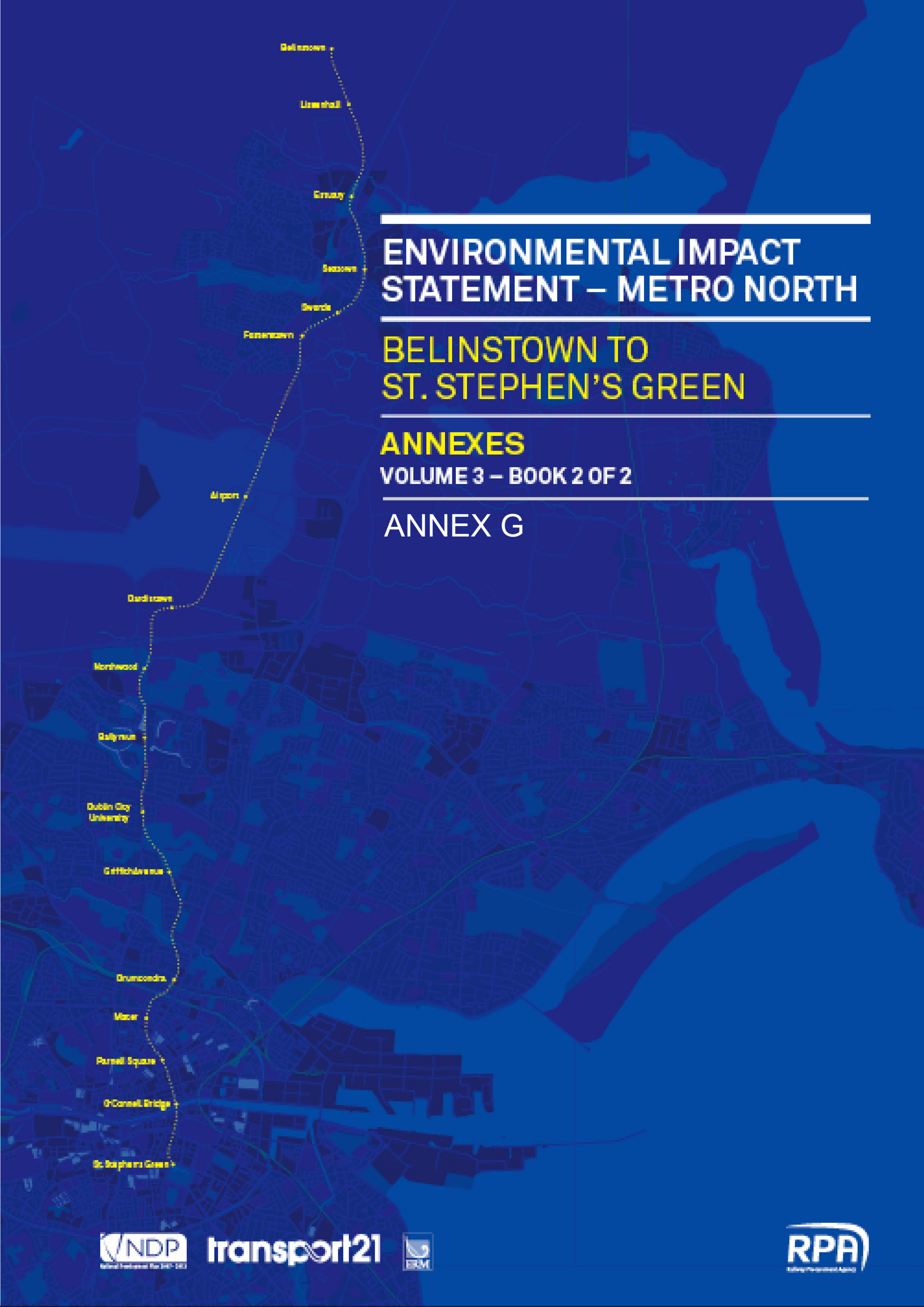


ENVIRONMENTAL IMPACT STATEMENT – METRO NORTH

BELINSTOWN TO ST. STEPHEN'S GREEN

ANNEXES

VOLUME 3 – BOOK 2 OF 2

ANNEX G

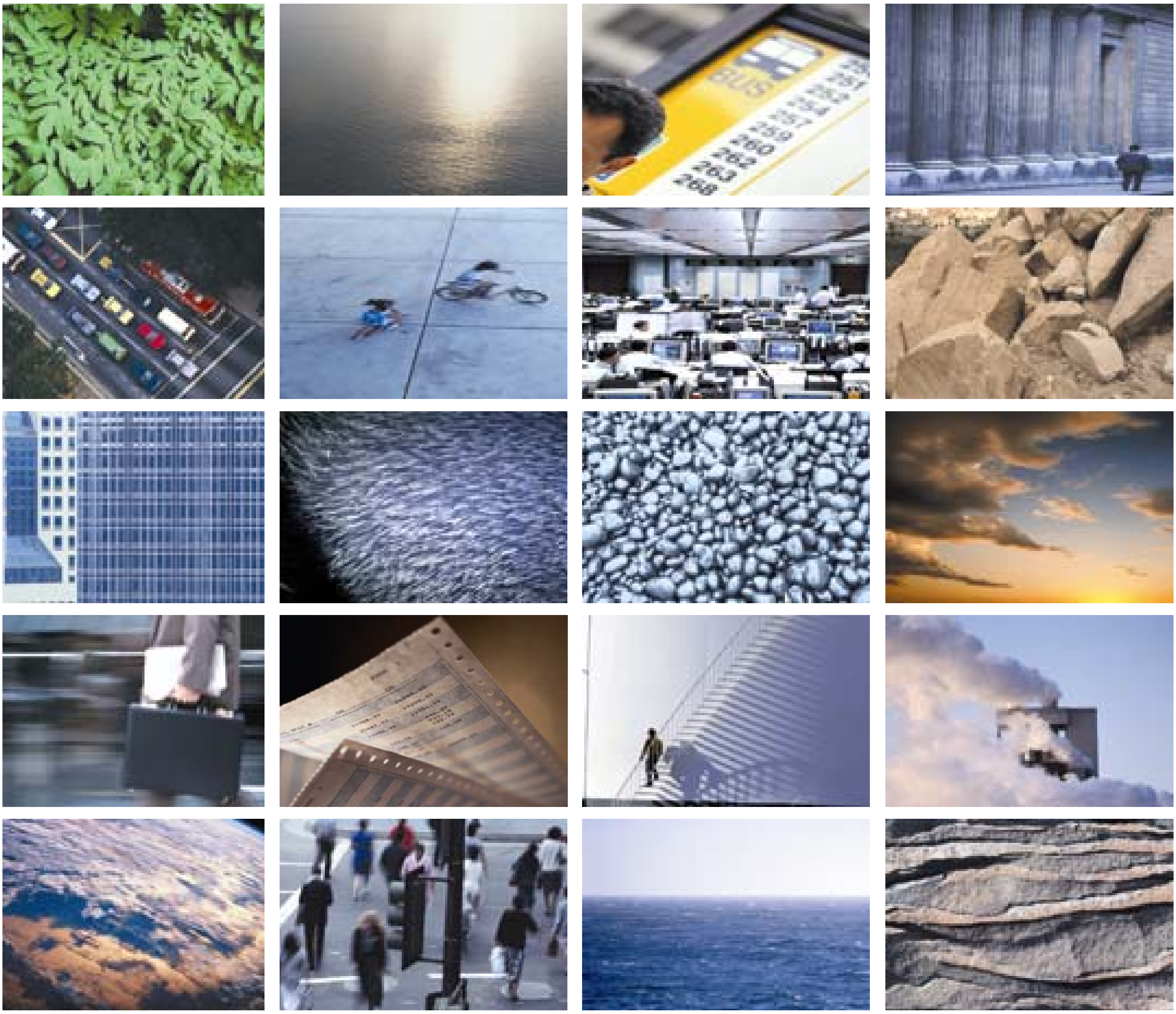
NDP National Development Plan 2007-2013
transport21
ERM
RPA Railway Procurement Agency

Annex G

Metro North EIS

Information supporting the air and climatic factors chapters

- Air modelling report



Air modelling report

For the Metro North EIS

Final Report

July 2008

www.erm.com

Railway Procurement Agency

Air modelling report: *For the Metro North EIS*

July 2008

For and on behalf of
Environmental Resources Management

Approved by: Roger Barowcliffe

Signed:

Position: Partner

Date: 18/07/2008

CONTENTS

1 AIR QUALITY AND CLIMATE CHANGE

1.1 INTRODUCTION

This report assesses the potential impact of the proposed Dublin Metro North alignment on air quality in terms of the changes in traffic movements associated with its operation and construction.

