5 AIR QUALITY

5.1 Introduction

This chapter presents the local and regional air quality assessment from the Scheme. The assessment includes a summary of the current baseline conditions, the potential impacts of the Scheme and, where appropriate, identifies mitigation measures for any significant effects that may arise.

The Scheme has the potential to affect air quality as a result of emissions during construction and operation including:

5.1.1 During Construction:

- Particulate matter / dust from enabling works including site preparation
- Particulate matter / dust from materials handling and transportation; and
- Exhaust emissions and dust from on and offsite construction vehicle movements and non-road mobile machinery

5.1.2 During Operation:

- Exhaust emissions from traffic on the local road network

This chapter refers to, and should be read in conjunction with, Chapter 8 – Nature Conservation, where the impacts of air quality on ecology are discussed. This chapter also refers to the effects of the Scheme on air quality in relation to Special Areas of Conservation (SAC), and should be read in conjunction with Volume 3, Appendix E.2 of this ES where this is further addressed.

5.2 Methodology

5.2.1 Overview

The methodology used to assess the operational air quality impacts for the Scheme follows that set out in detail in DMRB[5.1] for a detailed level assessment for local air quality and a simple level assessment for regional air quality. The methodology for local air quality also takes into account the following Interim Advice Notes IAN 170v3[5.2] and 174[5.3].

For construction, the assessment follows the guidance published by Institute for Air Quality Management[5.4]. This guidance is consistent with the DMRB guidance on construction dust but provides a more extensive framework for the qualitative assessment and is an industry standard methodology.

5.2.2 Construction Phase

The IAQM guidance[5.4] provides distance based criteria for qualitatively assessing dust/particulate matter impacts from construction activities and their significance. The assessment criteria consider the scale and nature of the works, classified as small, medium or large, as well as the proximity of the receptors. For the purposes of assessment, activities on construction sites are divided into the following four types:

- Demolition;

- Earthworks;
- Construction; and
- Trackout (the movement of dust/mud offsite on haulage vehicle wheels and bodies onto the public road network where it may be resuspended by other vehicles).

The three potential effects of dust arising from construction activities are defined in the guidance as:

- Annoyance / loss of amenity due to dust soiling;
- The risk to health due to an increase in PM_{10} exposure; and
- Impacts to ecological receptors.

The assessment has five stages:

- Definition of the potential dust emission magnitude for the works (termed dust emission class);
- Definition of the sensitivity of the area including identification of specific sensitivities, the proximity and number of receptors (human and ecological), background PM_{10} concentrations and any site specific factors;
- Assessment of the potential risk of impacts in the absence of mitigation;
- Definition of site specific mitigation measures; and
- Assessment of whether significant effects are likely following mitigation.

The criteria used to assess the dust emission magnitude and risk of impacts prior to mitigation for the various phases of the works are provided in Appendix B1.

The study area for the construction assessment is shown in Volume 2 in Figure 5.1 and encompasses the areas within 350m of any construction works (defined at present as the extent of the Scheme) and within 50m of any roads used for haulage vehicles up to 500m from the site boundary.

5.2.3 Operational Phase

Study Area

The study area for the assessment of operational impacts has been set with regard to the criteria set out in DMRB (HA207/07[5.1] Section 3) for determining affected links for the local air quality assessment and the 200m corridors either side of those links. These criteria are:

- road alignment will change by 5 m or more; or
- daily traffic flows will change by 1,000 AADT or more; or
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more; or
- daily average speed will change by 10 km/hr or more; or
- peak hour speed will change by 20 km/hr or more.

On this basis, the local air quality study area for the Scheme covers the major routes, including the Scheme, within the following cordon: Porthmadog in the south-east, Pwllheli in the south-west, northwards through Caernarfon and Llanberis to the A55 in the north. Within this area, the detailed traffic modelling covers the approach roads to and through Caernarfon and Bontnewydd from:

- A499/Pontllyfni in the South West
- A487/Penygroes in the South
- Minor road to Rhosgadfan in South-East
- A4085/Rhyd-Ddu in the South-East
- A4086/Llanberis in the East
- J9 of the A55 in the North-West
- J11 of the A55 in the North-East

This area is shown in Figure 5.2 in Volume 2 of this ES, and schematically in Appendix B2, Volume 3. The detailed local air quality assessment for the Scheme focuses on the area covered by the traffic model since this is the area within which the maximum impacts of the Scheme occur.

There are a number of human and ecological receptors potentially affected by the operation of the Scheme. Figure 5.2 shows the 85 local air quality receptors used in the detailed modelling of impacts on human health and Table 5.2.1 shows an overview of receptors and their location. The receptors were selected to be representative of the Scheme impacts, including most affected locations (whether adverse or beneficial) and examples of typical roadside impacts. Full details of all receptors can be found in Appendix B3 in Volume 3.

Table 5.2.1 Summary of human health air quality receptors used in dispersion modelling

IDs	Roads	Description of Area/Main Receptors	Sensitive Receptors
01_A to 05_A	A487 from A55 to Plas Menai Roundabout	Rural area, with few properties, all of which are set back from the main roads	No Sensitive Receptors within 200m of route
06_B to 11_B	A487 from Plas Menai Roundabout to Caernarfon	Predominantly rural area near Plas Menai, giving way to more densely populated northern outskirts of Caernarfon but properties set back from road	School 120m of the route, although it is located further from the road than the selected receptors.
12_C to 17_C	B4366 from A55 to Bethel	Rural area but with some villages including Bethel where some properties front onto the road	School located at roadside – selected receptors located at similar/closer roadsite locations.

IDs	Roads	Description of Area/Main Receptors	Sensitive Receptors
18_D to 21_D	B4366 from Bethel to Caernarfon	Predominantly rural area south of Bethel, giving way to more densely populated north-eastern outskirts of Caernarfon	Three schools within 150m of the road – (20m from road at closest point). Selected receptors located closer to the road.
22_E to 26_E	A4086 from Llanberis to Pont-rug	Rural area, with few properties, generally set back from the main roads	School located at roadside – selected receptors located at similar/closer roadsite locations.
27_F to 30_F	A4086 from Pont-rug to Caernarfon	Relatively densely populated eastern outskirts of Caernarfon	School 150m from the route. Selected receptors located closer to the road.
31_G to 35_G	A4085 from Bettws Garmon to Caeathro	Rural area with road passing through villages including Waunfawr and properties close to road	School 40m from the route - further from the road than the selected receptors.
36_H to 39_H	A4085 from Caeathro to Caernarfon	Relatively densely populated eastern outskirts of Caernarfon	School 140m from the route, Selected receptors located closer to the road.
40_I to 43_I	A499 from Pontllyfni to Goat Roundabout	Rural area, with few villages and properties generally set back from the road (with some exceptions)	Nursery 120m from the route, further from the road than the selected receptors.
44_J to 54_J	A487 from Goat Roundabout to Caernarfon	Some rural areas and large villages including Bontnewydd and Llanwynda, before becoming densely populated in Caernarfon with receptors close to the road	Hospital/School 30m and 50m respectively from the route. Both located further from the road than the selected receptors.
55_K to 58_K	A487 South of Goat Roundabout to Penygroes	Rural area, with few properties and receptors set back from the road	No Sensitive Receptors within 200m of route
59_L to 77_L	Scheme route	Properties currently in rural areas along the length of the Scheme	School 150m from the route. Selected receptors closer to the roadside.
78_M to 81_M	Minor road from Bontnewydd to Caeathro	Rural area, with few properties and receptors set back from the road	No Sensitive Receptors within 200m of route

IDs	Roads	Description of Area/Main Receptors	Sensitive Receptors
82_N to 85_N	Minor road from Caeathro to Pont-rug	Rural area, with few properties and receptors set back from the road	No Sensitive Receptors within 200m of route

In accordance with DMRB, the air quality assessment also considers the impact of the scheme on sites designated for nature conservation. In the air quality detailed study area, there are three designated sites with features potentially sensitive to air quality impacts namely:

- Glynllifon SSSI/SAC (T1/T2)
- Afon Gwyrfai and Llyn Cwellyn SSSI/SAC (T3/T4/T5/T6)
- Pant Cae Haidd SSSI (T7)

All ecological sites are indicated with shading in Figure 5.2 in Volume 2. The ecological sites are assessed in the modelling as a series of discrete receptors aligned as transects extending from the point of the site nearest road into the ecological sites in order to determine the spatial extent of potential impacts. These transects are shown in Figure 5.2 in Volume 2.

The Scheme is not expected to result in any net growth in traffic or release of suppressed demand. Nevertheless, there is a possibility that some limited realignment of traffic may occur on routes approaching Caernarfon from the south and east, notably between routes on the A499, the A487, the A4085 and the A4086. These routes are not explicitly included in the traffic model and, in the absence of detailed traffic data, have not been included in the air quality assessment. However, the potential impacts of the Scheme on these routes can, as set out below, be inferred from results presented for human and ecological receptors within the detailed study area.

The effects of the Scheme on traffic would decrease with distance from the Scheme, with a corresponding reduction in impacts on air quality.

The A4085 and A4086 to the east of Caernarfon may experience a potential decrease in traffic with the Scheme. To the south and east of the detailed study area, there are isolated receptors along these routes together with larger numbers of residential properties in Llanberis. These receptors would experience a decrease in pollutant concentrations, as would be shown to be the case at receptors 22_E to 26_E on the A4086, and 31_G to 35_G on the A4085 i.e. a beneficial impact.

To the south and east of Llanberis, there are also a number of sites designated for nature conservation: Coedydd Derw a Safleoedd Ystlumod Meirion SAC, Eryri SAC/SSSI, Coedydd Beddgelert a Cheunant Aberglaslyn SSSI, Coed Tremadog SSSI, Coedydd Nanmor SSSI, Glaslyn SSSI, Llyn Padarn SSSI, Coedydd Nantgwynant and Llyn Peris SSSI. These sites would experience a potential decrease in roadside pollution and beneficial impacts. The magnitude of the impact is, however, likely to be lower than that modelled for the Afon Gwyrfai and Llyn Cwellyn SAC (transect on A4085) and Pant Haidd SSSI due to the effects of the dispersal of traffic impacts.

In contrast, the A499 and A487 to the south of the Goat roundabout may experience a potential increase in traffic flows with the Scheme. Taking into account the distribution of settlements in the area, these changes in flow are unlikely to extend beyond Pwllheli and Portmadog respectively. Between the study area and these towns, the A499 and A487 are characterised by scattered properties, generally set back from the road. Impacts to the south of the study area can, therefore, be inferred from results at receptors 40_I to 43_I on the A499, and 55_K to 58_K on the A487.

These receptors would be shown to experience an increase in pollutant concentrations with the Scheme, but no exceedence of air quality standards. Therefore, taking into account the dispersal of traffic effects of the Scheme, no significant air quality impacts on human health are expected outside of the study area. Towards Pwllheli, there are a number of designated sites within 200m of the road: Coed Cwmgwared, Cappas Lwyd and Coed Elernion SSSIs. Towards Portmadog, the Llystyn Isaf and Tyn Llan SSSIs sit close to the road. Impacts on these designated sites are expected to be considerably lower than those modelled for the Glynllifon SAC. This is due to a combination of various factors including: the dispersal of traffic, distance from the roadside and relatively limited areas of the sites being affected.

