Welsh Government

M4 Corridor around Newport

Environmental Statement Volume 3: Appendix 5.4

Health and Equalities Impact Assessment

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Introduction

S.1 Health Impact Assessment (HIA) and Equality Impact Assessment (EqIA) are a key part of the appraisal process for major transport schemes in Wales. The Welsh Government has statutory duties to promote wellbeing and racial, disability and gender equality, and has set up a Public Health Strategic Framework to improve the quality and length of life for all members of the community. Social Impact Assessment (SIA) is often developed as an independent SIA report; however, social, health and equality impacts are intrinsically linked.

S.2 A combined Health, Social and Equalities Impact Assessment has therefore been undertaken for the proposed M4 Corridor around Newport (M4CaN), which is referred to in this document as the Scheme. This assessment considers how the Scheme may influence public health and wellbeing in the areas surrounding the proposed new section of motorway and the existing M4 corridor through environmental and socio-economic pathways. The assessment also considers, where possible, the distribution of impacts and any potential disproportionate impacts of the Scheme on sensitive community groups.

S.3 The Scheme proposes to provide a new three lane motorway to the south of Newport between Junctions 29 (Castleton) and 23 (Magor) of the existing M4, as well as a number of ‘Complementary Measures’ on the existing M4 route between these junctions. The Scheme has been put forward as a solution to the existing traffic, congestion, reliability and resilience problems between Magor and Castleton. The existing M4 between Magor and Castleton is the most heavily trafficked section of road in Wales, forming part of strategic routes to the south west, Midlands, the south of England and beyond. However, it does not meet modern motorway design standards. This section of the existing M4 is often congested, especially during weekday peak periods, resulting in slow and unreliable journey times and stop-start conditions and with incidents frequently causing delays.

S.4 The Scheme aims to address the current issues of capacity, resilience, safety and issues of sustainable development by improving traffic flows, which are predicted to worsen in the future in the absence of the Scheme.

Scope and Consultation

S.5 For the purpose of this HIA, the Scheme is defined as the operation of the proposed new section of motorway and Complementary Measures (including changes to the existing motorway), the changes to other road links connecting with either motorway, and the construction activities and land take associated with these changes. The Scheme has been assessed during construction and operation.

S.6 This assessment has been undertaken based on information regarding effects of the Scheme predicted in the Environmental Impact Assessment (EIA), Traffic Forecasting Report, Traffic and Collisions Report, Economic Appraisal Report, Wider Economic Impact Assessment report and Flood Consequence Assessment for the Scheme.

S.7 The Scheme has the potential to influence local communities in various ways. It is designed to reduce journey times, improve road safety, improve air quality and reduce noise disturbance for the areas adjacent to the existing M4. However, it would introduce new or increased air and noise pollution, would require land-take and would affect the amenity of areas around the proposed new section of motorway, and would have effects on a number of other roads linking to both the existing and proposed roads.

S.8 It may also affect local people by changing aspects of the community they live in, influencing health and wellbeing through social and economic pathways. By changing the distribution of road traffic within Newport, it may likewise affect the spatial distribution of environmental and social impacts across sections of the community, relevant to the assessment of equalities impacts.

S.9 Stakeholder engagement and public consultation has been undertaken as part of the planning process for the Scheme. Three previous stages of HIA have also been undertaken, with the most recent being published in 2014. These form the screening and scoping process for this HIA, and involved further consultation with the public and health stakeholders in 2013. Given the extensive previous and ongoing stakeholder engagement, no additional public consultation has been undertaken specifically for this HIA, but the scope and approach has been agreed through consultation with the Wales HIA Support Unit (WHIASU).

Assessment Findings

S.10 The assessment findings are summarised below under the headings of environmental pathways (air quality, noise, contaminated land and flood risk), social pathways (economic impacts, access to services and transport including safety and facilities for non-road/motorised users) and equalities impacts.

Environmental Impact Pathways

S.11 The principal environmental pathways by which the Scheme would have direct public health impacts are changes in air pollutant concentrations and change in noise levels. Air pollutant exposure affects mainly respiratory and cardiovascular health, increasing disease incidence, severity of symptoms and risk of premature mortality. Noise exposure can cause annoyance, stress and sleep disturbance above certain thresholds, affecting mental health and wellbeing and increasing the risk of cardiovascular disease via increased hypertension.