The impact that the scheme will have on air quality is assessed for the first construction year of 2011. The impact that the scheme will have on air quality is assessed for the first operational year of 2013-14 and also for 2028 - the 15 year post opening horizon date. In some areas, the operation of the scheme will give rise to reduced traffic on the road network, where car users switch from private car to rail. In other areas, the air quality may potentially be adversely affected by increases in traffic flows or congestion resulting from restrictions on roads carrying the transit rail system.

The potential Metro North alignment has been assessed with respect to the pollutants that relate to road traffic, nitrogen dioxide (NO_2) and particulate matter (PM_{10}), and the greenhouse gas, carbon dioxide (CO_2). The Transport Analysis Guidance (TAG) (1) and the Design Manual for Roads and Bridges (DMRB) Air Quality Assessment (2) have been used, as produced by the UK Highways Agency. These tools have been selected for their ability to assess the impacts across many roads in a network, rather than other tools that might restrict an assessor to consider individual roads in isolation.

1.2 ASSESSMENT CRITERIA

1.2.1 Air Pollution

In order to protect our health, vegetation and ecosystems, the EU has set down air quality standards in member states for a wide variety of pollutants. Principles of this approach are outlined in the *1996 Air Quality Framework Directive*. This has been transposed into Irish law through the *Environmental Protection Agency Act 1992* (Ambient Air Quality Assessment and Management) Regulations (SI 33 of 1999).

The new directive has not yet been transposed into Irish law, but does not introduce any new air quality limit values, except for the approach to particulate matter. Whereas the previous directive, and Irish law, have a limit value for PM_{10} to be achieved in 2010, the new directive calls for a limit value for $PM_{2.5}$ of 20 $\mu g\ m^{-3}$ to be achieved by 2020, with an interim target value of 25 $\mu g\ m^{-3}$ by 2015. This limit value will, at some point, be transposed into Irish law and has therefore been adopted as a criterion for this assessment.

(1)Department for Transport (2004) Transport Analysis Guidance (TAG), February 2004 www.webtag.org.uk
(2) Highways Agency (2003) Design Manual for Roads and Bridges, Air Quality Assessment, Version 1.03(c), July 2007

Four Daughter directives lay down limit values for specific pollutants. The first two daughter Directives set by the European Commission have been transposed into Irish law via the *Air Quality Standards Regulations 2002*. These established new air quality standards with respect to SO_2, NO_2, NO_x, PM_{10}, lead, CO and benzene. The third daughter directive transposed limits on ozone emissions into Irish law through The Ozone in Ambient Air Regulations (2004). The fourth daughter directive, which imposes restriction on emissions of arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons, was expected to be transposed into Irish law in 2007. However, the relevant Regulation is currently in draft form.

On the 14th April 2008 the European Commission adopted the *Directive on Ambient Air Quality and Cleaner Air for Europe 2008*. The directive merges the four directives mentioned above and one Council decision into a single directive on air quality.

A summary of the air quality standards relevant to the Dublin area is shown in *Table 1.1*.

Table 1.1 *Irish Air Quality Standards*

Pollutant	Limit Value Objective	Averaging Period	Limit Value ($\mu g\ m^{-3}$)	Basis of Application of the Limit Value	Limit Value Attainment Date
NO_2	Protection of Human Health	Calendar year	40	Annual mean	
		1 hour	200	Not to be exceeded more than 18 times in a calendar year	
PM_{10} Stage 1 (a)	Protection of Human Health	Calendar year	40	Annual mean	
		24 hours	50	Not to be exceeded more than 35 times in a calendar year	
PM_{10} Stage 2 (b)	Protection of Human Health	Calendar year	(20)	Annual mean	1 January 2010
		24 hours	(50)	(Not to be exceeded more than 7 times in a calendar year)	1 January 2010

(a) Stage 1: 1 January 2005 to 1 January 2010
(b) Stage 2: From 1 January 2010 (no longer part of EU legislation)

1.2.2 *Climate Change*

The impact of the scheme on global emissions has been identified through assessing absolute changes in emissions from road traffic of carbon dioxide (CO_2), a gas with the potential for global warming.

1.3 *ASSESSMENT METHODOLOGY*

1.3.1 *Introduction*

The development has the potential to cause changes to traffic flows on the road network. Some of these changes will be very small while others may be of significance. As such, nitrogen dioxide (NO_2) and particulate matter (PM_{10}) have been assessed here, as they are the principal pollutants relating to emissions from road traffic. The emissions of the greenhouse gas, carbon dioxide (CO_2) have also been quantified.

The effects on air quality may be experienced by a widespread population, some of which may be remote from the proposed alignment. This poses a real and practical problem for the air quality assessment. The Metro North alignment extends from Dublin City Centre northwards, to the city of Swords. Overall, it will traverse a network of over 3,000 road links. Quantifying the changes in air quality in detail along all roads with modified traffic flows would be an impossible task. To solve this problem, the approach that has been taken is detailed in TAG (Transport Analysis Guidance) (1). The traffic model results have been translated into changes in roadside air quality using a spreadsheet model that considers the effects in terms of the numbers of road links experiencing a change in air quality. The methodology provides a robust estimate of ground level concentrations for direct comparison/ evaluation with the standards included in the Irish Air Quality Standards Regulations 2002.

The spreadsheet model used here applies a graphical screening method to a large number of roads, using a series of graphical relationships to predict pollutant concentrations at receptors at a given distance from the road. These graphical relationships include relationships between vehicle speeds and pollutant emissions and between the assessment year and vehicle emissions.

Traffic assessments are usually undertaken for road links where traffic flows increase by 10% or more and air quality impacts are considered to be possible. This, however, would not reflect the large number of individually small changes to traffic flows on roads as a result of Metro North. For a more comprehensive assessment, all of the road links affected by the Metro North alignment have been assessed. The road links have, therefore, been screened on the basis of pollutant concentration change as a result of the scheme, instead of in terms of traffic flows at the beginning of the assessment.

This assessment does not quantify the cumulative impact of several roads situated close to individual houses, or at a specific location. The estimated number of links exceeding the relevant air quality limit values in each scenario is estimated. Also quantified in this assessment is the number of links that no longer exceed the relevant air quality limit values as a direct result of the

(1) Department for Transport (2004) Transport Analysis Guidance (TAG), February 2004 www.webtag.org.uk

traffic flow changes from implementation of Metro North. The net change in pollutant concentrations over the network is also reported.

1.3.2 Model Input Parameters

Air quality in two scenarios has been assessed for the construction phase:

- Do Minimum 2011; and
- Do Metro 2011.

Air quality in four scenarios has been assessed for the operational phase:

- Do Minimum 2013-14;
- Do Metro 2013-14;
- Do Minimum 2028; and
- Do Metro 2028.

Two comparisons have been made for the operational phase:

- Do Minimum 2013-14 to Do Metro 2013-14; and
- Do Minimum 2028 to Do Metro 2028.

The assessment takes into account road links within the entire network in the vicinity of the Metro North alignment. Associated with each road link in the traffic network modelled, are four distance bands, extending out to 200m. The change in air quality is predicted within each of these bands, ie at four distances from the centre of the road link. Changes in road traffic have no significant influence on air quality at distances beyond 200m.