Overall, therefore, limiting the spatial scope of the detailed air quality assessment to the area of the traffic model does not present a significant constraint on the assessment of the Scheme impacts, since impacts outside of the detailed study area are expected to be lower than those within the study area and can be inferred from modelled receptors and transects.

The assessment has considered the potential impacts and the associated significance of effects for the following scenarios:

- Baseline (2014)
- Opening Year (2018), Do Minimum and Do Something
- Design Year (2033), Do Minimum and Do Something

Traffic data were provided for a baseline year of 2015. However, with the critical air quality metrics being annual average concentrations of nitrogen dioxide/oxides and particulate matter, at the time of writing it is only possible to derive a robust annual mean for 2014 from the baseline survey data (Appendix B4 in Volume 3). As such, the baseline traffic data were assumed to be applicable to 2014 for model verification purposes. With relatively low traffic growth in the area (e.g. <1% on the A487 south of Caernarfon between 2013 and 2014), this is not a significant constraint on the assessment applicability.

For the future years (2018 and 2033), traffic data were provided for Do Minimum (without the Scheme) and Do Something (with the Scheme) scenarios.

A summary of the traffic data used in the assessment is provided in Appendix B2 in Volume 3.

5.2.4 Modelling Methodology

The modelling methodology seeks to compare future air quality concentrations and emissions, with and without the traffic changes associated with the operation of the Scheme.

Detailed dispersion modelling, using ADMS Roads v3.2, was used to assess concentrations of nitrogen oxides (including nitrogen dioxide) and particulate matter at the selected receptors.

The model requires receptor coordinates, coordinates of vertices on road links as well as traffic data for each link as light duty vehicle flows, heavy duty vehicle flows and traffic speeds. Traffic data were provided for morning and afternoon peak periods, the inter-peak period and as an annual average. Total offpeak traffic flows were calculated by subtracting the peak flows (assumed representative of 3 hours in the morning and afternoon) and inter-peak flows (assumed representative of 6 hours between morning and afternoon) from the daily average flows. In this way, traffic data were specified for each hour of the day and emissions, for both local and regional assessments, subsequently calculated using Defra's Emissions Factors Toolkit (EfT) v 6.02.

Pollutant concentrations were modelled using one year (2014) of hourly sequential meteorological data from Valley, approximately 24km north-west of Caernarfon. A wind rose for the station is shown in Diagram 5.1. Prevailing winds are from the south-west.

The assessment of ecological impacts follows the methodology in Annex F to HA707/07. Further details can be found in Appendix B3 in Volume 3.

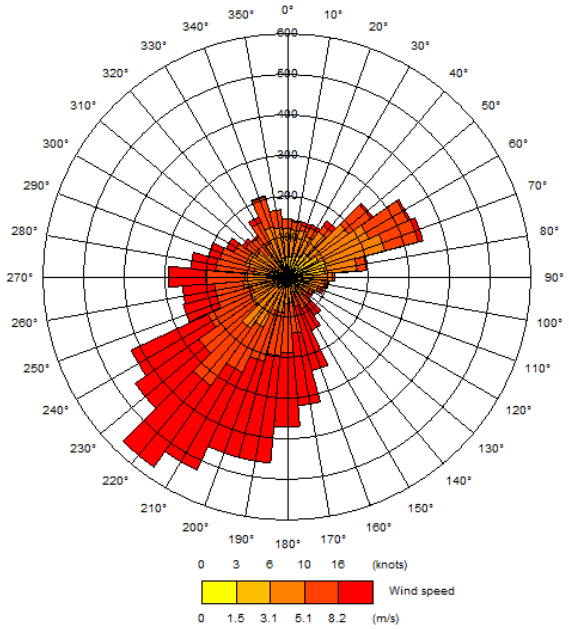


Diagram 5.1 Wind rose for Valley, Anglesey

5.2.5 Uncertainties and Verification

Any exercise in predictive modelling has, by its very nature, some degree of associated uncertainty. In the particular case of modelling traffic emissions, significant uncertainties lie in the specification of traffic data and dispersion specific parameters as described above.

In the baseline year, systematic uncertainties in the model inputs are accounted for by verifying the modelled roadside concentrations against observed roadside pollution levels. This process produces a verification factor which can then be applied to future scenario model results to account for the continued presence of systematic uncertainties.

All modelled pollution concentrations provided in this report are given as corrected values following the verification of the model. A site specific monitoring survey consisting of 40 nitrogen dioxide and 2 nitrogen oxide diffusion tubes was undertaken, as detailed in Section 5.3, and these data were used to determine appropriate verification factors for the dispersion model results (Appendix B3).

Chief among the remaining uncertainties in this assessment is the generation of vehicle emissions from published emissions factors. Recent research (Carslaw et al., 2011[5.5]) demonstrated that emissions of nitrogen oxides and nitrogen dioxide from road vehicles have not decreased at the rate projected by the national forecasts. It is, however, anticipated that emissions will reduce with the introduction of very low and zero emissions vehicles into the national fleet. In addition, Defra issued revised vehicle emission factors in November 2014 which incorporate an updated forecast of changes to fleet composition. Notwithstanding the release of revised emissions factors, this assessment takes a conservative approach and uses the DMRB IAN 170/12v3[5.2] to adjust future projections of roadside concentrations of nitrogen oxides to take into account potential over-optimism in the rate of improvement of vehicle emissions over time. This approach is considered to be conservative, particularly for the assessment of 2033 impacts.

5.2.6 Impacts at Short Timescales

It is not possible to assess, robustly, maximum hourly mean concentrations from road transport using dispersion modelling. By their nature, both local and background hourly mean concentrations are highly variable and therefore verification of the modelling of peak concentrations is challenging. Indeed, for the Scheme, hourly mean nitrogen dioxide background concentrations are not available. As a consequence, hourly mean impacts cannot be modelled directly and they are assessed by reference to annual mean concentrations, as per Defra advice that where the annual mean concentrations are below 60µg/m^3, the risk of exceedences of the 1-hour mean nitrogen dioxide objective is extremely unlikely.

Similarly, directly predicting the number of exceedences of the daily mean PM_{10} objective using dispersion modelling is less robust that predicting the annual mean. Therefore the empirical relationship, detailed in Defra's TG(09)[5.6] guidance, between annual mean PM_{10} and the number of daily exceedences of the 50µg/m^3 objective was used:

No. 24-hour mean exceedences =

$$-18.5 + 0.00145 \times \text{annual mean}^3 + (206/\text{annual mean})$$

5.2.7 Assessment Criteria

Under the requirements of the Environment Act 1995, the UK government published an Air Quality Strategy[5.6] (1997, revised in 2000 and 2007). The Strategy sets out the UK's national standards and objectives for ambient air quality, and measures to help achieve the objectives. The overall aim of the Strategy is to achieve steady improvement in air quality into the long term. The objectives are transcribed into

regulations in the Air Quality (Wales) Regulations 2000 and Air Quality (Amendment) (Wales) Regulations 2002.

The Environment Act also sets out the principles for Local Air Quality Management (LAQM) under which Local Authorities are required to review current and future air quality within their area against the air quality objectives. Where it is anticipated that an air quality objective will not be met, the Local Authority is required to declare an AQMA and to produce an Action Plan in pursuit of the achievement of the air quality objectives.

The air quality standards set out in the Strategy are purely health-based and reflect the levels of pollution thought to ensure the avoidance or minimisation of risks to health. The associated air quality objectives are policy targets, expressed as maximum permissible ambient (outdoor) concentrations which take into account economic efficiency, practicability, technical feasibility and timescales.

The European Union Ambient Air Quality Directive[5.7] sets similar limit values for the concentration of pollutants in air for the protection of health and ecosystems. The EU Directive is transposed into Welsh legislation in the Air Quality Standards (Wales) Regulations 2010.

For the pollutants of interest in the assessment of the Scheme, the EU limit values are numerically identical to the UK's air quality objectives. They are, however, statutory limits rather than policy targets.

Table 5.2.2 provides details of the air quality objectives relevant to the assessment of the Scheme.

Table 5.2.2 Ambient air quality objectives relevant to the assessment of air quality impacts for the Scheme

Pollutant	AQS Objective/Limit Value	Measured as
Set for the protection of human health		
NO_2	200 µg/m^3	1hr mean; not to be exceeded more than 18 times per year (AQS, EU)
	40 µg/m^3	Annual mean (AQS, EU)
PM_{10}	50 µg/m^3	24hr mean not to be exceeded more than 35 times per year (AQS, EU)
	40 µg/m^3	Annual mean (AQS, EU)
Set for the protection of vegetation (critical levels)		
NO_X	30 µg/m^3	Annual mean (AQS, EU)
	75 µg/m^3	24hr mean (WHO)

Note: AQS – UK Air Quality Strategy objective; EU = European Union limit value; World Health Organisation recommended guideline / non-statutory

The Air Quality (Wales) Regulations make clear that likely exceedences of the objectives should be assessed in relation to "the quality of the air at locations which are situated outside of buildings or other natural or man-made structures above or

below the ground, and where members of the public are regularly present". Air quality assessments should, therefore, focus on those locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. The assessment should not consider exceedences of the objectives at any location where relevant public exposure would not be realistic.

For ecological receptors, in addition to the air quality objectives for the concentration of pollutants in air listed in Table 5.2.2 (termed critical levels), impacts must also be assessed for nitrogen deposition (Annex F, HA207/07[5.1]). The relevant assessment criteria in this case are the critical loads which are defined as "*a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge*"[5.8]. Further information on the policy context of the assessment of ecological receptors is provided in Chapter 8: Nature Conservation. Table 5.2.3 sets out the critical loads for the designated sites in the study area. Critical loads are expressed as a range. To ensure a conservative assessment, the lower limit of the range is taken to be the assessment level.

Table 5.2.3 Critical loads for nationally and internationally designated sites in the study area

Designated Site	Habitat	Nitrogen Deposition kgN/ha/yr	
		min	max
Glynllifon SSSI/SAC	**Broadleaved Woodland (habitat for Lesser Horseshoe Bat)**	**10**	**20**
	Acid Grassland	8	15
Afon Gwyrfai a Llyn Cwellyn SSSI/SAC	**Oligotrophic to mesotrophic standing waters**	**3**	**10**
	Luronium natans – Floating water plantain	**3**	**10**
Pant Cae Haidd SSSI	Acid Grassland	8	15
	Lowland Beech and Yew Woodland	5	15

Note: The habitats shown in bold are the qualifying habitats (or habitats for qualifying species) for the SACs. Data are taken from the APIS website.

5.2.8 Assessment of Significance

In order to evaluate the impacts on local air quality from the scheme operations, the approach set out in IAN 174/13[5.3] was followed.

The criteria in Table 5.2.4 set out the classification of the magnitude of change of annual mean NO_2, NO_x and PM_{10}. These criteria are applied to both human and ecological receptors.

