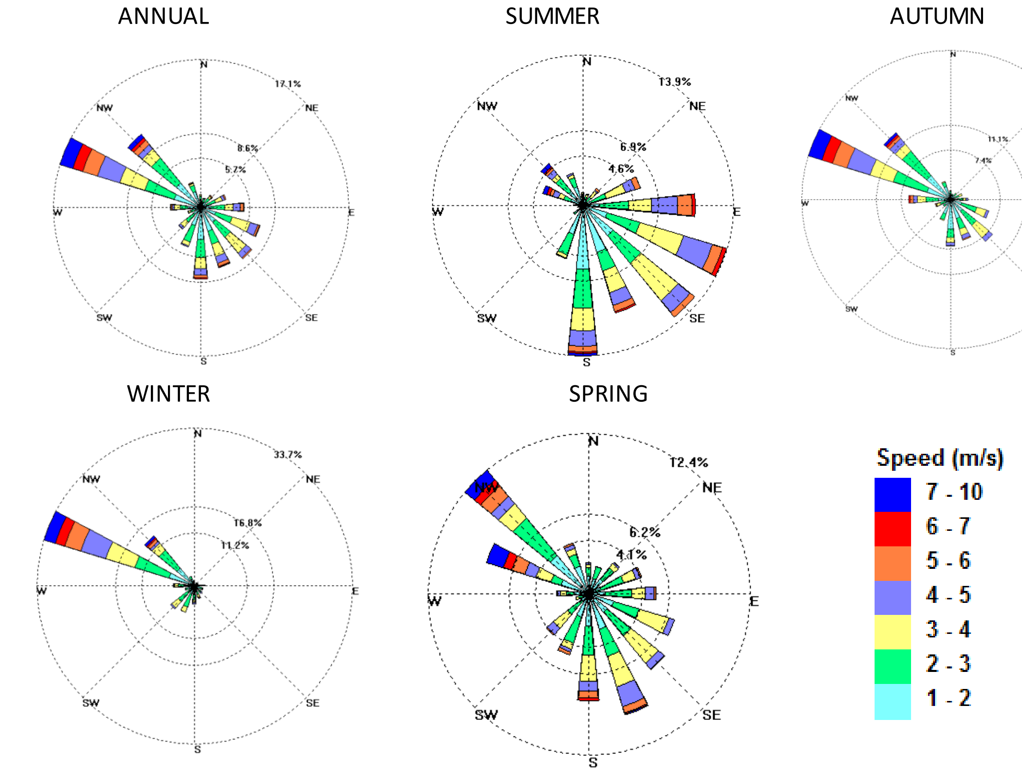

Figure 8: **Seasonal wind speed and direction**

4.6. Terrain

The proposed location for the Hexham Relief Roads is at river level and is generally flat, being adjacent to low lying swamp lands.

A key feature of this area is the Hunter River, which runs roughly on a north-south trajectory to the east of the proposed site (see Figure 1). The river is within 300 meters of rail track at some locations.

Nevertheless, terrain effects have been included in the model using a site specific terrain file.

4.7. Conservative Basis for Estimates

A conservative approach has been applied for predicting the likely environmental impact of the proposed development. This approach ensures that any bias created by the estimates used is towards higher emissions and hence predictions.

Given this approach the actual environmental impact should always be equal to or less than suggested by these results.

It is important that the results of the dispersion modelling are understood within this context.

The following is a summary of the items for which a conservative approach was taken and a description of the potential impact on results:

- worst case emission rates have been used (see section 4.2);
- these calculations have been performed for every hour of data in 2006. It is only under specific combinations of weather conditions that the maximum ground level concentration, (GLC_{max}), of any parameter will occur and it has been assumed that trains will in fact be lying idle in the Relief Roads when those particular weather conditions exist; and

- the probability of this occurring could be calculated based on expected traffic on the track, and the predicted number of occasions when 2 and 5 trains will be idling in the Relief Roads.

5. Construction Phase

Construction activities have potential to create particulate (dust) emissions which, if uncontrolled, may affect local amenity. It has been assumed that good dust management practices would be adopted where necessary during the construction phase, and that the resultant offsite impacts would be minimal.