Significance Criteria

For the purpose of this report the significance criteria in terms of changes in air quality for NO_2 and PM_{10} concentrations are shown below in *Table 1.2.*

Table 1.2 Significance Criteria for NO_2 and PM_{10}

NO_2 (µg m^{-3})	**Significance**
Change less than 0.4	Insignificant
Change between 0.4 and 1 (+/-)	Negligible
Change between 1 and 5 (+/-)	Minor
Change between 5 and 25 (+/-)	Moderate
Change between 25 and 50 (+/-)	Major

Traffic data were provided by the consultancy MVA, in Dublin. Details of the assumptions made and of the parameters required for the assessment are provided below.

AADT (Annual Average Daily Traffic)

AADT values were provided for the years of assessment. The AADT values were calculated from a combination of the available model hours of 7-9am and 2-3pm.

Existing National Roads Authority count information was used to calculate factors to apply to both the morning (AM) and inter-peak (IP) flow rates. The equations are:

2 Way AADT (Car) = [3.70 * (AM Cars)] + [8.58 * (IP Cars)]
2 Way AADT (HGV) = [3.95 * (AM HGV)] + [6.36 * (IP HGV)]

The AADT value is for two-way traffic flows.

Speed

The speeds provided were based on the flow between 8-9am and were provided directionally. The TAG assessment requires a single speed input for each AADT; therefore, where the individual road link was two-directional, the average speed over the two directions were used.

As the speeds used in the assessment were based on the morning peak traffic flows, it is likely that they will not represent traffic speeds throughout the day. Slower moving traffic emits higher pollutants at higher concentrations, and so, therefore, using the 8-9am traffic speed represents a conservative approach to the assessment.

LGV and HGV Percentage

HGV percentages were provided directionally for each individual link. As with the speed, where the individual road link was two-directional, the average HGV percentage over the two directions was used.

This value was then used to derive the LGV percentage.

Road Type

The TAG model requires the classification of roads as one of the following types:

- A – All motorways and A-roads;
- B – Urban roads which are neither motorways nor A-roads;
- C – Any other roads (including B-rural roads and minor roads); and
- D – Selected if traffic composition on the link is known.

Table 1.3 shows the classification of the link type, as provided by MVA, as well as the TAG road type assumed to be analogous to the MVA classification.

Table 1.3 ***Road Type Classification***

MVA Classification	MVA Definition	Tag Analogous Road Type
UM	Through route with grade separated junctions, hard shoulders or hardstrips and motorway restrictions. Speed limit: 60mph or less	A
UAP1	High standard single/dual carriageway road carrying predominantly through traffic with limited access. Speed limit: 40 to 60mph for dual carriageway, generally 40mph for single carriageway	A
UAP2	Good standard single/dual carriageway road with frontage access and more than two side roads per km. Speed limit: generally 40 mph	B
UAP3	Variable standard road carrying mixed traffic with frontage access, side roads, bus stops and at-grade pedestrian crossings. Speed limit: 30mph to 40mph	C
UAP4	Busy high street carrying predominantly local traffic with frontage activity including loading and unloading. Speed limit: 30mph	C

The majority of the roads in the network are of the C type.

Receptor Distance

As described previously, the method considers distances of four 50m bands from the road link, extending out to 200m. This produces estimates for concentrations at 20m, 75m, 115 m and 175m away. It is known that changes in road traffic have very little influence on air quality at distances beyond 200m.

1.3.3 *Background Concentrations*

Air Quality Zones

The TAG method allows the inclusion of background pollutant concentrations, to allow the identification of any exceedences of Air Quality Standards. This inclusion of background concentrations is particularly important for determining the NO_2 impact, as it establishes the true NO_x-NO_2 relationship.

The Air Framework Directive deals with each EU member state in terms of "Zones" and "Agglomerations". The Republic of Ireland is divided into four zones in the Air Quality Regulations (2002), for air quality monitoring purposes. These are as follows [(1)]:

(1) Source: http://www.epa.ie/whatwedo/monitoring/air/zones/

- Zone A – Dublin Conurbation;
- Zone B – Cork Conurbation;
- Zone C – Other cities and large towns including Galway, Limerick, Waterford, Clonmel, Kilkenny, Sligo, Drogheda, Wexford, Athlone, Ennis, Bray, Naas, Carlow, Tralee, and Dundalk; and
- Zone D - Rural Ireland, ie the remainder of the State excluding Zones A, B and C.

The Metro North scheme lies predominantly within Zone A. Background concentrations from the monitoring within this area have, therefore, been used in the TAG method.

NO_2 and NO_x Concentrations

There are 4 monitoring stations in Zone A that measured NO_2 and NO_x concentrations in the year of 2006. The annual average from the four stations was averaged to obtain an overall number for 2006.

The assessment of the operation of Metro North is for the years 2013-14 and 2028. Netcen provide a Year Adjustment Calculator through the National Air Quality Information Archive (NAQIA) website. Although the calculator is aimed at predicting future concentrations for the UK, similar changes can be expected to occur in Ireland and, therefore, this methodology has been adopted in this assessment. At present, the calculator can only predict up to the year 2020; this year was used to represent the concentrations in 2028.

The annual average from each station together with the model input value and associated calculations are shown in *Table 1.4.*

Table 1.4 **Background NO_2 and NO_x Concentrations ($\mu g\ m^{-3}$)**

Monitoring Station	Annual Average Concentration 2006	Average over all Stations for 2006	Average over all Stations for 2011	Average over all Stations for 2013	Average over all Stations for 2028(1)
NO_2					
Winetavern Street	35	27.8	24.5	23.8	23.0
Coleraine Street	31				
Rathmines	23				
Ballyfermot	22				
NO_x					
Winetavern Street	71	52.8	42.9	40.8	37.9
Coleraine Street	64				
Rathmines	40				
Ballyfermot	36				

(1) These concentrations are for 2020 as this is the last year for conversion

PM_{10}

There are 6 monitoring stations in Zone A that measured PM_{10} concentrations in the year of 2006. The annual average from the six stations was averaged to obtain an overall number for 2006, and the Year Adjustment Calculator used to predict future concentrations for the years of operation.

The annual average concentrations from each station, together with the model input value and associated calculations, are shown in *Table 1.5*.

Table 1.5 Background PM_{10} Concentrations ($\mu g\ m^{-3}$)

Monitoring Station	Annual Average Concentration (2006)	Average over all Stations for 2006	Average over all Stations for 20011	Average over all Stations for 2013	Average over all Stations for 2028(1)
Winetavern Street	20	17.8	16.2	15.9	16.0
Coleraine Street	21				
Marino	16				
Rathmines	19				
Phoenix Park	14				
Ballyfermot	17				

(1) These concentrations are for 2020 as this is the last year for conversion

No routine measurements are made of $PM_{2.5}$ concentrations. However, it is known from measurements made elsewhere in Europe that $PM_{2.5}$ concentrations are typically 50-60% of PM_{10} concentrations in urban areas.

1.4 IMPACT ASSESSMENT FOR CONSTRUCTION PHASE

1.4.1 *Air Quality Standard Exceedences*

The first stage of the assessment assessed the road links in terms of exceedences of air quality standards. The assessment looked at the impacts both with and without the construction of the Metro North alignment in 2011. The traffic flows and distribution on the roads affected by the scheme and their resulting impact on air quality has been compared to that predicted in 2011 without Metro North.

Using predicted background annual mean NO_2 concentrations of 24.5 $\mu g\ m^{-3}$ in 2011, as shown in *Section 1.3.3*, the TAG methodology predicts that there will be 3 links that will experience concentrations above the air quality limit value of 40 $\mu g\ m^{-3}$ without the proposed metro. There will be 4 links that will be above the air quality limit value with the proposed metro construction. All of these occur in the 50m band and are shown below in *Table 1.6*.

Predicted background annual mean PM_{10} concentrations of 16.22 $\mu g\ m^{-3}$ have been used in the assessment for 2011. The impact of emission of $PM_{2.5}$, have also been assessed; it is assumed that vehicle exhaust is essentially all in the form of $PM_{2.5}$ and therefore may be thought of as contributing to PM_{10} or $PM_{2.5}$ concentrations equally. An implied background concentration for $PM_{2.5}$ of about 8 $\mu g\ m^{-3}$ has been assumed.

There are no implications for compliance with the limit values for PM_{10} or $PM_{2.5}$.