S.12 The Scheme would essentially transfer a large amount of road traffic from the existing M4 corridor in the relatively densely populated area in the north of Newport to the new section of motorway in the less-populated area south of Newport. On the premise that the Scheme would not encourage additional future traffic growth (over the do-minimum scenario) and would not encourage residential development (beyond that foreseen in Local Development Plans), then this would reduce the number of people exposed to the greatest air pollution and noise impacts. The receiving environment south of Newport has better existing air quality and a quieter existing noise environment. This gives greater headroom to accommodate air and noise pollution from the proposed new section of motorway and potentially therefore reduces health impacts where the increase in risk with exposure is threshold-based and/or non-linear.

S.13 The assessment of road traffic air pollution impacts during the operational phase of the Scheme in the EIA concludes that the Scheme is predicted to improve air quality in urban areas alongside the existing M4 corridor that currently closely approach or breach the nitrogen dioxide air quality objective and remain at risk of exceedance without the Scheme in 2022. While it would have a negative effect on air quality around the new section of motorway and connecting roads, this is not predicted to cause any exceedances of air quality objectives. Although no exceedances of air quality objectives with the Scheme in place in 2022 are predicted, health impacts from air pollutant exposure are experienced at pollutant concentrations below the objectives, and on the basis of the available evidence, there may not be a threshold below which no adverse health effect occurs. The health effect due to air pollution with and without the Scheme has therefore been assessed at residential receptors within 200 m of the new section of motorway, existing M4 and other roads where traffic flows would be significantly affected by the Scheme.

S.14 The change in air pollutant exposure due to the Scheme in 2022 (the most affected year) is predicted to cause a net reduction in annual mortality equivalent to around 1.3 deaths at typical ages and a net annual reduction of fewer than one hospital admission for cardiovascular and respiratory diseases, based on present-day population and mortality/hospital admission rates.

S.15 The impacts of the Scheme would not be equally spatially distributed, but the great majority of residential receptors in the study area (91% for NO_2 and 92% for $PM_{2.5}$) are predicted to experience a decrease in pollutant exposure. In addition the average and 95^{th} percentile magnitudes of decreases are greater than the increases for both pollutants, meaning that overall the predicted net health effect due to change in air pollutant exposure is dominated by improved health outcomes.

S.16 Although expressed here as an instantaneous change in a single year, in reality the effects of the Scheme would occur over the lifetimes of the population exposed, contributing to a net reduction in statistical risk of mortality and disease across the population, rather than being the sole attributable cause in individual cases. Air pollutant exposure also causes wider health effects, such as increased severity of bronchial disease symptoms and reduced activity days due to short-term changes in concentrations, which cannot be quantified in this assessment but for which the Scheme would likely also represent a net benefit.

S.17 The assessment of construction dust risk in the EIA concludes that there is a high risk of dust soiling (nuisance) and low to medium human health risk before mitigation. The level of human health risk, in that assessment, is relative to other construction projects, determined by the magnitude of works – e.g. based on site area, volume of building constructed or demolished, nature of on-site activities, etc. – distance to receptors, number of receptors, and existing background particulate matter concentration. However, it is considered in the assessment that good practice mitigation measures during the construction period (implemented through the Construction Environmental Management Plan) would reduce these risks to a non-significant level.

S.18 The noise impact assessment in the EIA reports operational noise impacts ranging from ‘major beneficial’ to ‘major adverse’ for residential receptors within 1 km of the existing M4 and new section of motorway. More noise-sensitive receptors are likely to experience a noise decrease rather than a noise increase, but the magnitude of the increases tends to be greater, as the change occurs from a relatively low-noise baseline environment due to the introduction of a new noise source. With regard to nuisance, the assessment concludes that 480 to 277 residential receptors (in 2022 and 2037) would experience a significant (>10%) decrease in nuisance and 32 to 27 would experience a significant increase, based on the committed mitigation plus noise barriers scenario vs do-minimum 2022 scenario.

S.19 492 residential properties and seven sensitive non-residential properties would be significantly adversely affected by construction noise, but further mitigation to reduce these effects including temporary noise barriers where practicable would be offered through the Construction Environmental Management Plan. The effectiveness of such screening is described as inherently uncertain at this stage, but on the assumption that -10 dB attenuation is achieved, the number of significantly adversely affected residential properties would be reduced to 166. Construction phase impacts would be temporary, limiting the potential for any adverse health and wellbeing effects.

S.20 The change in road traffic noise exposure due to the Scheme in 2022 is predicted to cause a net reduction of 44 cases of hypertension, or 1.6 ischaemic heart disease (IHD) annual hospital admissions, or around 0.2 to 0.3 annual stroke or acute myocardial infarction (AMI) hospital admissions, or a reduction in annual mortality equivalent to 1.4 deaths at typical ages. The road traffic noise health evidence base is less clear than that for air quality, and so a range of possible health outcomes has been presented: these overlap (e.g. AMI falls within IHD, and both fall within all-cause mortality; stroke is one potential outcome of hypertension; etc.) and should not be summed. The evidence regarding the overlap in health impacts due to combined road traffic noise and air pollutant exposure is also mixed, and there is a risk of double-counting if the outcomes summarised above for each environmental pathway are summed.