Dust control practices would be implemented and may include:

- use of water sprays on stockpiles and unsealed construction areas;
- establishment and enforcement of onsite vehicle speed limit;
- covering of vehicles loads carrying loose material;
- maintenance of vehicles and machinery in an efficient condition to minimise potential emissions; and
- visual monitoring wind conditions and adjusting construction activities accordingly.

6. Operational Phase Air Dispersion Modelling Results

This section shows the cumulative impact of existing background concentrations, the Hexham Relief Roads, Hexham Crossing Loop and QR National's Train Support Facility.

Each parameter has been modelled for four scenarios, in which 1, 2, 3 and 5 trains are idle in the Relief Roads.

Note that the impact assessment criterion is applicable at any sensitive receptor.

6.1. Nitrogen Dioxide (NO_2)

Table 12 Nitrogen dioxide GLC(max) at each sensitive receptor for 1 hour averaging period

Sensitive Receptors	NO2 - 1 Hour								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop & QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m3)		246 µg/m3							
SR1	67.70	84	99	115	147	145	161	177	209
SR2	67.70	90	113	134	178	135	152	174	217
SR3	67.70	83	98	113	143	147	159	171	194
SR4	67.70	83	99	114	146	136	148	159	185
SR5	67.70	84	101	117	150	137	149	161	185
SR6	67.70	83	98	113	143	135	140	148	175
SR7	67.70	84	101	117	151	135	146	161	194
SR8	67.70	82	97	112	142	135	143	156	181
SR9	67.70	84	101	117	150	136	146	157	188
SR10	67.70	81	94	108	134	135	140	151	177
SR11	67.70	78	88	98	118	135	137	143	156
SR12	67.70	82	97	111	140	144	155	165	187
SR13	67.70	78	88	98	119	139	143	150	167
SR14	67.70	77	86	95	113	136	141	148	163
SR15	67.70	78	89	100	121	139	146	154	169
SR16	67.70	82	96	110	138	140	145	156	179

Sensitive Receptors	NO2 - 1 Hour								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop & QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
SR17	67.70	78	88	99	119	135	140	148	164
SR18	67.70	77	87	96	116	135	135	135	142
SR19	67.70	78	87	97	117	135	138	144	157
SR20	67.70	79	90	101	124	135	135	139	157
SR21	67.70	82	96	110	137	135	141	152	176
SR22	67.70	83	97	112	141	135	137	144	173
SR23	68.00	80	93	105	129	136	136	136	160
SR24	67.70	78	88	98	119	135	135	135	150

*T1 Refers to 1 train idle in the Relief Roads

Table 13 shows the $GLC_{(max)}$ predicted at each sensitive receptor for each of four scenarios for a 1 hour averaging period.

Table 13: Nitrogen dioxide $GLC_{(max)}$ at each sensitive receptor for 1 hour averaging period

Sensitive Receptors	NO_2 - 1 Hour								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop & QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m^3)		**246 µg/m^3**							
SR1	67.70	84	99	115	147	145	161	177	209
SR2	67.70	90	113	134	178	135	152	174	217
SR3	67.70	83	98	113	143	147	159	171	194
SR4	67.70	83	99	114	146	136	148	159	185
SR5	67.70	84	101	117	150	137	149	161	185
SR6	67.70	83	98	113	143	135	140	148	175
SR7	67.70	84	101	117	151	135	146	161	194
SR8	67.70	82	97	112	142	135	143	156	181
SR9	67.70	84	101	117	150	136	146	157	188
SR10	67.70	81	94	108	134	135	140	151	177

Sensitive Receptors	NO$_2$ - 1 Hour								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop & QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
SR11	67.70	78	88	98	118	135	137	143	156
SR12	67.70	82	97	111	140	144	155	165	187
SR13	67.70	78	88	98	119	139	143	150	167
SR14	67.70	77	86	95	113	136	141	148	163
SR15	67.70	78	89	100	121	139	146	154	169
SR16	67.70	82	96	110	138	140	145	156	179
SR17	67.70	78	88	99	119	135	140	148	164
SR18	67.70	77	87	96	116	135	135	135	142
SR19	67.70	78	87	97	117	135	138	144	157
SR20	67.70	79	90	101	124	135	135	139	157
SR21	67.70	82	96	110	137	135	141	152	176
SR22	67.70	83	97	112	141	135	137	144	173
SR23	68.00	80	93	105	129	136	136	136	160
SR24	67.70	78	88	98	119	135	135	135	150

*T1 Refers to 1 train idle in the Relief Roads

Modelling results indicate that GLC$_{(Max)}$ at all sensitive receptors is below the assessment criteria for the hourly averaging time.