Table 1.6 ***Road Links which show an exceedence of the NO_2 limit value in 2011***

2011 NO_2 - Do Minimum		2011 NO_2 - Do Metro	
Link	Street name	Link	Street name
9705_9704	Port Tunnel Northbound	9705_9704	Port Tunnel Northbound
9703_9700	Port Tunnel Northbound	9703_9700	Port Tunnel Northbound
4221_4220	Roundabout section of the N7 Red Cow Roundabout heading towards northbound M50	4221_4220	Roundabout section of the N7 Red Cow Roundabout heading towards northbound M50
		3562_3560	Link from M1 North to R132 at Lissenhall exit 4
Source: Road names provided by MVA traffic consultants			

The background concentration used in this assessment is derived for the whole of the area and is not specific to a particular link or even an area of Dublin. It is also limited by the fact that it is derived from available data, which may be collected in regions that are not strictly representative of each individual link being investigated. Therefore, although it provides an indication of where concentrations may be highest, the reporting of road links with exceedences should be regarded with caution.

1.4.2 *Further Analysis*

Table 1.7 presents an alternative way of addressing the results, in terms of the road links that are subject to an improvement, a degradation, or an insignificant change in air quality in the study area.

Table 1.7 ***Estimated Numbers of Road Links subject to an Improvement or Degradation in Air Quality***

Scenarios Compared	**Road links with an improvement in air quality**	**Road links with a degradation in air quality**	**Road Links with insignificant change in Air Quality**
Do Minimum 2011 v	151 (NO_2)	412 (NO_2)	11,921 (NO_2)
Do Metro 2011	65 (PM_{10})	108 (PM_{10})	12,311 (PM_{10})
	154 ($PM_{2.5}$)	252 ($PM_{2.5}$)	12,078 ($PM_{2.5}$)

In 2011, the construction of Metro North will affect a number of roads. In terms of NO_2 concentrations, 1.2% of the links are predicted to experience an improvement in air quality, 95.5% no change and 3.3% a degradation of air quality.

A similar pattern can be seen for the road links exposed to changes in PM_{10} and $PM_{2.5}$ concentrations; 0.5% and 1.5% of the links (respectively) are predicted to experience an improvement in air quality, 98.6% and 96.7%

(respectively) no change and 0.9% and 2.0% (respectively) a degradation of air quality.

The results are summarised in *Table 1.8*.

Table 1.8 Summary of Changes in Air Quality, expressed as a proportion of total road links, for 2011

	Change magnitude
Improvement	
NO_2	1.2%
PM_{10}	0.5%
$PM_{2.5}$	1.2%
No Change	
NO_2	95.5%
PM_{10}	98.6%
$PM_{2.5}$	96.7%
Degradation	
NO_2	3.3%
PM_{10}	0.9%
$PM_{2.5}$	2.0%

For the purposes of this assessment, insignificant changes in air quality are defined as being changes in concentration of less than 1% of the limit value, ie changes of less than 0.4 $\mu g\ m^{-3}$ for NO_2 and PM_{10}. and 0.2$\mu g\ m^{-3}$ for $PM_{2.5}$.

Table 1.7 and *Table 1.8* describe concentration changes of less than 0.4 $\mu g\ m^{-3}$ (NO_2 and PM_{10}) and less than 0.2 $\mu g\ m^{-3}$ ($PM_{2.5}$) as being effectively zero.

The majority of the road links fall into the -0.4 to 0.4 $\mu g\ m^{-3}$ category for the NO_2 and PM_{10} concentration change and the -0.2 to 0.2 $\mu g\ m^{-3}$ category for the $PM_{2.5}$ concentration change, as can be seen in *Figure 1.1* to *Figure 1.3*. These figures present the results in a way that makes it possible to distinguish the insignificant changes from those that could potentially be significant.

Figure 1.1 *Change in NO_2 Concentration ($\mu g\ m^{-3}$) from 2011 Do Minimum to 2011 With Metro, expressed as number of road links*

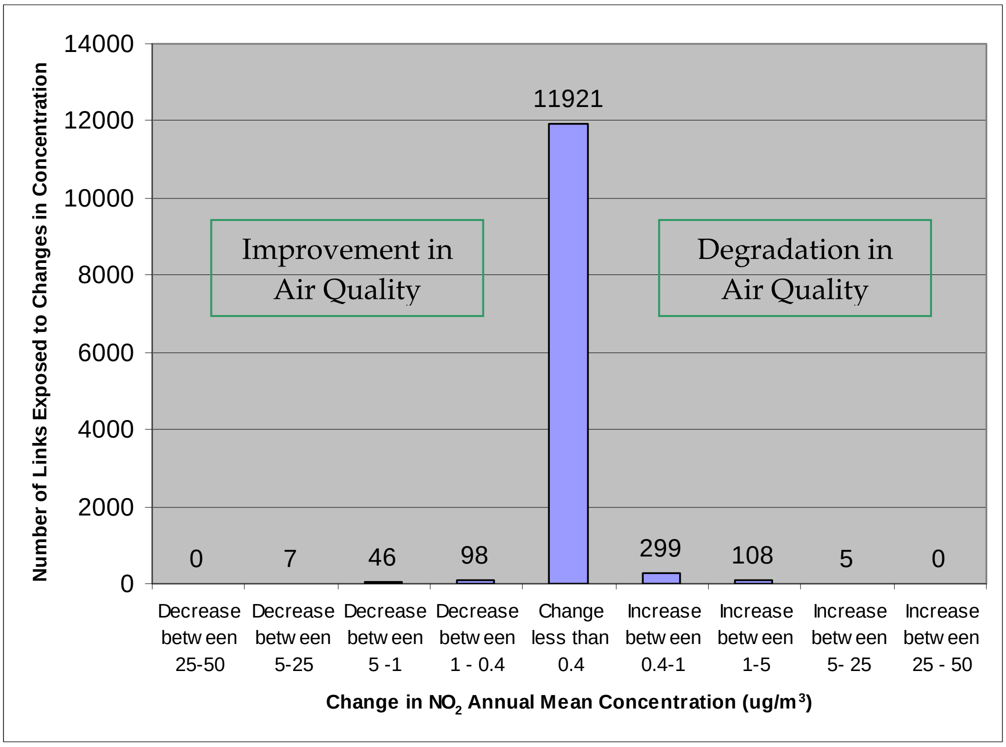


Figure 1.2 *Change in PM_{10} Concentration ($\mu g\ m^{-3}$) from 2011 Do Minimum to 2011 With Metro, expressed as number of road links*