Table 5.2.4 Classification of the magnitude of change of pollutant concentration

Classification of Magnitude	Change in concentration (as a %age of the relevant objective)
Large	>10%

Medium	5-10%
Small	1-5%
Imperceptible	<1%

HA guidance (IAN 174/13) suggests that receptor locations where concentrations do not exceed the relevant objective (either in the Do Minimum or Do Something scenarios), or where the change in concentration is imperceptible as defined in Table 5.2.3, can be scoped out of any further assessment of the significance of effects. The impact is negligible. Where receptor locations exceed the air quality objective, the overall significance of the Scheme is assessed in relation to the numbers of affected receptors and the balance between receptors experiencing beneficial or adverse impacts.

In the assessment of nitrogen deposition on ecological receptors, the change in deposition due to the scheme is assessed using the criteria in Table 5.2.3, in relation to the critical loads relevant to the features of interest in the site, the background deposition and the extent of any exceedence.

5.2.9 Baseline Conditions

Overview

Baseline air quality conditions across the study area have been assessed by means of combined desk and field studies. The desk studies have included a review of the data collected by Gwynedd Council and the national modelling undertaken by Defra for EU Air Quality Directive compliance assessment reporting. The field study comprised a project specific nitrogen dioxide diffusion tube survey.

5.2.10 Local Air Quality Management

Under the requirements of the Local Air Quality Management regime, Gwynedd Council assess and review air quality within their administrative boundary. In general, air quality within the region is very good, with only limited areas of elevated pollutant concentrations. To date, Gwynedd Council have not considered it necessary to declare an air quality management area for any pollutants in the UK's Air Quality Strategy.

For the pollutants relevant to this assessment, the primary sources of pollution in the area are road transport and isolated, relatively small scale, industrial processes. Gwynedd Council monitor roadside ambient concentrations of nitrogen dioxide, using diffusion tubes, throughout their district. Elevated concentrations have been found in the centre of the main urban areas of Caernarfon and Bangor. Gwynedd Council does not undertake monitoring for any other pollutants.

The latest data relevant to the Scheme are shown in Table 5.3.1. At the kerbside site in Caernarfon, (C2), nitrogen dioxide concentrations exceeded the air quality objective of 40µg/m^3 as an annual mean by some considerable margin in the years 2009 to 2011 but decreased to just above the objective in 2012. Moreover, at the nearest properties to the monitoring site, concentrations were within the objective. At the remaining sites, concentrations were within the air quality objective, and well within the objective on Lon Campbell (C3) and Llanwnda (LL1). This emphasises the fact that road transport is the major source of pollution in the study area.

There is no distinct temporal trend in the data, with some locations showing an increase in pollution levels between 2009 and 2012 and others showing a decrease. What is of particular note is that pollution levels have not decreased in line with national projections.

Table 5.3.1: Annual mean nitrogen dioxide in study area.

Council Site	Location	Type	Annual Mean Nitrogen Dioxide µg/m^3			
			2009	2010	2011	2012
C1	Bro Helen, Caernarfon	Roadside	15.8	20.6	22.7*	-
C2	Morrisons Rbt, A487 Caernarfon	Kerbside	***48.2***	***52.7***	***49.7***	***40.3***
C3	Lon Campbell, Caernarfon	Urban Background	12.1	17.6	14.2	11.5
C4	Llys Merion, Caernarfon	Roadside	21.8	21.3	26.7*	-
C5	Ffordd Bangor, Caernarfon	Kerbside	16.3	30.3	32.6	32.5
LL1	Llanwnda	Kerbside	24.5	30.6	29.6	25.8

Note: The data are provided in µg/m^3. (Data not bias adjusted). Exceedences of the air quality objective (40µg/m^3) are shown in bold italic.* Period mean based on 3 months of data only.

5.2.11 Project Specific Monitoring

Project specific monitoring of air quality in the study area, using nitrogen dioxide diffusion tubes, is on-going. At the time of writing, 10 months of data from late January 2015 to late November 2015 are available. Table 5.3.2 shows the data as the survey period mean and annualised to 2014 following the methodology set out in LAQM TG(09)[5.10]. The monitoring locations are shown in Figure 5.3 in Volume 2 and the full set of monitored data is provided in Appendix B4 in Volume 3.

The monitoring data are consistent with the conclusions of the Council's LAQM reports, namely that road transport is the primary source of pollution in the study area, namely that concentrations away from the main road (A487) are very low but that there is a risk of exceedence of the air quality objective in the centre of Caernarfon. DT_22, DT_23 and DT_24 on the A487 in Caernarfon are representative of exposure at the roadside and indicate a significant risk of exceedence of the air quality objective. A risk of exceedence of the objective is also evident on the A487 towards Plas Menai roundabout (DT_02, DT_04 and DT_05) and in Bontnewydd (DT_32).

Table 5.3.2 Nitrogen dioxide diffusion tube monitoring in study area. Annual mean bias adjusted.

ID	Location Name	Easting	Northing	Height (m)	No of Months of Data	Period Mean	2014 Annual Mean
DT_1	Bypass (Port Dinorwic)	251811	366256	1	5	14.5	22.6
DT_2	Caernarfon Rd. Rbt A487 North	250544	365796	2.2	10	30.5	33.0
DT_3	Caernarfon Rd. Rbt A487 South	250491	365776	2.2	10	17.2	18.6
DT_4	Rhyd Menai	249786	365102	2	10	32.1	34.7
DT_5	Opposite Rhyd Menai	249778	365111	2	10	34.3	37.0

ID	Location Name	Easting	Northing	Height (m)	No of Months of Data	Period Mean	2014 Annual Mean
DT_6	Bus Stop, Bangor Road	248784	364000	2	10	24.6	26.6
DT_7	Mor Awelon Waterloo Port Road	248765	363958	2	10	27.6	28.2
DT_8	A487/A4086 Exit Slip	248220	362750	1.5	4	23.1	23.8
DT_9	Pool Side	248155	362737	2	7	25.7	26.2
DT_10	Bethel Rd, B4366	250730	364476	2	10	14.1	14.4
DT_11	Roundabout Bethel Road West	250864	364467	2	10	13.6	13.9
DT_12	Roundabout Bethel Road East	250911	364484	2	9	13.2	14.1
DT_13	Lay-by, Lon Glair Farm	251196	363716	2	10	13.6	13.8
DT_14	Bethel Sign Post, Llanberis Rd.	250911	363207	1.3	5	20.1	20.5
DT_15	Fence Post, Bron Seiont Farm	250994	362741	1.6	10	14.7	15.0
DT_16	Fence Post, Ty'r Ysgol	250696	362422	4	10	12.2	12.4
DT_17	Lampost, A4085 Roundabout	250430	361587	2	9	12.0	12.4
DT_18	Footpath Sign, Y Wern	250073	361228	1.8	10	11.9	12.2
DT_19	Lampost, Opp. Bryn Gwna Pub	250101	361716	2	10	12.7	12.9
DT_20	Bryn Gwna Pub	250068	361733	2	10	10.3	10.5
DT_21	Lampost, A4085 Bridge	249223	362064	2	9	8.3	8.5
DT_22	Lampost, Caer Service Station	248234	362393	2	5	34.5	36.9
DT_23	Signpost, NHS health Clinic	248252	362332	1.7	4	32.0	27.7
DT_24	Lampost, A487/Henwalia	248253	362162	2	10	32.4	33.1
DT_25	Lampost, Coed Helen Lane/Pant Rd. Junction	248236	361605	1.7	7	21.7	23.2
DT_26	Lampost, Penybryn Rd/A487 Junction	248363	361417	2	10	30.9	31.6
DT_27	Lampost, Roundabout Glan Beuno/A487	248289	360154	2	10	24.3	24.8
DT_28	Post, Ffordd Beuno	248313	360207	1.9	10	19.6	20.0
DT_29	Sign Post, Gypsy Wood Park	248605	360168	1.7	8	13.4	14.4
DT_30	National Speed Sign Post, Afon Beuno	248827	360300	1.8	10	15.9	16.3
DT_31	Lampost, Ysgol y Cynchor	248278	359832	2	8	25.4	27.2
DT_32	Lampost, Opposite McColl's Store	248247	359801	2	8	31.5	32.2
DT_33	Lampost nr. Glanrhyd/A487 Jct	247670	358423	2	10	30.2	30.8
DT_34	Opposite Vauxhall Garage	247639	358403	2	10	30.1	30.7
DT_35	A499/A487 Roundabout	247322	357786	1.5	9	20.1	20.5
DT_36	Lampost, Goat Hotel/A499	247214	357669	1.8	8	18.4	18.8
DT_37	A499, Opp Bus Stop/Collfryn Farm	246753	357020	2	9	19.7	20.1

ID	Location Name	Easting	Northing	Height (m)	No of Months of Data	Period Mean	2014 Annual Mean
DT_38	Background, Ffordd Cae Garw	250424	363672	2	9	5.1	5.5
DT_39	Signpost, Rhyddalli Ganol	249339	360890	1.8	8	12.4	12.7
DT_40	Opp. Farm Entrace, Lon Cefn Glyn	247149	355967	2	10	12.1	12.3

Note: The period mean (all available data from 29 January 2015 to 24 September 2015) and annual mean (2014) data are provided in µg/m^3. (Data bias adjusted). Exceedences of the air quality objective (40µg/m^3) are shown in bold italic.

5.2.12 Defra Pollution Climate Modelling

The pollutant concentration at any location has two components, namely a contribution from the local (modelled) sources and a contribution from more distant sources. Background pollutant concentrations for this assessment, i.e. those resulting from distant sources and pollutant transport, have been taken from the mapped data provided by Defra[5.11], and interpolated to the locations of the selected receptors. The data have been provided by Defra as hindcasts/predictions for all years from 2010 to 2030 from the output of their Pollution Climate Model (PCM). This model is used by Defra for the assessment of compliance with EU Ambient Air Quality Directive limit values.

Highways England has produced IAN 175/13 (Highways Agency, 2013a) to assess the impact of individual schemes on compliance with the EU Directive. However, IAN175/13 has been withdrawn and is currently pending update. Furthermore, it should be noted that Defra do not undertake PCM modelling of roadside pollutant concentrations within the study area and, as such, the Scheme cannot impact on compliance. Therefore, no assessment has been undertaken following the IAN175/13 assessment methodology in this study.

Table 5.3.3 shows a summary of the PCM data for the assessment years 2014, 2018 and 2033. Background concentrations are currently well within the air quality objectives for the protection of human health and ecological receptor for all pollutants, and it is predicted that they would improve over time due to a reduction in emissions from all emission sources and sectors, both in the UK and in Europe.

Background concentrations are very low outside of the Caernarfon. They increase in the urban area but still remain well within the objectives. In 2014, background concentrations of nitrogen dioxide were well within the objective and averaged 4.8µg/m^3 across the study area; within Caernarfon background concentrations increase to 7.9µg/m^3. Nitrogen oxides background concentrations are well below the objective of 30µg/m^3 with an average of 6µg/m^3 across the area.