Table 14 shows the GLC$_{(max)}$ predicted at each sensitive receptor for each of the four scenarios for an annual averaging period.

Table 14: Nitrogen dioxide GLC($_{max}$) at each sensitive receptor for an annual averaging period

Sensitive Receptors	NO$_2$ - Annual								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	1T*	2T	1T*	2T	1T*	2T
Assessment criteria (µg/m^3)		**62 µg/m^3**							
SR1	19	19	20	20	21	25	26	26	27
SR2	19	20	21	22	23	26	26	27	29

Sensitive Receptors	NO$_2$ - Annual								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	1T*	2T	1T*	2T	1T*	2T
SR3	19	19	20	20	20	25	25	26	26
SR4	19	19	20	20	21	25	26	26	27
SR5	19	19	19	20	20	25	25	25	26
SR6	19	19	19	19	20	25	25	25	26
SR7	19	19	19	19	19	25	25	25	25
SR8	19	19	19	19	20	25	25	25	26
SR9	19	19	19	19	19	25	25	25	25
SR10	19	19	19	19	19	25	25	25	25
SR11	19	19	19	19	19	25	25	25	25
SR12	19	19	19	20	20	25	25	26	26
SR13	19	19	19	19	19	26	26	26	26
SR14	19	19	19	19	19	25	25	25	25
SR15	19	19	19	19	19	25	25	25	25
SR16	19	19	19	19	20	25	25	25	26
SR17	19	19	19	19	19	25	25	25	25
SR18	19	19	19	19	19	25	25	25	25
SR19	19	19	19	19	19	25	25	25	25
SR20	19	19	19	19	19	25	25	25	25
SR21	19	19	19	19	19	25	25	25	25
SR22	19	19	19	19	20	25	25	25	25
SR23	19	19	19	19	19	25	25	25	25
SR24	19	19	19	19	19	25	25	25	25

*T1 Refers to 1 train idle in the Relief Roads

Modelling results indicate that GLC$_{(Max)}$ at all sensitive receptors is below the assessment criteria for both the annual averaging time.

6.2. Carbon Monoxide (CO)

Table 15 shows the Carbon monoxide $GLC_{(max)}$ predicted at each sensitive receptor for the four scenarios. Note that background concentration of CO is not measured at the Beresfield Air Monitoring Station. There are no significant sources of CO in the region so it is reasonable to assume that background levels are negligible.

Table 15: Carbon monoxide GLC(max) at each sensitive receptor for 15 minute averaging times

Sensitive Receptors	CO – 15 Min Average							
	Hexham Relief Roads Only				Hexham Relief Roads + Crossing Loop + QR National			
	1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m³)	**100,000 µg/m³**							
SR1	12	23	35	58	14	25	37	60
SR2	16	33	48	80	19	35	51	82
SR3	11	22	33	55	13	24	35	57
SR4	11	22	34	57	13	24	36	59
SR5	12	24	36	60	14	26	38	62
SR6	10	20	31	52	12	23	33	55
SR7	12	24	36	60	14	26	38	63
SR8	11	21	32	54	13	23	34	56
SR9	12	24	36	61	14	27	39	63
SR10	10	20	29	49	12	22	31	51
SR11	7	15	22	37	10	17	24	39
SR12	11	21	32	52	13	23	34	54
SR13	7	15	22	37	21	21	24	39
SR14	7	13	20	33	14	15	22	36
SR15	8	16	23	39	20	20	26	41
SR16	10	20	31	51	12	23	33	54
SR17	7	15	22	37	10	17	24	39
SR18	7	13	20	34	13	16	22	36
SR19	7	14	21	34	11	16	23	36
SR20	8	16	24	39	10	18	26	42
SR21	10	20	30	49	17	27	36	55

Sensitive Receptors	CO – 15 Min Average							
	Hexham Relief Roads Only				Hexham Relief Roads + Crossing Loop + QR National			
	1T*	2T	3T	5T	1T	2T	3T	5T
SR22	11	21	32	52	15	26	36	57
SR23	9	18	27	44	14	23	32	49
SR24	7	15	23	38	13	21	28	43

*T1 Refers to 1 train idle in the Relief Roads

The modelling results indicate that the maximum predicted CO concentrations will not exceed the assessment criteria for 15 minute averaging time at any sensitive receptor.