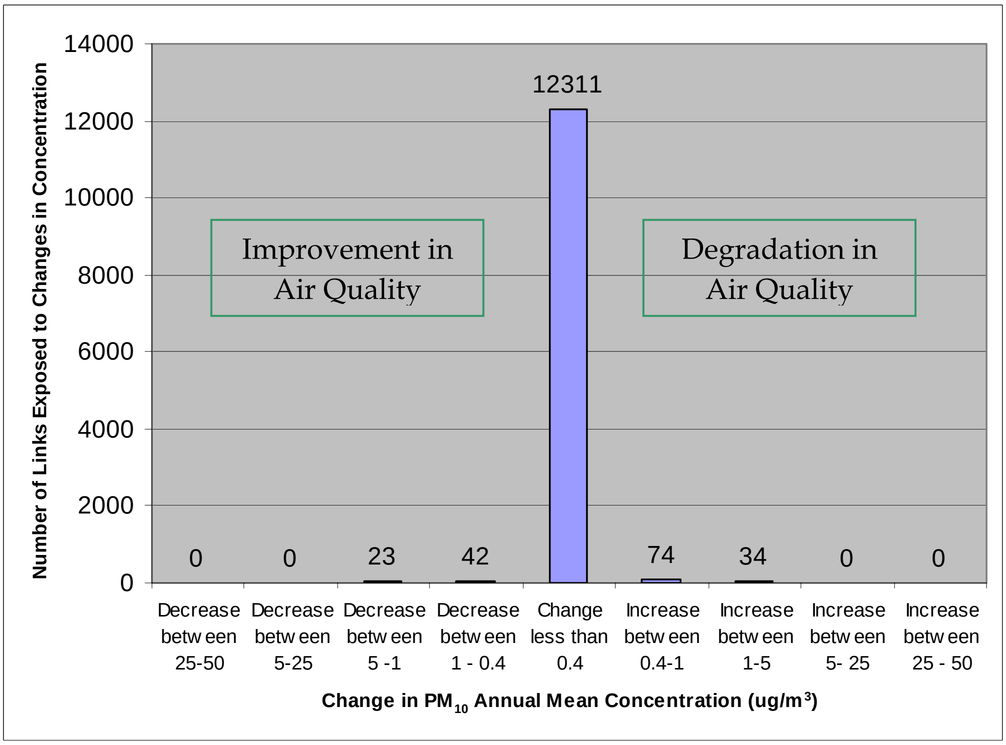
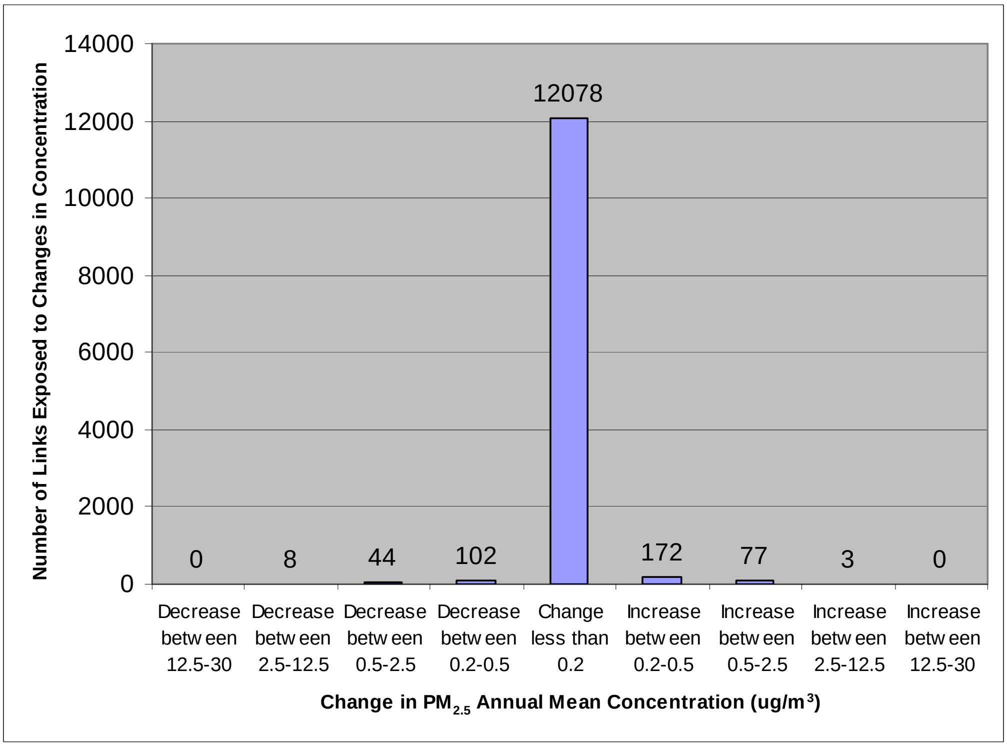


Figure 1.3 *Change in $PM_{2.5}$ Concentration ($\mu g\ m^{-3}$) from 2011 Do Minimum to 2011 With Metro, expressed as number of road links*



It can be seen from the figures above that the introduction of the Metro North alignment is predicted to result in the vast majority of the road links in the study area experiencing negligible (either insignificant or no change) changes in air quality.

For NO_2, 151 links out of 12,484 experience an improvement to air quality, while 412 experience a degradation in air quality (relative to the 1% of limit value threshold).

For PM_{10}, 65 links out of 12,484 experience improvements to air quality, while 108 experience a degradation in air quality (relative to the 1% of limit value threshold).

For $PM_{2.5}$, 154 links out of 12,484 experience improvements to air quality, while 252 experience a degradation in air quality (relative to the 1% of limit value threshold).

Table 1.8 shows that overall there will be a small net degradation in air quality in the Do Metro scenario during construction, as measured by numbers of road links.

1.4.3 *Climate Change*

The contribution to greenhouse gas emissions was estimated by considering the changes in traffic flow, traffic speeds and vehicle mixes in the Dublin area and calculated using the DMRB methodology. *Table 1.9* lists the annual CO_2 emissions from traffic when comparing the Do Minimum and Do Metro 2011 traffic data. The traffic data for 2011 includes the effects of traffic re-routing arising from the Dublin Metro North construction.

The DMRB tool provides an output for tonnes of carbon emitted per year. In this context, 'carbon' relates to the carbon bound in the emitted pollutants (carbon dioxide, carbon monoxide, hydrocarbons and particulate matter).

This was converted into carbon dioxide emitted per year by a mass ratio.

Table 1.9 ***CO_2 Emissions from the Road Network (tonnes/year)***

Do Minimum 2011 (tonnes annum^{-1})	**Do Metro 2011 (tonnes annum^{-1})**
2,654,111(a)	2,671,268 (a)
Overall Change - Do Min v Do Metro 2011	17,157 (+0.6%)
(a) Estimated using DMRB methodology	

When comparing the Do Minimum and Do Metro 2011 emissions, there will be a slight increase of 0.6% (approximately 17,000 tonnes) of CO_2 emissions from the changes in road traffic on the network.

The slight increase arises through a slight reduction in overall vehicle speeds on parts of the network and the additional traffic associated with construction activity.

1.5 IMPACT ASSESSMENT FOR OPERATION

1.5.1 Air Quality Standard Exceedences

The first stage of the assessment assessed the road links in terms of exceedences of air quality standards. The initial comparison looked at the impacts both with and without the Metro North alignment in 2013-14. The traffic flows and distribution on the roads affected by the scheme and their resulting impact on air quality has been compared to that predicted in 2013-14 without Metro North.

Using a predicted background annual mean NO_2 concentration of 23.8 $\mu g\ m^{-3}$ for the assessment year 2013-14, as shown in *Section 1.3.3*, the TAG methodology predicts that there will be four links that will experience concentrations above the air quality limit value of 40 $\mu g\ m^{-3}$ without the proposed metro; the same four links will also have NO_2 concentrations above the air quality limit value with the proposed metro. All of these occur within the 50 m band adjacent to the road and are shown below in *Table 1.10*.

Predicted background annual mean PM_{10} concentrations of 15.9 $\mu g\ m^{-3}$ have been used in the assessment for 2013-14 (with an implied background concentration of 8 $\mu g\ m^{-3}$ for $PM_{2.5}$). There are no implications for compliance with the limit values for PM_{10} or $PM_{2.5}$.

Table 1.10 ***Road Links which show an exceedence of the NO_2 and PM_{10} limit value in 2013-14***

2013-14 NO_2 - Do Minimum and Do Metro links	
Link	**Street Name**
9705_9704	Port Tunnel Northbound
9704_9703	Port Tunnel Northbound
9703_9700	Port Tunnel Northbound
4221_4220	M50/N7 Interchange
Source: Road names provided by MVA traffic consultants	

The background concentration used in this assessment is derived for the whole of the area and is not specific to a particular link or even area of Dublin. It is also limited by the fact that it is derived from available data, which may be collected in regions that are not strictly representative of each individual link being investigated. Therefore, although it provides an indication of where there may be potential air quality problems, the reporting of road links with exceedences should be regarded with care.

This assessment was then repeated for the Metro North alignment in 2028. As for 2013-14, the traffic flows and distribution on the roads affected by the scheme and their resulting impact on air quality has been compared to that predicted in 2028 without Metro North.

Using background NO_2 concentrations of 23µg m^{-3} in 2028, the TAG methodology predicts that six road links will exceed the air quality limit value without the proposed metro. These exceedences occur within the 50m band and are also predicted to cause non compliance as a result of the Metro North scheme. The result of the implementation of Metro North in 2028 is that there will only one road link predicted to exceed the NO_2 limit value. These are shown in *Table 1.11*.