Table 5.3.3 Annual mean background pollutant concentrations from Defra mapped data for 2014, 2018 and 2033

Year	Nitrogen Oxides NOx	Nitrogen Dioxide NO_2	Particulate Matter PM_{10}	Particulate Matter $PM_{2.5}$
Objective	**30 µg/m³ ***	**40 µg/m³**	**40 µg/m³**	**25 µg/m³**
Total Pollutant Concentrations (µg/m³)				
2014	4.8 - 10.2	3.8 - 7.9	10 - 13.6	6.6 - 8.5
2018	4.2 - 8.9	3.3 - 6.9	9.8 - 13.2	6.3 - 8.2
2033	3.6 - 7.7	2.9 – 6	9.5 - 13.2	6.1 - 6.5
Concentrations with road contribution removed (µg/m³)				
2014	4.8 - 8.4	-	10 - 13.6	6.6 - 8.5
2018	4.2 - 7.6	-	9.8 - 13.2	6.3 - 8.2
2033	3.6 - 6.9	-	9.5 - 13.1	6.1 - 8.1

Note: * Objectives set for the protection of ecosystems and under UK regulations do not apply in urban areas.

A comparison of the mapped Defra concentrations for 2014, presented in Table 5.3.3 with monitored concentrations at the project specific monitoring (Table 5.3.2) shows a good correlation e.g. the annual mean nitrogen dioxide concentration at the background site, DT_38, is 5.2µg/m³, whereas concentrations on the outskirts of Caernarfon DT_21 are 8.6µg/m³. This indicates that the PCM background data are a robust estimate of background pollutant concentrations for the purpose of this assessment. In order to avoid double counting, the Defra mapped data for all modelled years were adjusted by removing the road contribution. The adjusted values were utilised in the assessment of traffic impacts associated with the Scheme[1].

5.2.13 Background Pollutant Deposition

Baseline levels of nitrogen deposition and critical load values for the types of habitats present in designated sites within the study area were taken from the Air Pollution Information System[5.9]. These are presented in Table 5.3.4 where it can be seen that the baseline deposition for each type of habitat is already in exceedence of each critical load value (except neutral grassland in Pant Cae Haidd). Furthermore, the maximum baseline deposition over each site exceeds the upper limit of the critical load for at least one habitat in all sites. As such, all designated sites are at risk of impacts from excess nitrogen deposition.

[1] The Defra mapped data include the contribution to pollution levels from vehicles on roads explicitly included in the dispersion modelling. To avoid double counting of these emissions, Defra also provide source apportioned data which can be used to exclude from the background concentrations any sources being modelled. For the scheme, the contribution from motorways, trunk roads, and A-roads has been excluded from the background pollution level, but as noted above is explicitly included in the modelled contribution from local pollutant sources.

Table 5.3.4 Critical load and background deposition for designated ecological sites in the study area.

Designated Site	Classification	Most Sensitive Habitat	Critical Load (kgN/ha/yr)		Background Deposition (kgN/ha/yr)	
			Min	Max	Min	Max
Glynllifon SAC	Lesser Horseshoe Bat	Broadleaved Deciduous Woodland	10	20	16.80	25.62
Glynllifon SSSI	Acid Grassland	Inland dune pioneer grassland	8	15	11.34	18.48
	Fens	Valley Mires / Poor fens	10	15		
Afon Gwyrfai a Llyn Cwellyn SAC	Oligotrophic to mesotrophic standing waters	Permanent oligotrophic waters	3	10	10.22	16.94
	Floating water-plantain					
Afon Gwyrfai a Llyn Cwellyn SSSI	Acid Grassland	Inland dune pioneer grassland	8	15	13.86	18.34
	Fens	Valley Mires / Poor fens	10	15		
	Upland Hay Meadows	Mountain Hay Meadows	10	20		
	Scrub	Lowland Beech and Yew Woodland	5	15	22.26	30.38
Pant Cae Haidd SSSI	Acid Grassland	Inland dune pioneer grassland	8	15	15.54	15.54
	Neutral Grassland	Low and Medium Altitude Hay Meadows	20	30		
	Scrub	Lowland Beech and Yew Woodland	5	15	25.2	25.2

5.3 Predicted Environmental Effects

5.3.1 Construction

Construction activities can give rise to emissions of dust/particulate matter. For larger particles (>75µm), these emissions can give rise to nuisance dust soiling effects on property and effects on ecological receptors. The smaller particles (<10µm) can give rise to effects on human health when inhaled.

In assessing the impacts of construction dust using the IAQM methodology, the study area is sub-divided on the basis of a review of the receptors potentially affected by works from different areas of the scheme extent. As can be seen in Figure 5.1, the area potentially affected by construction activities is generally sparsely populated agricultural land. Over 100 properties lie within 350m of the scheme boundary, largely located around Bontnewydd, Llanwnda and at the Glan Gwna Holiday Park, but only 15 residential properties within 50m of the site.

A summary of the dust emission magnitude assessment is presented in Table 5.4.1. The potential magnitude of dust emissions is large for all construction activities except demolition, primarily due to the overall size of the Scheme. The magnitude of dust emissions from demolition is small due to the limited requirements for removal of existing road surfaces/street furniture at junctions but no requirements for demolition of properties. The large magnitude of dust emission from earthworks is due to the large total site area (>10,000m^2), a generally clayey soil and large amounts of materials movement. In addition, to the northern end of the Scheme, there is a significant requirement for blasting and cutting of rock. Similarly, the large site area is the primary contributor to the large magnitude dust emission potential from construction activities, together with the requirement for piling and concrete batching activities. The potential for dust emissions from track-out is also considered large due to the high numbers of potential HDV movements and the presence of lengths of unpaved roads on site and road crossing points. Further details of the assessment are provided in Volume 3, Appendix B.1.

Table 5.4.1 Outcome of the assessment of potential dust emission magnitude from construction related activities

Activity	Dust Emission Magnitude
Demolition	Small
Earthworks	Large
Construction	Large
Trackout	Large

It should be noted that dust risk levels do not remain constant at all times. Actual risks on any given day will depend on the activities being undertaken, the meteorological conditions and the proximity of receptors to activities with high dust generating potential. This variability is particularly relevant to the Scheme which will not have construction activities across the whole site for the whole construction period. The assessment is therefore conservative and indicative of the maximum potential impact of construction related dust at any given time.

The assessment of the sensitivity of the construction study area to the various activity categories is summarised in Table 5.4.2. Sensitivity to human health impacts and to dust soiling and nuisance is generally low in the study area. This is a result of the sparseness of the population, the relatively large distance from activities to receptors and, in relation to human health, the low background concentrations of PM_{10} (~14µg/m^3 in 2014). However, a few properties have been identified as being of medium sensitivity to risks of dust soiling and nuisance. These properties were identified on the basis of their proximity to the boundary of the scheme and include Morogoro (Ch900), Glan Gwna Holiday Park (Ch5500 to Ch6000) and Tyddyn Hen (Ch8400). Properties in the vicinity of plant crossing points and site access roads are also of potential medium sensitivity.

The Afon Gwyrfai a Llyn Cwellyn SSSI and SAC is crossed by the scheme north of Bontnewydd. Direct physical effects, such as the smothering of vegetation, and indirect effects such as chemical alterations to soils or watercourses could occur at ecological receptors in such proximity to potential dust generating activities. However, the habitats within these designations do not contain dust sensitive features and the site is accorded a low sensitivity to soiling.

Table 5.4.2 Sensitivity of the area to construction dust impacts

Potential Impact	Sensitivity of the surrounding area			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Low	Medium*/Low	Medium*/Low	Medium*/Low
Human Health	Low	Low	Low	Low
Ecological	Low	Low	Low	Low

Note: * For selected properties only

To determine the risk of impacts in the absence of mitigation, the dust emission magnitude is combined with the sensitivity of the area, as summarised in Table 5.4.3.

In general, the risks of impacts on human health would be negligible, due to the low sensitivity of the area (low background PM_{10} concentrations). Similarly, the risk of ecological impacts would be negligible due to the absence of dust sensitive habitats in the vicinity of the Scheme.

The risk of dust soiling effects would be largely negligible over the study area, but at a limited number of properties as outlined above, the risk must be considered to be medium due to the proximity of receptors to the site.

Table 5.4.3 Risk of dust impacts in the absence of mitigation

Potential Impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Negligible	Medium/low	Medium/low	Medium/low
Human Health	Negligible	Negligible	Negligible	Negligible
Ecological	Negligible	Negligible	Negligible	Negligible

5.3.2 Operation

Human Receptors

Overall, the predicted air quality effects of the Scheme on human health are beneficial. This is due to the redistribution of traffic from the A487 through Caernarfon, a relatively densely populated area, onto the Scheme, which runs primarily through rural, sparsely populated areas.

The full set of modelled concentrations is provided in Appendix B5 in Volume 3. The remaining discussion focuses on annual mean nitrogen dioxide, since this is the only metric at risk of exceeding an air quality objective. The spatial distribution of impacts

on particulate matter concentrations is the same as that for nitrogen dioxide since the impacts are driven by overall changes to traffic flows. However, there is no risk of exceedence of either the annual mean or daily mean objectives / limit values for PM_{10}.

Table 5.4.4 shows a summary of the predicted impacts on nitrogen dioxide in the Scheme Opening Year (2018). Similar conclusions hold in the Design Year (2033).

In the Baseline and without the Scheme in operation in 2018, predicted concentrations of annual mean nitrogen dioxide vary from very low (<10µg/m^3) in the rural areas, distant from main roads, to close to or just above the objective (40µg/m^3) along the A487 through Caernarfon. More typically, at the roadside properties on the A487, concentrations are of the order of 20 - 25µg/m^3.

With the Scheme in operation, predicted concentrations of annual mean nitrogen dioxide in 2018 are well below the annual mean objective at all receptors, with a corresponding negligible risk of exceedence of the hourly mean air quality objective. That is to say, all risk of exceedences of air quality objectives for the protection of human health is removed with the operation of the Scheme.

The largest magnitude impacts relate to the decrease in traffic on the A487, from south of Bontnewydd (where daily traffic decreases from around 22,000 to 6,000) to the Plas Menai roundabout in the north (where daily traffic decreases from around 19,000 to 11,000). These traffic decreases result in large decreases in nitrogen dioxide concentrations, of up to 17µg/m^3. The modelled increase in concentration along the Scheme is up to 4.5µg/m^3. The traffic flow on the bypass is of the order of 18,000 vehicles per day, but the closest properties are over 10m from the roadside which mitigates the impacts.

In general, traffic flows (and pollutant concentrations) on arterial routes into Caernarfon and on minor roads between these arterial routes also decrease with the Scheme as drivers opt to use the bypass. However, as noted in the methodology, there is some potential for increases in traffic on the A487 and A499 as drivers opt to use these roads in conjunction with the bypass rather than other minor roads. These impacts would generally be lower in magnitude than those within the detailed study area.

In 2033, without the Scheme in operation, modelled nitrogen dioxide concentrations would decrease in comparison to the modelled 2018 concentrations. This is due to the effects of improvements in vehicle technology more than offsetting the effects of traffic growth. When using the methodology set out in IAN 170v3 for projecting future pollutant concentrations, this decrease is relatively modest (less than 10%) and the maximum predicted concentrations in the study area are only just below the air quality objective (39.8µg/m^3 at receptor 54_J on the A487 through Caernarfon in the Do Minimum scenario).