Table 16: Carbon monoxide GLC($_{max}$) at each sensitive receptor for 1hour averaging times

Sensitive Receptors	CO – 1 Hour Average							
	Hexham Relief Roads Only				Hexham Relief Roads + Crossing Loop + QR National			
	1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m^3)	**30,000 µg/m^3**							
SR1	6	12	18	30	8	14	21	32
SR2	11	23	34	56	14	25	36	58
SR3	5	9	14	24	7	12	16	26
SR4	5	11	16	27	7	13	18	29
SR5	4	8	12	20	6	10	14	22
SR6	4	8	12	20	7	10	14	22
SR7	4	8	12	20	6	10	15	23
SR8	3	7	10	17	7	9	12	19
SR9	4	8	11	19	6	10	14	21
SR10	4	7	11	19	6	10	13	21
SR11	3	5	8	13	5	7	10	15
SR12	4	9	13	22	8	11	15	24
SR13	3	6	9	15	21	21	21	21
SR14	3	7	10	17	7	9	12	19
SR15	3	5	8	12	10	10	10	15
SR16	4	8	12	20	6	10	15	23

Sensitive Receptors	CO – 1 Hour Average							
	Hexham Relief Roads Only				Hexham Relief Roads + Crossing Loop + QR National			
	1T*	2T	3T	5T	1T	2T	3T	5T
SR17	3	5	8	13	5	7	10	15
SR18	3	6	9	15	6	8	11	17
SR19	3	6	8	14	6	8	11	16
SR20	2	5	7	12	6	8	11	16
SR21	5	10	14	24	9	14	19	28
SR22	4	8	12	21	7	11	15	24
SR23	3	6	10	16	6	10	13	19
SR24	2	5	7	12	6	8	11	15

*T1 Refers to 1 train idle in the Relief Roads

The modelling results indicate that the maximum predicted CO concentrations will not exceed the assessment criteria for 1 hour averaging time at any sensitive receptor.

6.3. Dust - PM_{10}

The Level 2 methodology for applying background NSW Department of Environment and Conservation's 2005 Publication *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* has been used for PM_{10} 24 hour averaging time.

This method requires the application of contemporaneous background data. It is not practical to conduct this level of assessment at all sensitive receptors and so the study has been limited to a selected number of receptors. The sensitive receptors have been selected to demonstrate the highest impact in all directions from the Hexham Relief Roads.

All results are calculated based on five trains idling simultaneously in the Relief Roads.

Table 17 shows the highest 10 results for GLC at each of the selected sensitive receptors.

All results are below the assessment criteria of 50 µg/m^3.

Table 17: Particulate Matter (PM_{10}) $GLC_{(top\ ten)}$ at selected sensitive receptors - 24 hour averaging period

Rank	Background	Hexham Relief Roads + Background						Hexham Relief Roads + Background + Hexham Crossing Loop + QR National					
		SR1	SR2	SR4	SR12	SR16	SR21	SR1	SR2	SR4	SR12	SR16	SR21
1	45	46	45	46	45	45	45	49	48	49	48	48	48
2	44	45	45	45	44	44	44	48	48	47	47	47	47
3	44	45	44	45	44	44	44	47	48	48	47	47	47
4	44	45	44	45	44	44	44	47	47	47	47	47	47
5	44	45	44	45	44	44	44	47	47	47	47	47	47

Rank	Background	Hexham Relief Roads + Background						Hexham Relief Roads + Background + Hexham Crossing Loop + QR National					
		SR1	SR2	SR4	SR12	SR16	SR21	SR1	SR2	SR4	SR12	SR16	SR21
6	42	43	42	43	42	42	42	45	45	45	45	45	45
7	41	42	41	42	41	41	41	44	45	44	44	44	44
8	40	41	40	41	40	40	40	43	44	43	43	43	43
9	39	40	39	40	39	39	39	42	42	43	42	43	42
10	39	40	39	40	39	39	39	42	42	42	42	43	42

Table 18 shows the Particulate Matter (PM_{10}) $GLC_{(max)}$ predicted at each sensitive receptor annually at all four scenarios.