Table 1.11 ***Road Links which show an exceedence of the NO_2 limit value in 2028***

2028 NO_2 - Do Minimum	
Link	Street name
5165_5144	Taney Road
5014_5011	N11
4250_4210	N7 Eastbound
2013_2012	Junction between College Green, Westmorland Street and College Street
1833_1832	Oscar Traynor Road
1415_1408	Berkeley Road
Source: Road names provided by MVA traffic consultants	

1.5.2 *Further Analysis*

Table 1.12 presents an alternative way of addressing the results, in terms of the number of road links that are subject to an improvement, a degradation, or an insignificant change in air quality in the study area.

Table 1.12 ***Estimated Number of Road Links subject to Improvements or Degradation in Air Quality***

Scenarios Compared	Road links with an improvement in air quality	Road links with a degradation in air quality	Road Links with an insignificant change in air quality
Do Minimum 2013-14 v Do Metro 2013-14	15 (NO_2) 6 (PM_{10}) 21 ($PM_{2.5}$)	4 (NO_2) 0 (PM_{10}) 4 ($PM_{2.5}$)	12,537 (NO_2) 12,550 (PM_{10}) 12,531 ($PM_{2.5}$)
Do Minimum 2028 v Do Metro 2028	1,320 (NO_2) 273 (PM_{10}) 613 ($PM_{2.5}$)	1,480 (NO_2) 268 (PM_{10}) 633 ($PM_{2.5}$)	9,828 (NO_2) 12,087 (PM_{10}) 11,382 ($PM_{2.5}$)

In 2013-14, the operation of Metro North is predicted to have an insignificant change in air quality for the overwhelming majority of the road links. In terms of NO_2 concentrations, 0.12% of the links in the network considered are predicted to experience an improvement in air quality, 99.8% no change and 0.03% a degradation of air quality.

A similar pattern can be seen for the road links exposed to changes in PM_{10} and $PM_{2.5}$ concentrations; 0.05% and 0.17% of the links are predicted to experience an improvement in air quality respectively, 99.95% and 99.8% respectively no change and 0%and 0.03% respectively a degradation of air quality.

In 2028, the changes affect more roads. There is a decrease in the number of road links that remain unchanged as a result of the operation of Metro North, as compared to 2013-14. In terms of NO_2, PM_{10} and $PM_{2.5}$ concentrations respectively, 10.5%, 2.2% and 4.9% of the links are predicted to experience an improvement in air quality, 77.8%, 96.3% and 90.0% no change and 11.7%, 2.1% and 5.0% a degradation of air quality. The results are summarised in *Table 1.13*.

Table 1.13 ***Summary of Changes in Air Quality, expressed as a proportion of total road links***

	2013-14	2028
Improvement		
NO_2	0.12%	10.5%
PM_{10}	0.05 %	2.2%
$PM_{2.5}$	0.17 %	4.9%
No Change		
NO_2	99.8%	77.8%
PM_{10}	99.95%	96.3%
$PM_{2.5}$	99.8%	90.0%
Degradation		
NO_2	0.03%	11.7%
PM_{10}	0%	2.1%
$PM_{2.5}$	0.03%	5.0%

For the purposes of this assessment, insignificant changes in air quality are defined as changes in concentration of less than 1% of the limit value. This will address changes in concentration of less than 0.4 µg m^{-3} for NO_2 and PM_{10} and 0.2µg m^{-3} for $PM_{2.5}$.

Table 1.12 and *Table 1.13* describe concentration changes of less than 0.4 µg m^{-3} (NO_2 and PM_{10}) and less than 0.2 µg m^{-3} ($PM_{2.5}$) as being effectively zero.

The majority of the road links fall into the -0.4 to 0.4 µg m^{-3} category for the NO_2 and PM_{10} concentration change and the -0.2 to 0.2 µg m^{-3} category for the $PM_{2.5}$ concentration change, as can be seen in *Figure 1.4* to *Figure 1.9*. These figures present the results in a way that makes it possible to distinguish the insignificant changes from those that could potentially be significant.

Figure 1.4 to *Figure 1.6* show the results for 2013-14.

Figure 1.4 ***Change in NO_2 Concentration (µg m^{-3}) from 2013-14 Do Minimum to 2013-14 With Metro, expressed as numbers of road links***

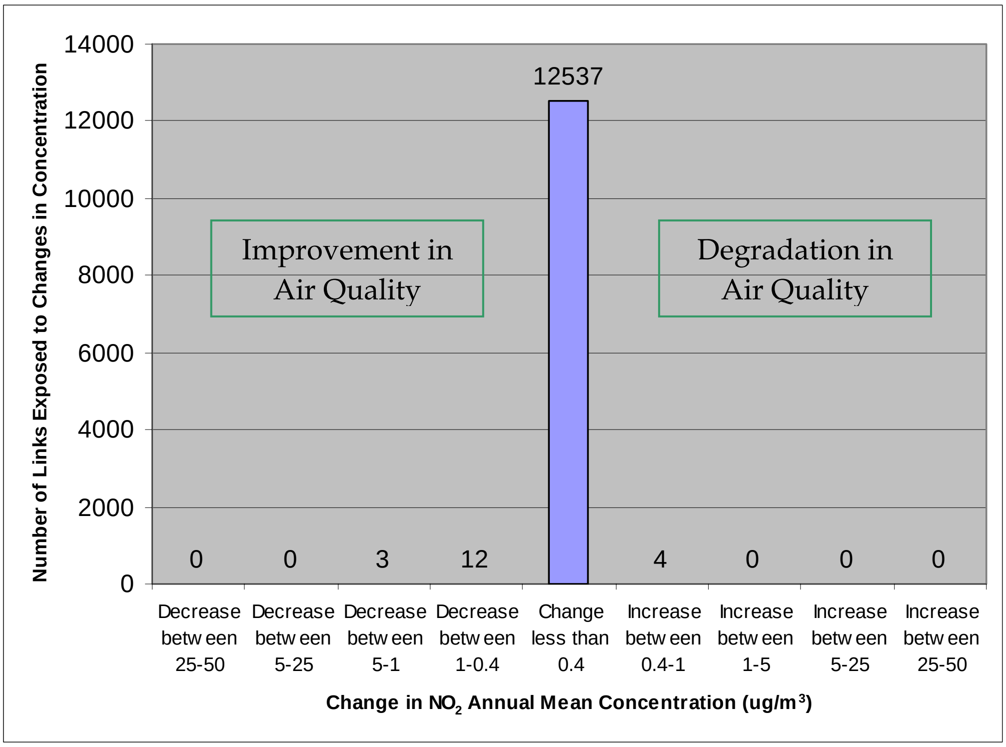


Figure 1.5 *Change in PM_{10} Concentration ($\mu g\ m^{-3}$) from 2013-14 Do Minimum to 2013-14 With Metro, expressed as numbers of road links*