With the Scheme in operation, concentrations at this receptor would decrease to 28.6µg/m^3 but remain the highest in the study area. By 2033, however, significant improvements in vehicle technology are anticipated and the IAN 170 adjusted concentrations are considered highly conservative. Using the national forecasts of future emissions without adjustment, nitrogen dioxide concentrations at this receptor are modelled to be 17.1µg/m^3 without the Scheme and 12.3µg/m^3 with the Scheme. Appendix B5 in Volume 3 provides results for all receptors as both IAN 170 adjusted and unadjusted values.

As for nitrogen dioxide, receptor 54_J on the A487 through Caernarfon experiences the highest particulate matter pollution in both Do Minimum and Do Something scenarios, and sees a beneficial impact of the Scheme. Maximum annual mean PM_{10} concentrations are 15.4µg/m^3 in the opening year Do Minimum scenario, falling to 13.8µg/m^3 in the Do Something scenario, with no modelled exceedences of the daily mean standard of 50µg/m^3 in either scenario. These concentrations, whether or not the Scheme is in operation, reflect negligible risk of exceedence of air quality objectives / limit values.

These results are consistent with the results of the WelTAG assessment undertaken at Key Stage 2 for the Scheme (Table 5.4.5). The negative scores for PM_{10} and NO_2 reflect a net reduction in exposure to air quality with over 2000 properties experiencing an improvement in air quality and less than 250 experiencing deterioration in air quality.

Table 5.4.4 Summary of annual mean ambient NO2 concentrations at human receptors in 2018

Receptors		Impact At Most Affected Receptor							Overall Comment
		Baseline 2014 (µg/m^3)	2018 DM (µg/m^3)	2018 DS (µg/m^3)	Change in concen-tration (µg/m^3)	% Change in concen-tration	Magnitude of Change	Significance	
01_A to 05_A	A487 from A55 to Plas Menai Roundabout	11.5	11.4	11.7	0.3	0.9%	Imp.	Negligible	Generally very low concentrations at all receptors due to distance from roads; slight increase in traffic flows results in slight increase in pollutant concentrations
		8.1	8.0	8.2	0.2	0.4%	Imp.		
06_B to 11_B	A487 from Plas Menai Roundabout to Caernarfon	27.1	27.3	19.5	-7.8	-19.4%	Large	Negligible	Concentrations well below the objective; large decreases in concentration due to significant redistribution of traffic from A487 to Scheme
		25.6	25.8	17.3	-8.5	-21.2%	Large		
12_C to 17_C	B4366 from A55 to Bethel	13.7	13.4	11.8	-1.7	-4.1%	Small	Negligible	Generally very low concentrations at all receptors due to distance from major roads; decrease in traffic flows results in slight decrease in pollutant concentrations
		11.5	11.2	9.6	-1.7	-4.2%	Small		
18_D to 21_D	B4366 from Bethel to Caernarfon	15.1	14.9	13.4	-1.5	-3.8%	Small	Negligible	Generally very low concentrations at all receptors, and a decrease with the Scheme. Decrease is greatest towards Caernarfon due to overall impacts on traffic
22_E to 26_E	A4086 from Llanberis to Pont-rug	16.2	16.9	14.1	-2.8	-7.0%	Medium	Negligible	Generally very low concentrations at all receptors, due to modest traffic flows; decrease in traffic and pollutant concentrations with the Scheme
27_F to 30_F	A4086 from Pont-rug to Caernarfon	19.7	19.9	16.6	-3.3	-8.3%	Medium	Negligible	Generally low concentrations at all receptors, due to modest traffic flows; decrease in traffic and pollutant concentrations with the Scheme

Receptors		Impact At Most Affected Receptor							Overall Comment
		Baseline 2014 (µg/m^3)	2018 DM (µg/m^3)	2018 DS (µg/m^3)	Change in concen-tration (µg/m^3)	% Change in concen-tration	Magnitude of Change	Significance	
31_G to 35_G	A4085 from Bettws Garmon to Caeathro	9.2	9.1	8.0	-1.1	-2.8%	Small	Negligible	Generally very low concentrations at all receptors due to distance from major roads; decrease in traffic flows results in slight decrease in pollutant concentrations
36_H to 39_H	A4085 from Caeathro to Caernarfon	18.2	18.1	14.5	-3.6	-9.0%	Medium	Negligible	Generally very low concentrations at all receptors, and a decrease with the Scheme. Decrease is greatest towards Caernarfon due to overall impacts on traffic
40_I to 43_I	A499 from Pontllyfni to Goat Roundabout	12.4	12.6	15.6	3.0	7.5%	Medium	Negligible	Generally very low concentrations at all receptors, due to modest traffic flows; increase in traffic and pollutant concentrations with the Scheme
44_J to 54_J	A487 from Goat Roundabout to Caernarfon	39.0	39.2	23.9	-15.3	-38.2%	Large	Slight Beneficial	Roadside concentrations just below to just above air quality objective; large decrease in concentrations with Scheme due to redistribution of traffic from A487 to the Scheme
		41.6	41.5	27.9	-13.6	-34.0%	Large		
55_K to 58_K	A487 South of Goat Roundabout to Penygroes	15.0	14.8	15.6	0.8	2.0%	Small	Negligible	Generally very low concentrations; small increase in concentrations with the Scheme due to movement of traffic from minor roads onto A487 with Scheme
		9.6	9.4	9.8	0.4	1.0%	Small		
59_L to 77_L	Scheme route	21.3	21.3	17.2	-4.1	-10.3%	Large	Negligible	Very low concentrations generally; majority of receptors see an increase with the Scheme due to introduction of

Receptors		Impact At Most Affected Receptor							Overall Comment
		Baseline 2014 (µg/m^3)	2018 DM (µg/m^3)	2018 DS (µg/m^3)	Change in concen-tration (µg/m^3)	% Change in concen-tration	Magnitude of Change	Significance	
		6.2	6.1	10.4	4.3	10.8%	Large		traffic where there were no roads previously; a few receptors experience a decrease in concentrations where they currently sit on minor roads used to travel north-south without using the A487
78_M to 81_M	Minor road from Bontnewydd to Caeathro	13.8	14.0	8.4	-5.6	-14.1%	Large	Negligible	Very low concentrations generally; decrease in concentrations with the Scheme due to realignment of traffic from minor roads used to travel north-south without using the A487 and the Scheme
82_N to 85_N	Minor road from Caeathro to Pont-rug	15.8	16.1	10.0	-6.1	-15.3%	Large	Negligible	Very low concentrations generally; decrease in concentrations with the Scheme due to realignment of traffic from minor roads used to travel north-south without using the A487 and the Scheme

Note: (% change expressed as a proportion of the objective) (Imp. = Imperceptible change). Exceedences of the air quality objective of 40µg/m^3 are shown in bold italic.

Table 5.4.5 Results of WelTAG assessment of change in population exposure to pollution for the Scheme opening year (from Key Stage 2).

Scenario	Assessment Score		Properties experiencing a Decrease in exposure		Properties experiencing an Increase in exposure	
	PM_{10}	NO_2	PM_{10}	NO_2	PM_{10}	NO_2
The Scheme (Yellow Option)	-1317	-7645	2660	2823	220	57

5.3.3 Ecological Receptors

Table 5.4.6 and 5.4.7 show the predicted impact of the Scheme on ambient NO_X concentrations at ecological receptors in 2018 for annual mean and daily mean concentrations respectively; Table 5.4.8 shows the impacts on nitrogen deposition. Similar conclusions hold for predictions for 2033, although overall concentrations and deposition levels are slightly lower than in 2018.

In summary, the overall impacts of the Scheme on sites designated for nature conservation are:-

- Glynllifon SAC/SSSI — Neutral to Adverse Impacts
- Afon Gwyrfai a Llyn Cwellyn SAC/SSSI — Neutral Impacts
- Pant Cae Haidd — Neutral to Beneficial Impacts

Over the Glynllifon SAC/SSSI, the Scheme would result in adverse impacts at the roadside due to increases in traffic on both the A487 and the A499. The spatial extent of exceedences of the daily and annual mean critical levels for NO_X is limited. For annual mean nitrogen dioxide, the Scheme would result in the extension of the roadside zone exceeding the air quality objective (30µg/m^3) by between 5 and 10m along the A499 and the A487 i.e. concentrations fall below the objective at a distance of 5 - 15m from the roadside without the Scheme and 15 – 20m from the roadside with the Scheme. Daily mean nitrogen oxides concentrations exceed the air quality objective (75µg/m^3) by some considerable margin at the roadside in all scenarios, including the baseline. As a worst case, the impacts of the Scheme on daily mean nitrogen oxides are large within 200m of the road. Nitrogen deposition exceeds the upper limit of the critical load in all modelled scenarios but the increase with the Scheme falls to negligible levels (<1% of the critical load) at 25m of the A487 and 80m of the A499. Moreover, the exceedence of the critical load is due to the high background deposition levels rather than the Scheme.

The Afon Gwyrfai a Llyn Cwellyn SAC/SSSI traverses both the Scheme itself and the A487. As a result, the overall impacts of the Scheme are neutral. The impacts would be beneficial where the SAC/SSSI crosses the A487 (which experiences a significant decrease in traffic with the Scheme) and adverse where the site crosses the new bypass. For annual mean nitrogen oxides near the A487, this results in a decrease in the distance from the roadside to where concentrations exceed the objective from 35m without the Scheme to 5m with the Scheme. Alongside the Scheme, it would result in the creation of corresponding but smaller areas of exceedence of the objective within 15m of the side of the Scheme. Where the SAC/SSSI crosses the A4085, there would be a small beneficial impact but no exceedences of the objective,

with or without the Scheme. Background nitrogen deposition levels exceed both the lower and upper ranges of the critical loads for the most sensitive habitats. As for nitrogen oxides, the Scheme results in an increase in nitrogen deposition near the Scheme, but a decrease near the A487.

Maximum daily mean nitrogen oxides concentrations are above the air quality objective at the side of existing major roads (A487) in the Do Minimum Scenario out to a distance of 200m. With the Scheme, the concentrations exceed the objective alongside the Scheme to a distance of over 170m (where previously there was no exceedence), and decrease along the A487 (north of the Goat Roundabout) but remain above the objective. The distance to the exceedence alongside the A487 is, however, reduced from 200m to 65m.

Over Pant Cae Haidd SSSI, there would be small beneficial impacts at the roadside, due to the decrease in traffic on the A4085 but no exceedences of the annual mean critical level for NOx, with or without the Scheme. In relation to the daily mean critical level, the Scheme results in the removal of the exceedence of the critical level at the roadside but beyond 5m from the road, concentrations are below the critical level in both Do Minimum and Do Something scenarios. Nitrogen deposition exceeds the upper limit of the critical load in all scenarios (due to the high background deposition levels). It decreases slightly with the Scheme but the impact of the Scheme is negligible after 10m.

Both critical levels and critical loads are set to be protective of ecosystems. Therefore, locations where concentrations or deposition levels are below the standards would not experience adverse impacts from air quality. Moreover, if the impact of a scheme is less than 1% of the standard, then the effects can be considered inconsequential. This is not to say that effects will occur where the impact is marginally above 1%, but below this level they will be imperceptible. As such, it is reasonable to assume in the first instance, and without regard to the spatial distribution of different habitats within a designated site or variations in physical conditions across the site (e.g. soil type, exposure etc), the potential for significant effects can be eliminated in all areas of the site except where the concentration or deposition exceeds the relevant standard and the impact of the Scheme is greater than 1% of the standard.