Table 18: Particulate Matter (PM_{10}) GLC(max) at each sensitive receptor annually

Sensitive Receptors	PM_{10} - Annual								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m^3)		30 µg/m^3							
SR1	21	21	21	21	21	21	21	21	21
SR2	21	21	21	21	21	21	21	21	22
SR3	21	21	21	21	21	21	21	21	21
SR4	21	21	21	21	21	21	21	21	21
SR5	21	21	21	21	21	21	21	21	21
SR6	21	21	21	21	21	21	21	21	21
SR7	21	21	21	21	21	21	21	21	21
SR8	21	21	21	21	21	21	21	21	21
SR9	21	21	21	21	21	21	21	21	21
SR10	21	21	21	21	21	21	21	21	21
SR11	21	21	21	21	21	21	21	21	21
SR12	21	21	21	21	21	21	21	21	21
SR13	21	21	21	21	21	21	21	21	21
SR14	21	21	21	21	21	21	21	21	21
SR15	21	21	21	21	21	21	21	21	21

Sensitive Receptors	PM$_{10}$ - Annual								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
SR16	21	21	21	21	21	21	21	21	21
SR17	21	21	21	21	21	21	21	21	21
SR18	21	21	21	21	21	21	21	21	21
SR19	21	21	21	21	21	21	21	21	21
SR20	21	21	21	21	21	21	21	21	21
SR21	21	21	21	21	21	21	21	21	21
SR22	21	21	21	21	21	21	21	21	21
SR23	21	21	21	21	21	21	21	21	21
SR24	21	21	21	21	21	21	21	21	21

*T1 Refers to 1 train idle in the Relief Roads

The modelling results indicate that the maximum predicted PM$_{10}$ concentrations will not exceed the assessment criteria for annual averaging time at any sensitive receptor.

6.4. Dust - PM$_{2.5}$

The Level 2 methodology for applying background NSW Department of Environment and Conservation's 2005 Publication *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* has been used for PM$_{2.5}$ 24 hour averaging time due to the higher levels found in the background data.

This method requires the application of contemporaneous background data. It is not practical or necessary to conduct this level of assessment at all sensitive receptors. The sensitive receptors have been selected to demonstrate the highest impact in all directions from the Hexham Relief Roads.

All results are calculated based on five trains idling simultaneously in the Relief Roads.

Table 19 shows the highest 10 results for GLC at each of the selected sensitive receptors.

All results are within the assessment criteria of 25 µg/m^3.

Table 19: PM$_{2.5}$ GLC(max) at each sensitive receptor for 24 hour averaging period

Rank	Background	Hexham Relief Roads + Background						Hexham Relief Roads + Background + Hexham Crossing Loop + QR National					
		SR1	SR2	SR4	SR12	SR16	SR21	SR1	SR2	SR4	SR12	SR16	SR21
1	21	22	23	22	21	21	21	22	23	22	21	21	21
2	17	18	19	18	17	17	17	18	19	18	17	17	17
3	16	17	18	17	16	16	16	17	18	17	16	16	16

Rank	Background	Hexham Relief Roads + Background						Hexham Relief Roads + Background + Hexham Crossing Loop + QR National					
		SR1	SR2	SR4	SR12	SR16	SR21	SR1	SR2	SR4	SR12	SR16	SR21
4	16	17	18	17	16	16	16	17	18	17	16	16	16
5	16	17	17	17	16	16	16	17	17	17	16	16	16
6	15	16	16	16	15	15	15	16	16	16	15	15	15
7	14	15	15	15	14	14	14	15	15	15	14	14	14
8	14	15	15	15	14	14	14	15	15	15	14	14	14
9	14	15	15	14	14	14	14	15	15	15	14	14	14
10	13	14	14	13	13	13	13	14	14	13	13	13	13

Note: SLR Global Environmental Solutions did not address $PM_{2.5}$ concentrations to their results; therefore $PM_{2.5}$ has not been applied for the QR National site.