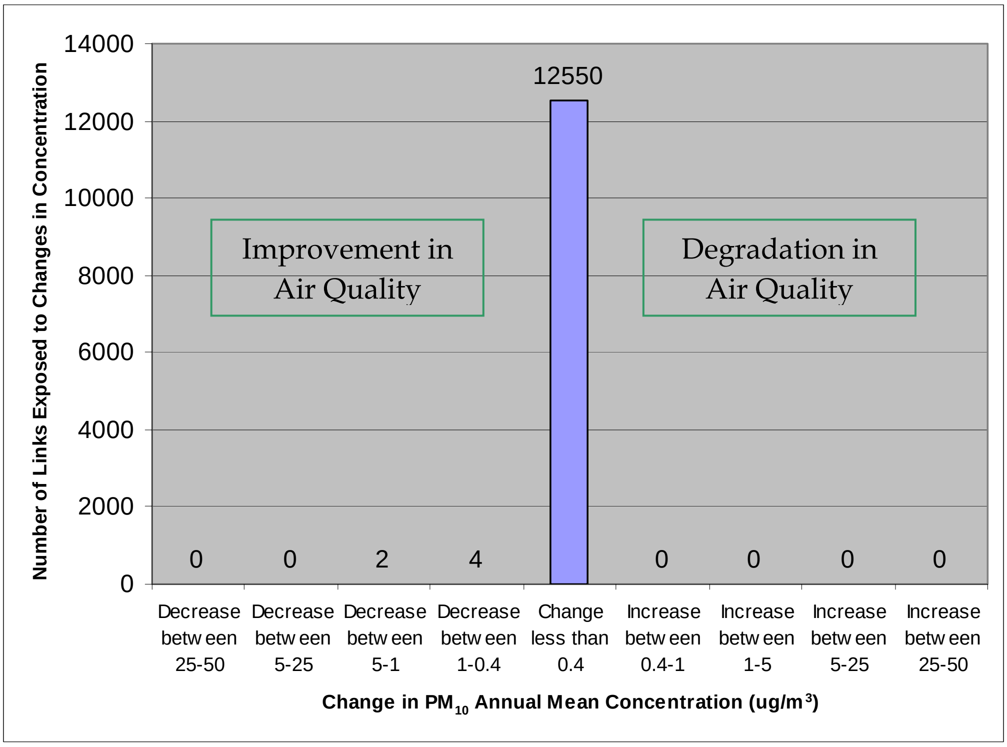
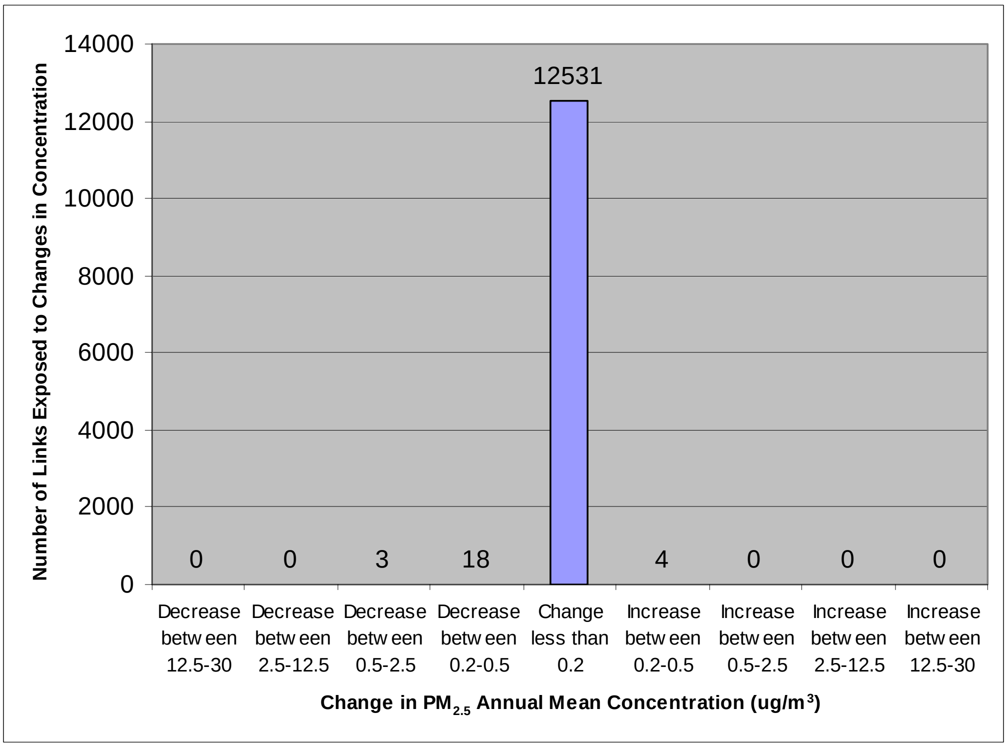


Figure 1.6 *Change in $PM_{2.5}$ Concentration ($\mu g\ m^{-3}$) from 2013-14 Do Minimum to 2013-14 With Metro, expressed as numbers of road links*



It can be seen from the figures above that the introduction of the Metro North alignment is predicted to result in the vast majority of the road links in the study area experiencing negligible (either insignificant or no change) changes in air quality.

For NO_2 concentrations, 15 links out of 12,556 would experience an improvement, while 4 would experience a degradation, relative to the 1% of limit value threshold.

For PM_{10} concentrations, 6 links out of 12,556 would experience an improvement, while no links would experience a degradation in air quality, relative to the 1% of limit value threshold.

For $PM_{2.5}$ concentrations, 21 links out of 12,556 would experience an improvement, while 4 would experience a degradation in air quality, relative to the 1% of limit value threshold.

Figure 1.7 to *Figure 1.9* show the results for 2028.

Figure 1.7 ***Change in NO_2 Concentration ($\mu g\ m^{-3}$) from 2028 Do Minimum to 2028 With Metro, expressed as numbers of road links***

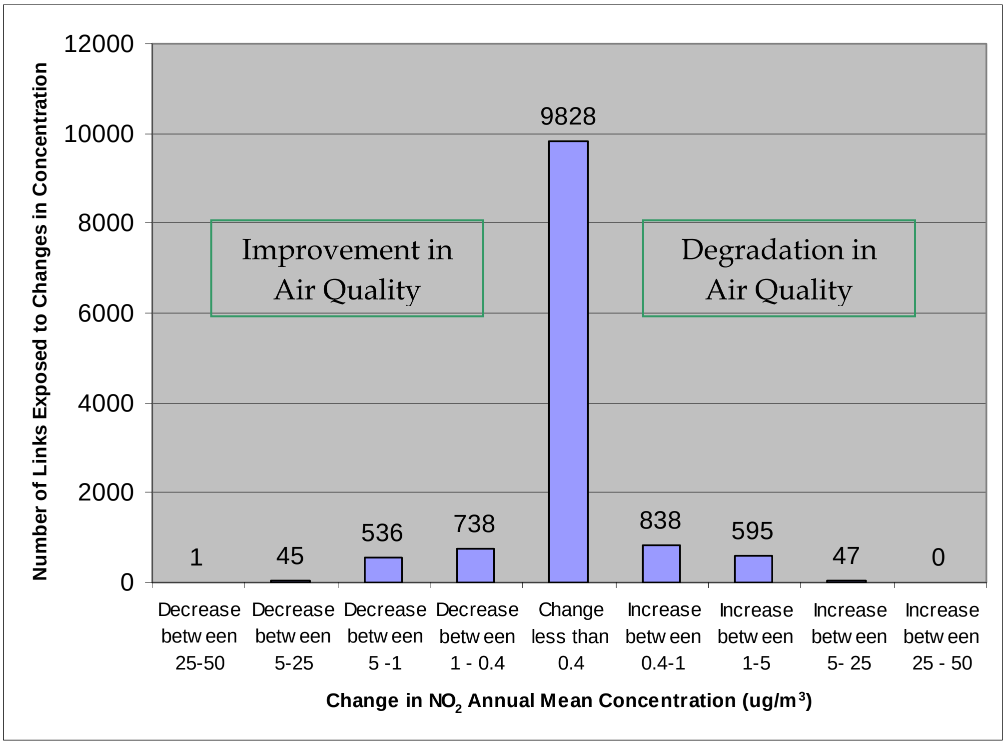


Figure 1.8 *Change in PM_{10} Concentration ($\mu g\ m^{-3}$) from 2028 Do Minimum to 2028 With Metro, expressed as numbers of road links*