S.21 As with the air pollutant health impacts, the noise health impacts would not be distributed evenly, with an increase in adverse health outcomes around the new section of motorway to the south of Newport and the connections to the existing M4 to the east and west. There would be a decrease in adverse health outcomes around the existing M4 corridor in the north of Newport.

S.22 The operational noise assessment in the EIA also considers impacts at specified sensitive non-residential receptors including schools, colleges, nurseries, places of worship and libraries. This identifies significant adverse impacts at eight receptors, but significant beneficial impacts at 52 receptors. Health impacts due to these changes are not quantifiable (with the available evidence not indicating an association between road noise exposure and children's learning in the affected schools). There is potential for minor negative wellbeing impacts if the nuisance is unmitigated and sufficient to disrupt use of these services, but minor positive wellbeing impacts at the 52 receptors with beneficial impacts are also likely.

S.23 Sleep disturbance cannot be accurately assessed as night time traffic flows have not been predicted. As a rough estimate based on a simple -12.5 dB correction from the predicted daytime noise level, around 969 people would experience high sleep disturbance in the 2022 do-minimum (without Scheme) scenario, reduced to 688 in the 2022 do-something scenario including committed mitigation and additional noise barriers. This net effect would have a similar spatial distribution in people experiencing benefits and dis-benefits to the other air quality and noise change impacts discussed above.

S.24 The health outcomes predicted due to change in air pollution and noise exposure are based on a number of modelling assumptions (predicted traffic, predicted air pollution dispersion / noise propagation, statistical exposure-response metrics, average residential population exposed and baseline health indicator rates) with both uncertainty and natural variability, and are indicative of the order of magnitude of likely changes rather than being precise figures. For this reason, only results using the central estimate exposure-response metrics have been presented, as use of the 95% confidence intervals for these metrics (which do not encompass all the other assessment uncertainties and variability) would give a misleading impression of precision.

S.25 Given uncertainties and variability discussed above, the predicted noise and air pollution health outcomes are indicative of the order of magnitude of likely changes rather than being precise figures. The order of magnitude, however, is clearly low relative to the exposed population within the noise and air quality study areas (around forty-eight and seventy-seven thousand people, respectively).

S.26 With committed mitigation measures in place, no adverse health impact due to land contamination (including soils, ground gas and ground water) or flood risk due to the Scheme is predicted.

Social Impact Pathways

S.27 Employment and income are among the most significant social determinants of long term health. However, training and community involvement is required in order to link and develop skills to employment, reduce the risk of inequality and maximise health benefits.

S.28 Construction of the Scheme would support employment, training and local supply chain investment. Over the approximately four year construction period, it is estimated that 1,275 people per month would be employed by the Scheme, while procurement of approximately £543 m worth of goods and services would be required, resulting in a significant capital investment and socio-economic benefits for the local area where local procurement and supply chains can be used. A commitment has been made for 20% of labour costs to consist of employment of new entrant trainees undertaking an appropriate training programme. On this basis, the development has the potential for socio-economic benefits from increased employment, local investment and skills development and training, which can in turn provide lasting benefits for mental and physical health and wellbeing for local communities within the area.

S.29 The Scheme also has the potential to affect health and wellbeing by affecting access to services (such as healthcare, education, sports facilities and other essentials), community severance and permeability (physical barriers to non-road transport modes), recreation and the amenity of recreational and other green spaces, and community viability (due to land take or demolition).

S.30 During construction, there would be disruption including temporary closures or diversions to some public rights of way, cyclepaths, road crossings and highways, with the potential to affect permeability, access to services and recreation or physical activity opportunities. However, measures would be put in place to limit such disruption, minimising potential for health and wellbeing impacts. During operation, most existing crossings and non-motorised transport routes around the existing M4 would be retained, with the exception of the crossing at Pound Hill, affecting residents of that area and Pen-y-Lan. Any health outcome from this is likely to be minor.

S.31 The new section of motorway would inevitably form a major physical barrier to north-south access for non-road users, and would affect the amenity of existing footpaths and cycleways in what is presently a mainly rural area. However, new road crossings for all travellers would be provided, as would new or diverted sections of footpaths and cycleways where required to replace those lost. Furthermore, new public rights of way will be created around the new section of the motorway and to the south of the existing motorway. Taken as a whole, permanent impacts on permeability, physical activity and risk of community severance are likely to be neutral, given the facilities that would be provided for non-motorised road users as part of the Scheme. Health and wellbeing impacts due to reduced opportunities for physical activity and recreation are therefore likely to be correspondingly neutral.