6.5. Sulphur Dioxide (SO_2)

The modelling results for Sulphur dioxide (SO_2) GLC(max) are presented in Table 20, showing the predicted concentrations at each sensitive receptor for a 1 hour averaging period for the four scenarios. All results are well below the assessment criteria.

Table 20: Sulphur Dioxide GLC(max) at each sensitive receptor for a 1 hour averaging time

Sensitive Receptors	SO_2 – 1 Hour								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m³)		**570 µg/m³**							
SR1	107	110	112	115	120	110	113	115	121
SR2	107	111	114	118	125	111	115	119	126
SR3	107	109	112	114	119	110	113	115	120
SR4	107	110	112	115	120	110	113	115	121
SR5	107	110	112	115	121	110	113	116	121
SR6	107	109	112	114	119	110	113	115	120
SR7	107	110	112	115	121	110	113	116	121
SR8	107	109	112	114	119	110	112	115	120
SR9	107	110	112	115	121	110	113	116	121
SR10	107	109	111	114	118	110	112	114	119

Sensitive Receptors	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
	SO_2 – 1 Hour								
		1T*	2T	3T	5T	1T	2T	3T	5T
SR11	107	109	110	112	115	109	111	113	116
SR12	107	109	112	114	119	110	112	115	119
SR13	107	109	110	112	115	111	111	113	116
SR14	107	108	110	111	114	109	111	112	115
SR15	107	109	110	112	116	110	111	113	116
SR16	107	109	112	114	119	110	112	114	119
SR17	107	109	110	112	115	109	111	113	116
SR18	107	109	110	112	115	109	111	112	115
SR19	107	109	110	112	115	109	111	112	116
SR20	107	109	111	113	116	109	111	113	117
SR21	107	109	112	114	118	111	113	115	120
SR22	107	109	112	114	119	110	113	115	120
SR23	107	109	111	113	117	110	112	114	118
SR24	107	109	110	112	115	110	111	113	117

*T1 Refers to 1 train idle in the Relief Roads

The modelling results indicate that the maximum predicted SO_2 concentrations will not exceed the assessment criteria for 1 hour averaging time at any sensitive receptor.

The modelling of Sulphur dioxide (SO_2) for GLC (max) is presented in Table 21, showing the predicted concentrations at each sensitive receptor for a 24-hour averaging period for the four scenarios.

Table 21: Sulphur dioxide GLC(max) at each sensitive receptor for 24 hour averaging period

Sensitive Receptors	SO_2 – 24 Hour								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m^3)		**228 µg/m^3**							
SR1	28	28	29	29	30	29	29	30	31
SR2	28	29	31	32	34	30	31	32	34
SR3	28	28	29	29	29	29	29	29	30
SR4	28	28	29	29	30	29	29	30	31
SR5	28	28	29	29	29	29	29	29	30
SR6	28	28	29	29	29	29	29	29	30
SR7	28	28	28	29	29	29	29	29	30
SR8	28	28	28	29	29	29	29	29	30
SR9	28	28	28	29	29	29	29	29	29
SR10	28	28	28	29	29	29	29	29	29
SR11	28	28	28	29	29	29	29	29	29
SR12	28	28	28	29	29	29	29	29	30
SR13	28	28	28	28	28	30	30	30	30
SR14	28	28	28	28	29	29	29	29	29
SR15	28	28	28	28	29	29	29	29	29
SR16	28	28	28	29	29	29	29	29	30
SR17	28	28	28	28	28	29	29	29	29
SR18	28	28	28	28	29	29	29	29	29
SR19	28	28	28	28	29	29	29	29	29
SR20	28	28	28	28	28	29	29	29	29
SR21	28	28	28	28	29	29	29	29	29
SR22	28	28	28	28	29	29	29	29	29
SR23	28	28	28	28	29	29	29	29	29
SR24	28	28	28	28	29	29	29	29	29

*T1 Refers to 1 train idle in the Relief Roads

The modelling results indicate that the maximum predicted SO_2 concentrations will not exceed the assessment criteria for 24-hour averaging time at any sensitive receptor.

The modelling of Sulphur dioxide (SO_2) for GLC (max) is presented in Table 22, showing the predicted concentrations at each sensitive receptor for an annual averaging period for the four scenarios.