Using these criteria, the area of the Glynllifon SAC (SSSI) *potentially* at risk from significant effects from air pollution amounts to 1.4% (1.5%) of the site in relation to long term exposure to nitrogen oxides, 19.8% (21.5%) of the site in relation to maximum daily exposure to nitrogen oxides and 5.1% (5.3%) of the site in relation to nitrogen deposition.

For daily mean nitrogen dioxide impacts, the assessment is based on the maximum modelled daily concentration in the year. Impacts on other days are lower, but roadside concentrations exceed the standard on over 100 days of the year in both the Do Minimum and Do Something scenarios and the area at risk from significant effects is 5% or more of the site area for approximately 10% of the year.

As was the case for human receptors, concentrations and deposition levels are expected to decrease over time due to improvements in vehicle technology. The impacts presented in Table 5.4.6 and Appendix B5 as adjusted values relate to model predictions following IAN 170 which allows for only modest improvements in vehicle technology over time. By 2033, this becomes increasingly over-pessimistic. Using the official forecasts of vehicle emissions improvements over time, exceedence of the daily mean objective is not completely removed for the worst day of the year in terms

of dispersion at the side of major roads, but the area of impact is substantially reduced, to less than 5% of the site area as a worst case.

Table 5.4.6 Summary of annual mean NOx concentrations at ecological receptors for 2018

Ecological Receptor	Impact At Nearest Point to Road							Comment
	Baseline 2014 (µg/m^3)	2018 DM (µg/m^3)	2018 DS (µg/m^3)	Change in concen-tration (µg/m^3)	% Change in concen-tration	Magnitude of Change	Distance to insignificant impact (m)	
Glynllifon SAC/SSSI (Transect T1 on A487)	60.5	56.6	61.4	4.7	16%	Large	130m	Adverse impacts, with exceedence of objective to 20m from roadside with scheme and 15m without scheme; Impacts fall to negligible significance at 140m and greater from roadside
Glynllifon SAC/SSSI (Transect T2 on A499)	36.4	35.5	47.0	11.5	38%	Large	Roadside	Adverse impacts, with exceedence of objective to 15m from roadside with scheme and 5m without scheme; Impacts fall to 2.2% of objective at 200m, but are well below the objective at this distance
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect T3 on A487, Bontnewydd)	89.5	85.6	33.8	-51.8	-173%	Large	>200m	Beneficial impacts, with exceedence of objective to 5m from roadside with scheme and 35m without scheme
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect T4 on Scheme)	12.2	11.3	41.7	30.4	101%	Large	>200m	Adverse impacts, with exceedence of objective to 10m from roadside with scheme and no exceedence without scheme
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect T5 on minor road, north of Saron)	13.3	12.4	12.5	0.1	0%	Small*	Roadside	Increase in concentration with Scheme; maximum impacts occur away from side of minor road as proximity to bypass increase, but no exceedence of objectives with or without Scheme
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect T6 on A4085, south of Waunfawr)	15.6	14.4	13.1	-1.3	-4%	Small	40m	Decrease in concentration with the Scheme, but no exceedence of objectives in any scenario
Pant Cae Haidd SSSI (Transect T7 on A4085, north of Waunfawr)	23.4	21.7	20.2	-1.5	-5%	Small	20m	Decrease in concentration with the Scheme, but no exceedence of objectives in any scenario

Note: Distance to insignificant impact relates to the distance from the roadside that impacts fall to less than 1% of the air quality objective/critical level of 30µg/m^3

Table 5.4.7 Summary of daily mean NOx concentrations at ecological receptors for 2018

Ecological Receptor	Impact At Nearest Point to Road							Comment
	Baseline 2014 (µg/m^3)	2018 DM (µg/m^3)	2018 DS (µg/m^3)	Change in concen-tration (µg/m^3)	% Change in concen-tration	Magnitude of Change	Distance to insignificant impact (m)	
Glynllifon SAC/SSSI (Transect on A487)	440.3	413.2	449.8	36.6	49%	Large	>200m	Adverse impacts, with exceedence of objective to >200m from roadside with scheme and 185m without scheme
Glynllifon SAC/SSSI (Transect on A499)	175.8	172.4	237.8	65.3	87%	Large	>200m	Adverse impacts, with exceedence of objective to 120m from roadside with scheme and 60m without scheme
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect on A487, Bontnewydd)	593.5	568.7	200.0	-368.7	-492%	Large	>200m	Beneficial impacts, with exceedence of objective to 35m with Scheme, >200m without Scheme
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect on Scheme)	51.1	48.4	354.9	306.5	409%	Large	>200m	Adverse impacts, with no exceedence of objective without scheme, exceedence to >200m with Scheme
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect on minor road, north of Saron)	50.6	48.7	55.3	6.6	9%	Medium	>200m	Increase in concentration with Scheme, but no exceedence of objective in any scenario
Afon Gwyrfai a Llyn Cwellyn SAC/SSSI (Transect on A4085, south of Waunfawr)	44.8	41.7	36.1	-5.6	-8%	Medium	>200m	Decrease in concentration with Scheme, but no exceedence of objective in any scenario
Pant Cae Haidd SSSI (Transect on A4085, north of Waunfawr)	85.7	80.1	73.7	-6.4	-9%	Medium	>200m	Beneficial impact, with no exceedence of objective with Scheme, and exceedence to 5m without scheme

Note: Distance to insignificant impact relates to the distance from the roadside that impacts fall to less than 1% of the air quality objective/critical level of 75µg/m^3

Table 5.4.8 Summary of nitrogen deposition impacts at ecological receptors

Ecological Receptor		Impact At Nearest Point to Road							Comment
		Critical Load	Baseline 2014 kgN/ha/yr	2018 DM kgN/ha/yr	2018 DS kgN/ha/yr	Change in deposition kgN/ha/yr	% Change in deposition	Distance to insignificant impact (m)	
Gynlliffon (A487)	Broadleaved woodland	10-20	26.00	25.96	26.18	0.22	2.2%	10	Small adverse impact; exceedence of critical load upper limit in all scenarios
	Acid grassland	8-15	21.24	21.20	21.42	0.22	2.8%	15	
Glynllifon (A499)	Broadleaved woodland	10-20	24.91	24.95	25.53	0.58	5.8%	75	Medium adverse impact; exceedence of critical load upper limit in all scenarios
	Acid grassland	8-15	20.15	20.19	20.77	0.58	7.2%	95	
Afon Gwyrfai (Bontnewydd, A487)	Oligotrophic Waters	3-10	19.08	19.10	16.74	-2.36	-78.6%	>40	Large beneficial impact; exceedence of critical load upper limit in all scenarios
	Lowland Beech & Yew	5-15	34.34	34.36	32.00	-2.36	-47.1%	>40	
Afon Gwyrfai (Bypass)	Oligotrophic Waters	3-10	15.59	15.57	17.20	1.63	54.4%	>40	Large adverse impact; exceedence of critical load upper limit in all scenarios
	Lowland Beech & Yew	5-15	30.85	30.83	32.46	1.63	32.7%	>40	
Afon Gwyrfai (Saron)	Oligotrophic Waters	3-10	15.65	15.63	15.64	0.00	0.1%	Roadside	Exceedence of critical loads in all scenarios, but impacts insignificant
	Lowland Beech & Yew	5-15	30.91	30.89	30.90	0.00	0.1%	Roadside	
Afon Gwyrfai (A4085)	Oligotrophic Waters	3-10	15.77	15.74	15.67	-0.07	-2.5%	Roadside	Small beneficial impact; exceedence of critical load upper limit in all scenarios
	Lowland Beech & Yew	5-15	31.03	31.00	30.93	-0.07	-1.5%	Roadside	
Pant Cae Haidd	Lowland Beech & Yew	5-15	26.26	26.23	26.15	-0.08	-1.6%	10	Small beneficial impact; exceedence of critical load upper limit in all scenarios
	Acid Grassland	8-15	16.60	16.57	16.49	-0.08	-1.0%	Roadside	

5.3.4 Regional Air Quality

Table 5.4.8 below shows the impacts of the Scheme on regional air quality as illustrated by the total emissions from road transport within the study area in each of the modelled scenarios.

The Scheme would result in an overall increase in emissions of both greenhouse gases (carbon dioxide) and the local air quality pollutants (nitrogen oxides and PM_{10}). This is due to an overall increase in vehicle kilometres travelled.

Emissions of nitrogen oxides are expected to decrease substantially over time. Taking into account the recent research of Carslaw[5.5], which suggests that vehicle emissions of NO_X are not decreasing as rapidly as expected, absolute emissions of NO_X may be higher than the values presented here, but the impact of the Scheme would be unchanged i.e. an increase of around 5% in comparison to the Do Minimum scenario. This is likely to be most noticeable in the opening year (2018), since significant reductions in emissions per vehicle are expected post 2030.

Emissions of particulate matter decrease between the baseline and 2018 scenarios, but then are relatively constant in time. This implies that relatively modest improvements in emissions per vehicle nearly balance the effects of increasing traffic volume. For carbon dioxide, an absolute increase in emissions is expected with the Scheme, in relation to both the Do Minimum and Baseline scenarios. That is to say, improvements in vehicle efficiencies are not expected to compensate for an overall increase in vehicle kilometres travelled.

However, on a regional scale, the increase in emissions would be negligible. For example, in 2013, total greenhouse gas emissions from the transportation sector (primarily road transport) for Wales were 5,719kilotonnes of carbon dioxide equivalent. The impact of the Scheme is 3kilotonnes, less than 0.1% of the total emissions for Wales.

Table 5.4.8 Summary of change in emissions from road transport within the study area with the Scheme

Pollutant	Baseline 2014 tonnes/yr	Do Minimum	Do Something	Change with Scheme	% Change with Scheme
		2018			
Nitrogen Oxides	144.0	95.5	99.7	4.2	4%
Particulate Matter, PM_{10}	8.8	7.9	8.3	0.4	5%
Carbon Dioxide	45,875	44,689	47,723	3034.3	6%
		2033			
Nitrogen Oxides	144.0	105.4	109.3	3.9	4%
Particulate Matter, PM_{10}	8.8	8.7	9.1	0.4	5%

Carbon Dioxide	45,875	49,504	52,738	3234.1	6%

5.4 Proposed Mitigation

5.4.1 Construction

In the absence of mitigation, the risk of impacts from construction dust (soiling/nuisance) is, at worst, medium but is more generally negligible to low. As a result, the proposed mitigation is set out as general measures that reflect best practice and should be implemented across the whole construction site and period, and an additional set of measures that should be implemented in locations where construction activities (earthworks/construction/track-out) occur with 50m of sensitive receptors such as residential properties.

General Dust Mitigation Measures

The following mitigation measures should be integrated into a Dust Management Plan (DMP) to ensure that good construction practices are followed.