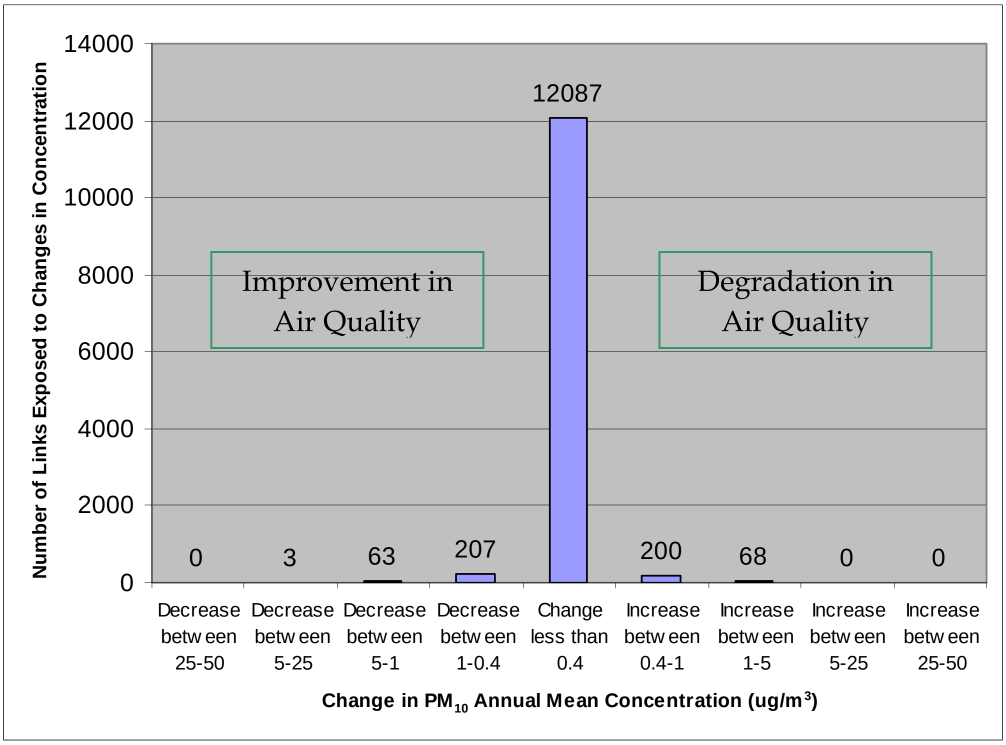
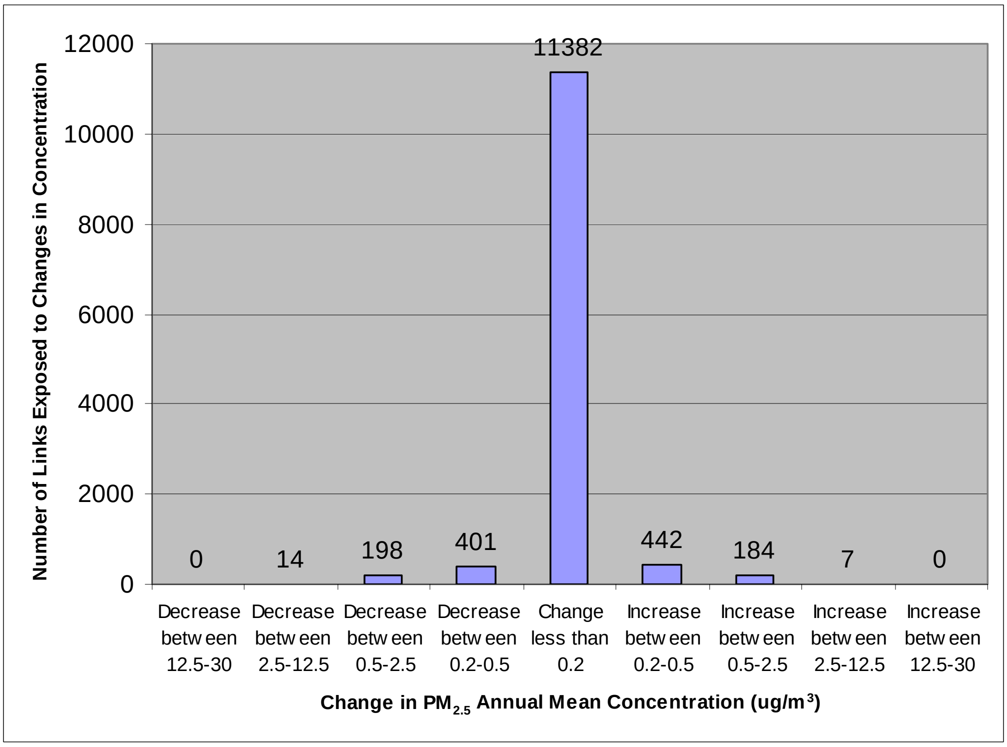


Figure 1.9 *Change in $PM_{2.5}$ Concentration ($\mu g\ m^{-3}$) from 2028 Do Minimum to 2028 With Metro, expressed as numbers of road links*



The results for 2028 show that Metro North has a larger influence on air quality than for 2013-14, as described below.

For NO_2 concentrations, 738 links out of the 12,556 experience slight improvements to air quality, 536 links experience a minor improvement in air quality, 45 links experience moderate improvements in air quality and one link will show a major improvement in air quality.

Similar numbers are mirrored for those links that experience an increase in concentrations. 838 road links will experience as slight degradation in air quality over the 1% threshold. 595 links experience a minor degradation in air quality and 47 links experience a moderate degradation in air quality.

For PM_{10} concentrations, 268 links out of 12,556 experience negligible changes or improvements to air quality, 68 links experience minor improvement in air quality. 273 experience a slight degradation in air quality and 63 links and three links experience minor and moderate degradation in air quality respectively.

For $PM_{2.5}$ concentrations, 401 links out of 12,556 experience negligible changes or improvements to air quality, 198 links experience minor improvement in air quality and 14 links experience moderate improvements in air quality. 442 experience a slight degradation in air quality and 184 links and seven links experience minor and moderate degradation in air quality respectively.

Table 1.13 shows that, overall, there is almost no net change in air quality across the road network in the Do Metro scenario.

1.5.3 Climate Change

The contribution to greenhouse gas emissions was estimated by considering the changes in traffic flow, traffic speeds and vehicle mixes in the Dublin area and calculated using the DMRB methodology. *Table 1.14* lists the annual CO_2 emissions from traffic when comparing the Do Minimum and Do Metro 2013-14 and Do Minimum and Do Metro 2028 traffic data. The traffic data for 2013-14 and 2028 include the effects of modal shift on traffic flows and traffic re-routing arising from the Dublin Metro North alignment.

The DMRB tool, like TAG, is not capable of carrying out assessments beyond 2020. The results presented for 2028 are based on background concentrations and improvements predicted for 2020 but with traffic movements for 2028.

The DMRB tool provides an output for tonnes of carbon emitted per year. In this context, 'carbon' relates to the carbon bound in the emitted pollutants (carbon dioxide, carbon monoxide, hydrocarbons and particulate matter).

This was converted into carbon dioxide emitted per year by a mass ratio.

Table 1.14 CO_2 Emissions from Road Traffic on the Network (tonnes/year)

Do Minimum 2013-14 (tonnes annum^{-1})	Do Metro 2013-14 (tonnes annum^{-1})	Do Minimum 2028 (tonnes annum^{-1})	Do Metro 2028 (tonnes annum^{-1})
2,679,245 [(a)]	2,652,365 [(a)]	3,114,124[(a)]	3,096,110 [(a)]
Overall Change - Do Min v Do Metro 2013-14		- 26,880 (-1%)	
Overall Change – Do in v Do Metro 2028		- 18,014 (-0.6%)	
(a) Estimated using DMRB methodology			

When comparing the Do Minimum and Do Metro 2013-14 emissions, there will be a reduction of 1% (approximately 27,000 tonnes) of CO_2.

When Do Minimum and Do Something 2028 emissions are compared, emissions of CO_2 decrease by approximately 0.6% (18,000 tonnes) of CO_2.

The decreases are a result of a combination of traffic re-routing associated with the direct impacts of Metro North on road capacity and the modal shift from car to the rail system and future improvements in CO_2 emissions from vehicles. Emission factors are used to predict future emissions; these depend on fuel consumption and the carbon content of fuel. Emission factors decrease in the future as fuel consumption changes with improvements in vehicle efficiency and carbon content from 2008 to 2020 will reflect the introduction of biofuels.

1.6 CONCLUSIONS

Air quality alongside the majority of the road links within the study area is predicted to experience an insignificant change in air quality (±0.4 µg m^{-3} for NO_2 and ±0.4 µg m^{-3} for PM_{10}), as a result of the introduction of the Metro North alignment. The minority of road links predicted to experience a more significant change, both positive and negative, have been identified.

The scheme is additionally expected to reduce CO_2 emissions from road traffic.