Table 22: Sulphur dioxide GLC(max) at each sensitive receptor annually

Sensitive Receptors	SO_2 – Annual								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
Assessment criteria (µg/m³)		60 µg/m³							
SR1	5	5	5	5	5	5	5	5	6
SR2	5	5	5	5	6	5	5	6	6
SR3	5	5	5	5	5	5	5	5	5
SR4	5	5	5	5	5	5	5	5	6
SR5	5	5	5	5	5	5	5	5	5
SR6	5	5	5	5	5	5	5	5	5
SR7	5	5	5	5	5	5	5	5	5
SR8	5	5	5	5	5	5	5	5	5
SR9	5	5	5	5	5	5	5	5	5
SR10	5	5	5	5	5	5	5	5	5
SR11	5	5	5	5	5	5	5	5	5
SR12	5	5	5	5	5	5	5	5	5
SR13	5	5	5	5	5	5	5	5	5
SR14	5	5	5	5	5	5	5	5	5
SR15	5	5	5	5	5	5	5	5	5
SR16	5	5	5	5	5	5	5	5	5
SR17	5	5	5	5	5	5	5	5	5
SR18	5	5	5	5	5	5	5	5	5
SR19	5	5	5	5	5	5	5	5	5
SR20	5	5	5	5	5	5	5	5	5

Sensitive Receptors	SO_2 – Annual								
	Existing Background Only	Existing Background+ Hexham Relief Roads				Existing Background+ Hexham Relief Roads + Crossing Loop +QR National			
		1T*	2T	3T	5T	1T	2T	3T	5T
SR21	5	5	5	5	5	5	5	5	5
SR22	5	5	5	5	5	5	5	5	5
SR23	5	5	5	5	5	5	5	5	5
SR24	5	5	5	5	5	5	5	5	5

*T1 Refers to 1 train idle in the Relief Roads

The modelling results indicate that the maximum predicted SO_2 concentrations will not exceed the assessment criteria for annual averaging time at any sensitive receptor.

6.6. Hydrocarbons

Dispersion modelling was conducted using an estimate for total hydrocarbon emission rate. There is no ground level acceptability criterion for total hydrocarbons, but criteria are set for some of the individual compounds that comprise total hydrocarbons (1, 3-butadiene, benzene and polycyclic aromatic hydrocarbons).

The highest predicted GLC for total hydrocarbons anywhere in the modelling domain that encompasses all of the identified sensitive receptors is 0.087 mg/m^3. As this result is the highest anywhere in the domain, it follows that results at any specific receptor are below this level.

In reality, the amount of each of these compounds comprising total hydrocarbons is many times lower than the combined total. Using the ratio of emissions of these constituents to total hydrocarbons, the predicted GLCs of these compounds were calculated for the proposed signal locations (see Table 23). All concentrations are well below acceptance criteria.

Table 23: Predicted GLC of hydrocarbons

Parameter	Acceptability Criteria (mg/m^3)	Proportion of total hydrocarbons	Predicted GLC (mg/m^3)
Total hydrocarbon	-	100%	0.087
Benzene	0.029	8.2%	0.0071
1,3 butadiene	0.04	7.3%	0.0063
PAHs	0.0004	0.04%	0.000035

7. Cumulative Impact

An estimate of the contribution of two nearby proposed sites has been included in this study. These sites are:

- Hexham Crossing Loop; and
- Train Support Facility (QR National).

The methodology used is shown in Section 4.4 and the results are shown in Section 5. Total (cumulative) impact has been calculated to be the sum of the existing background and predicted contribution from Hexham Relief Roads, Hexham Crossing Loop and QR National's Train Support Facility.

The results show that the expected impact on sensitive receptors from these sites is relatively minor and is below all OEH impact assessment criteria.

8. Conclusions

The dispersion modelling shows that the ground level concentrations of all parameters included in this study would be below recommended levels at all of the identified sensitive receptors. The dispersion modelling is based on a conservative basis which assumes five trains idle continuously (i.e. 24 hours per day) in the Relief Roads. In reality this will not happen as trains would move in and out of the Relief Roads, but has been represented as a worst-case scenario.

The modelling also accounts for additional emission contributions from the Hexham crossing loop and the concentrations provided by SLR Global Environmental Solutions for the QR National Train Support Facility.

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