Site Management

- Records of dust and air quality complaints to be kept, including likely causes and mitigation measures to reduce impacts if appropriate;
- Keep site perimeter, fences etc. clean;

Site Planning

- Consideration of weather conditions;
- Consideration of dust generating potential of material to be excavated prior to commencement of works
- Plan site layout to maximise distance from plant/stockpiles etc. to sensitive receptors;
- Dusty materials should be removed from site as soon as possible;

Construction Traffic

- Loads entering and leaving the site with dust generating potential should be covered and wheel washing facilities made available;
- No idling of vehicles;
- Vehicles to comply with site speed limits (15mph on hard surfaces, 10mph of unconsolidated surfaces);
- Water assisted sweeping of local roads to be undertaken if material tracked out of site;
- Install hard surfacing as soon as practicable on site and ensure that they are maintained in good condition;

Site Activities

- Exposed soils should be re-vegetated as soon as practicable. Near residential properties or sensitive ecosystems (<50m), use hessian/mulches etc. where not possible to re-vegetate or cover with topsoil;
- Minimise dust generating activities, particularly near residential receptors / sensitive ecosystems during prolonged dry, dusty weather unless damping / other suppressants are used;
- Ensure an adequate water supply to site and use water as dust suppressant where applicable;
- Ensure any site machinery is well maintained and in full working order;
- Ensure equipment available for cleaning spills etc. Available at all times;
- Sand and aggregates should be stored away from sensitive receptors and screened shielded. Similarly, concrete batching should take place away from receptors.

Additional Mitigation Measures in Vicinity of Sensitive Receptors

The following paragraphs outline the additional mitigation measures appropriate for locations where construction activities occur within 50m of sensitive receptors. The dust risk assessment identified the most sensitive receptor/locations to be the following residential properties:

- Morogoro
- Glan Gwna Holiday Park
- Tyddyn Hen

together with:

- All site access points
- All plant crossing points

At this stage, a detailed construction plan has not been developed, as such, the above locations may need to be modified. In any case, it is imperative that the DMP reflect that the additional mitigation measures should apply wherever activities occur within 50m of potentially sensitive receptors.

Communications

- Develop and implement a stakeholder communications plan that includes community engagement before work commences on site
- Display the name and contact details of the person(s) accountable for air quality and dust issues on the site boundary (this is particularly pertinent at the residential receptors).

Monitoring

- Undertake daily inspection where receptors (including roads) are nearby, to monitor dust, record inspection results and make a log available to the local authority when asked. This should include regular dust soiling checks of

surfaces such as street furniture, cars and window sills within 100m of the boundary, with cleaning to be provided if necessary.

- Increase the frequency of site inspections during prolonged periods of dry and windy conditions and when activities with a high potential to produce dust are being carried out.

Preparing and maintaining the site

- Erect solid screens at the site boundary adjacent to the receptors that are as high as any stockpiles on site.
- Ensure any nearby stockpiles are covered / seeded to prevent wind whipping.

5.4.2 Operation

The Scheme would have an overall beneficial impact on air quality and, as such, no mitigation of operational impacts is warranted in relation to human health.

The significance of the impacts of the enhanced levels of air pollution on the Glynllifon SAC is hard to predict but is unlikely to affect the population of the Lesser Horseshoe Bats significantly.

Bats may be exposed to direct effects of air pollution whilst breathing when flying. There are no physiological data on direct effects of air pollution on Lesser Horseshoe Bats or guidelines for air quality standards for them, so the ambient air quality objectives for human health are taken as an indicative guide (NO_2 40 µg/m^3 annual mean; PM_{10} 40 µg/m^3 annual mean). The existing background levels are well within the guidelines (Do minimum; Table 5.3.3), as are the predicted levels (Do something; Table 5.3.4). The ambient air quality objectives for protection of vegetation (which forms the structure of the SAC) for NOx are 30 µg/m^3 annual mean, and again the predicted levels are within the guidelines. Similarly, it is unlikely there would be direct effects on the overall abundance of their invertebrate food resources, such as small flies (mainly midges), moths, caddis flies, lacewings, beetles, wasps and spiders.

Furthermore, the 1.4% of the SAC affected by enhanced NOx levels is confined to the edges of the SAC parallel to the roads (up to 18 m from the A499 and up to 23 m from the A487). The total area affected is small compared to the area designated as SAC, or very small to the extensive areas of the wider landscape which the bats may utilise.

The daily mean nitrogen oxides concentrations would exceed the air quality objective (75µg/m^3) in all cases for up to 105 m from the A499 and 210 m from the A487 and 19.8% of the SAC could be affected by enhanced daily concentrations. However, as the main periods of bat activity during the summer are generally at night (typically about half an hour after dusk until near dawn) when traffics levels are low, the bats are likely to experience much lower than average daily exposures, though there may be some overlap with peak evening traffic flow during the spring (April/May onwards) and autumn (September/October).

It is possible that deposition of nitrogen-based air pollution might affect either Lesser Horseshoe Bats indirectly through effects on habitats where they forage (the main maternity roosts and hibernation roosts are in buildings or mines and would not be affected by deposition). The Glynllifon SAC has mixed broad-leaved and conifer woodland over areas of bracken, which suits the Lesser Horseshoe Bats which typically feed amongst open woodland in sheltered lowland valleys, in the canopies of mature trees or within 5 m of the ground. The critical loads for nitrogen deposition are

10-20 kg N/ha/yr for broad-leaved woodland and the background deposition levels (16.8-25.6 kg N/ha/yr) are already above these loads (Table 5.3.4). The nitrogen deposition models predict enhanced significantly levels for nitrogen deposition up to 15 m parallel to the A499 and 65 m parallel to the A487. The most likely consequence is a continuing slow change in the composition of the ground flora in these areas with increases in nitrophilous species such as brambles, nettles and grasses, whilst the canopy trees and shrubs remaining broadly the same. Thus the structure will probably remain broadly the same providing similar foraging and feeding roost opportunities as now.

There would be no change in the extent of the SAC as this is not directly affected by the Scheme.

5.5 Residual Environmental Effects (following mitigation)

5.5.1 Construction

There would be no permanent residual risks associated with the construction of the scheme. All risks of impacts outlined above relating to construction activities and traffic are temporary.

5.5.2 Operation

There would be no significant adverse residual effects anticipated as a result of the introduction of the scheme, indeed in relation to human health, the impacts of the Scheme are beneficial.

For ecological receptors, even with modest improvements in vehicle technology over time, no significant worsening of exposure to pollution or pollutant deposition is expected in relation to existing conditions.

5.6 Summary and Conclusions

Current air quality in the vicinity of the scheme is generally very good, although exceedences of the air quality objective for annual mean nitrogen dioxide were monitored at the roadside of the A487 through the centre of Caernarfon. There are no AQMAs in the study area. Three statutory nature conservation sites lie within the study area, namely Glynllifon SAC/SSSI, Afon Gwyrfai a Llyn Cwellyn SAC/SSSI and Pant Cae Haidd SSSI. Nitrogen oxides concentrations at the roadside within these sites exceed the air quality objectives / critical levels for the protection of vegetation, although in the case of Pant Cae Haidd this applies to the daily mean NO_X critical level only. Levels of nitrogen deposition exceed both the lower and upper ranges of the critical loads for the most sensitive features within these sites.

A qualitative assessment of the potential for dust emission from construction activities was undertaken, and the significance of likely impacts was determined for both human and ecological receptors. The area around the scheme is not heavily populated and, as such, there is limited potential for dust nuisance during construction. Furthermore, with low background particulate matter concentrations, there is negligible risk to human health. However, due to the scale of the Scheme and duration of activities, at the limited numbers of properties close to the works, there is a medium potential for dust impacts. As such, good practice measures have been proposed across all areas of the site, with enhanced measures and monitoring (visual) of dust, in the vicinity of residential properties, site access points and plant crossing points.

The assessment of impacts of changes to traffic flows as a result of the Scheme was undertaken using detailed dispersion modelling and analysed against criteria set out in DMRB guidance. Changes in pollutant concentration at human and ecological receptors relate in large part to the redistribution of traffic from the A487 through Bontnewydd and Caernarfon to the new bypass.

The overall impact of the Scheme on air quality in relation to human health would be beneficial. Elevated pollution levels, including existing exceedences of the annual mean nitrogen dioxide objective, alongside the A487 through Bontnewydd and Caernarfon are significantly reduced with the Scheme such that all risk of exceedence of air quality objectives is removed with the Scheme. Pollution levels increase in the vicinity of the Scheme, but concentrations remain well within the objectives.

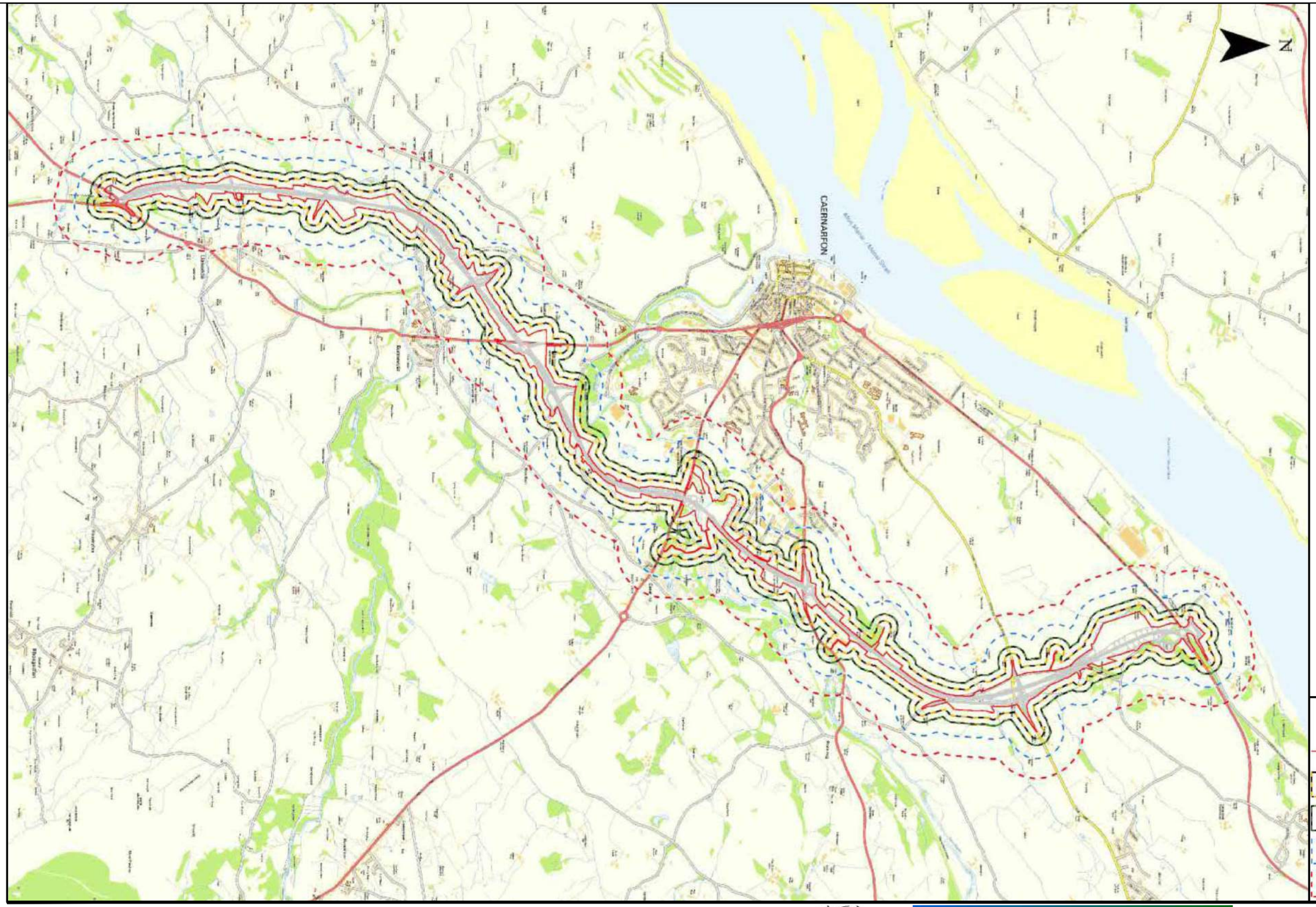
At the designated sites, roadside impacts range from adverse over Glynllifon SAC/SSSI, neutral over Afon Gwyrfai a Llyn Cwellyn SAC/SSSI and beneficial over Pant Cae Haidd. At Afon Gwyrfai a Llyn Cwellyn, the area of the site intersecting major roads is limited but, where the site crosses the A487 concentrations and deposition levels reduce, where the site crosses the proposed route of the Scheme concentrations and deposition levels increase. Taking into account the redistribution of impacts and the small area of the site affected, the overall impact is considered neutral. Concentrations and deposition levels over Glynllifon increase with the Scheme, with worsened and newly created areas of exceedence of the critical levels for annual mean and daily mean nitrogen oxides and critical loads for nitrogen deposition. As a worst case, the area of the site affected ranges from less than 2% (worsened exceedence of the statutory critical level for annual mean NO_X) to 5% and 20% of the site, for worsened exceedences of the non-statutory critical loads for nitrogen deposition and critical level for daily mean NO_X. However, the impacts are expected to decrease over time as vehicle technology improves and emissions reduce.

Overall, the air quality effects on human receptors associated with the scheme are unlikely to:

- Interfere with or prevent the implementation of actions being undertaken by the Gwynedd County Council to improve air quality;
- Lead to an exceedence of a UK air quality objective;
- Cause a new AQMA to be declared;
- Lead to a significant increase in emissions, degradation of air quality or increase in exposure to pollutants; or
- Result in adverse dust effects from construction activities.

In relation to ecological receptors the air quality effects related to the scheme are likely to result in large increases in NO_X concentrations and nitrogen deposition over Glynllifon SAC, negligible net change in exposure to pollution over Afon Gwyrfai a Llyn Cwellyn SAC, and small benefits over Pant Cae Haidd.

Air quality effects do not represent a constraint, to the scheme as a result of impact to human receptors. Further information on the effects of changes in air quality resulting from the Scheme on ecological receptors are set out in Chapter 8: Nature Conservation.



Legend

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- 100m Buffer
- 200m Buffer
- 350m Buffer

REV	DATE	DESCRIPTION	BY	CHKD	APPD

• TITLE

A487 CAERNARFON AND BONTNEWYDD BYPASS

Air Quality
Construction Dust Study Area

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Welsh Government

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Ty Glyn, Canol Y Dre, Ruthin
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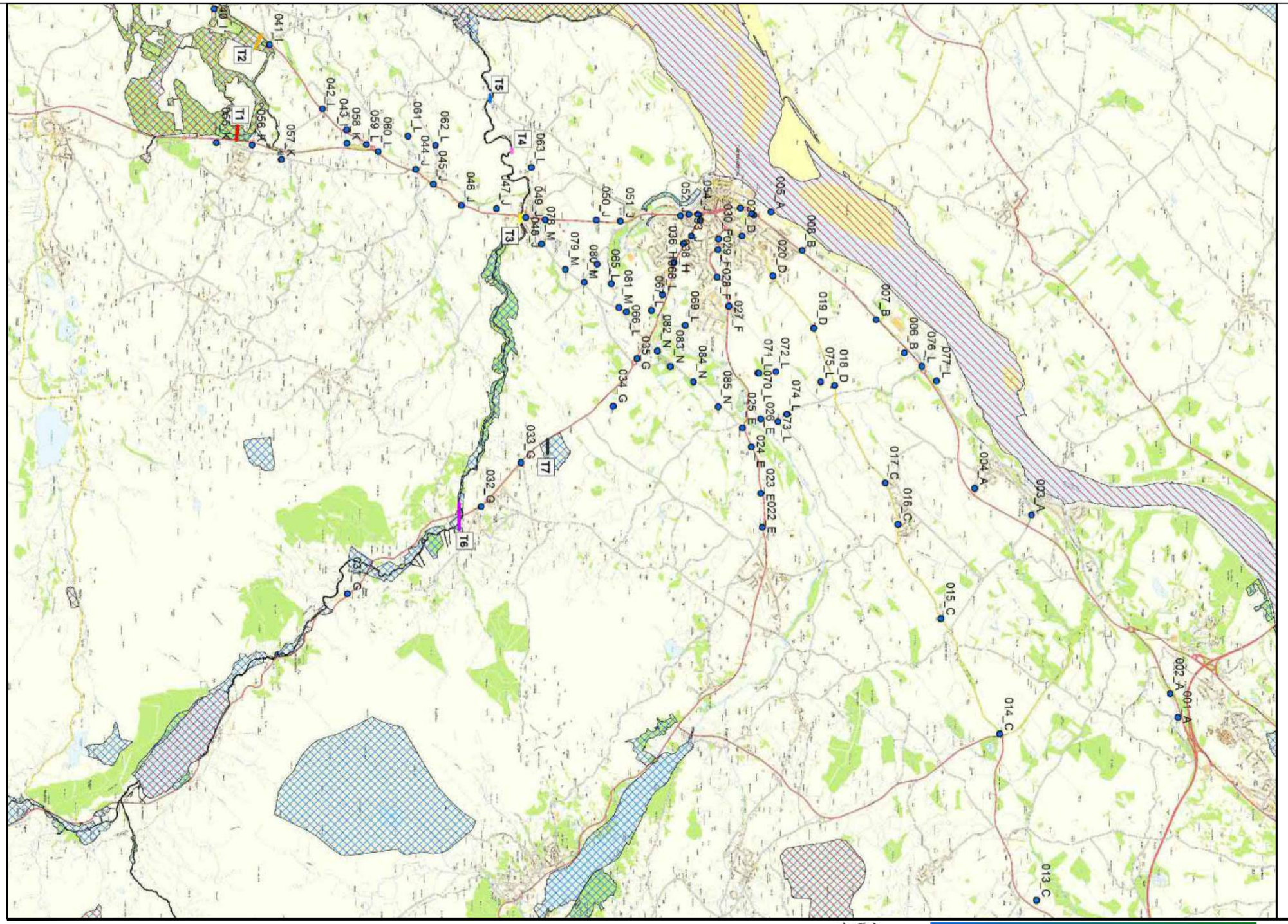

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A487 CAERNARFON AND BONTNEWYDD BYPASS

Air Quality
Operation Assessment Detailed Study Area Including Receptors

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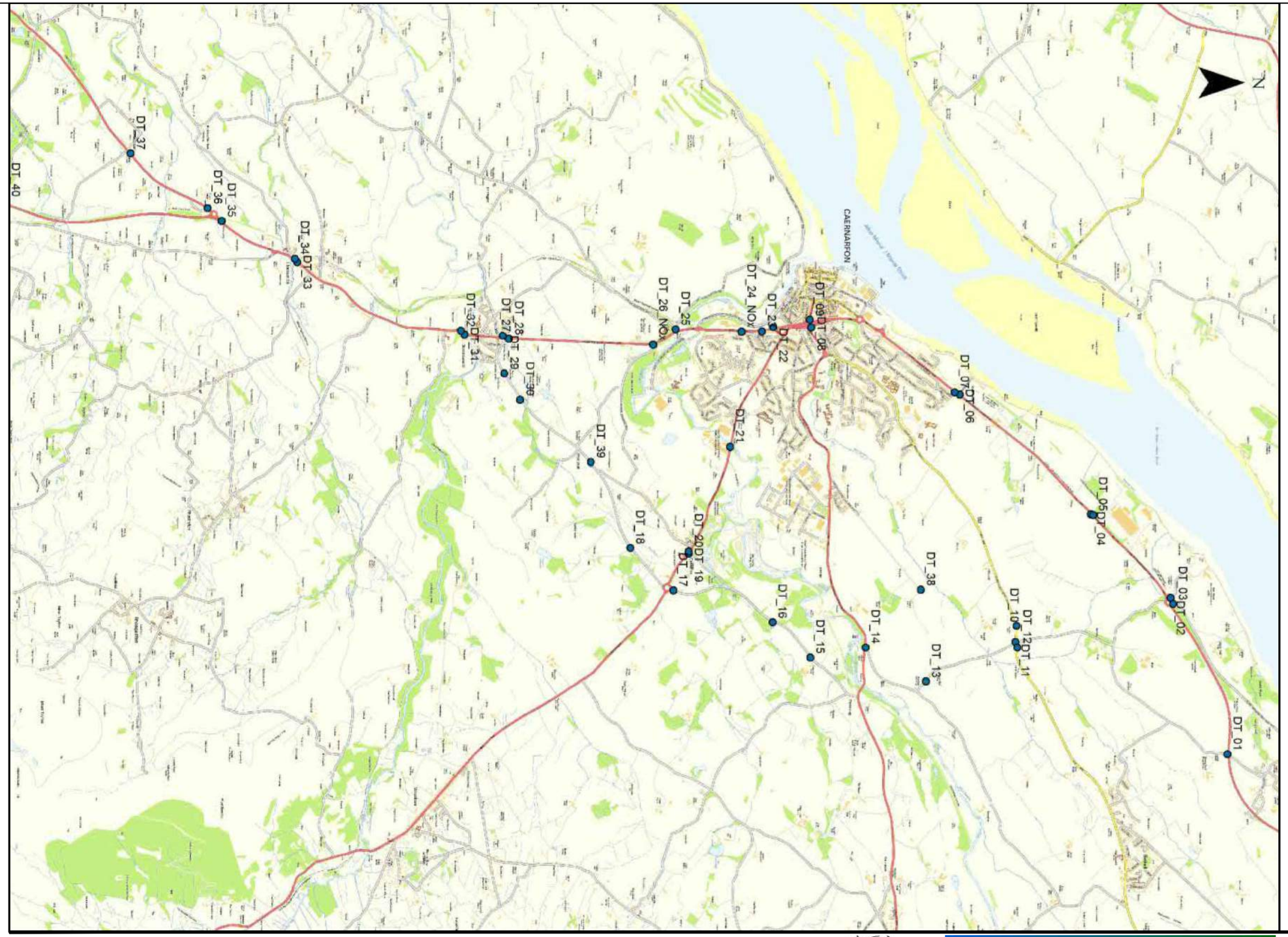

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- 100m Buffer
- 200m Buffer
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A487 CAERNARFON AND BONTNEWYDD BYPASS

Air Quality
Diffusion Tube Monitoring Sites

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