S.32 Demolition and land take required by the Scheme would not cause the loss of any community services, with the exception of some common access land used for recreation and some land used for allotments at Castleton. Twelve residential dwellings would be demolished (with compensation), but these are individual or very small clusters of houses outside main settlements, and would not cause loss of community viability at settlements.

S.33 One of the overall goals for the Scheme is to improve transport safety. Under the do-minimum scenario, without the proposed new motorway, traffic would be expected to increase on the existing M4 with conditions likely to become more unstable leading to a higher frequency of incidents and accidents. Despite improvements in traffic safety achieved through the introduction of a variable speed limit in 2011 on the existing M4, three sections of the M4 corridor around Newport still have a collision rate that is higher than the default rate for motorways.

S.34 The new section of motorway and improved junctions would be designed to a modern motorway safety standard, which suggests that an improvement in safety per vehicle-km is likely to be achieved compared to the older design of the existing M4 (which includes tunnels and sections with no hard shoulder).

S.35 An accident appraisal using default accident rates for different road classifications and the forecast traffic flows on the road network indicates a reduction of around nine accidents causing personal injury per year in 2022 or 2037 with the Scheme in place. This reduction in accidents is predicted to lead to around 14 slight injuries being avoided per year in 2022, or around 13 per year by 2037. The number of serious and fatal injuries avoided per year would be less than one in both cases.

S.36 The accident appraisal indicates that the improvement in traffic safety with the Scheme would offer a minor health benefit.

Equalities Impacts

S.37 Socio-economic status, age, ethnicity and any existing burden of poor health have the potential to affect individuals' and communities' vulnerability and resilience to adverse health impacts or the uptake of health benefits. Existing inequalities in the distribution of environmental amenity and socio-economic conditions could be exacerbated by any negative effects of the Scheme, but also offer opportunities to realise improvements in health outcomes.

S.38 In general, at this level of analysis (considering the impacts of the Scheme at a high level, across a large study area encompassing Newport and parts of surrounding south Wales), it is difficult to provide a quantitative analysis of community-scale or individual-scale inequalities impacts.

S.39 The Scheme is being designed to maintain facilities for non-car travel through retaining or providing alternative/diverted footpaths and cycleways, and there are no predicted effects on public transport routes. No significant inequality impact due to severance or reductions in accessibility for those with mobility impairment or who are not car owners is therefore anticipated.

S.40 Construction-stage employment and investment is likely to be a positive measure for reducing economic and educational inequality in the Newport area, given the commitment to new entrant trainees, if this is effectively targeted.

S.41 As discussed above, the health impacts due to change in air pollution and noise exposure resulting from the Scheme would be unevenly distributed, with most of the benefit being experienced in the north of Newport, and most of the adverse impacts (albeit among a smaller population) being felt in the south and junctions to the east and west. Again, at this level of analysis it is not possible to investigate differential health impacts on groups within the exposed populations (such as by age or existing health). However, it is reasonable to conclude that those most vulnerable to air pollution would benefit more from the improvements in air quality around the existing M4.

S.42 Looking at the index of multiple deprivation scores across the areas affected by positive and negative impacts does also allow some commentary on social inequalities in the health impacts. Noise reduction and hence associated health benefits around the existing M4 affect areas with a mixture of deprivation characteristics, but do encompass some areas with the highest recorded deprivation levels in Newport. The majority of the area affected by increases in noise lies in the middle of the deprivation scale, although adverse impacts in the area of high deprivation around Newport Docks are apparent. The health impacts from change in air pollution exposure are weighted more heavily towards benefits from improvements in air quality, but again affecting areas with a range of socio-economic characteristics.

S.43 Overall, there is no clear pattern of adverse or beneficial health outcomes from these two main environmental pathways disproportionately affecting areas of high or low multiple deprivation, and thus little evidence at this scale of analysis for significant inequalities in impacts. The nature of the Scheme itself is not such that any specific disproportionate impact on individuals or groups based on their gender, race, ethnicity, religion, sexual orientation or sexual preference is anticipated.

1 Introduction

1.1 Background

1.1.1 The M4 Corridor around Newport (M4CaN), referred to as the Scheme, proposes to provide a new three-lane motorway to the south of Newport between Junctions 29 (Castleton) and 23 (Magor) of the existing M4, as well as a number of Complementary Measures.

1.1.2 Specific objectives of the Scheme to address transport related problems in the area are as follows.

1. Safer, easier and more reliable travel in South Wales.
2. Improved transport connections within Wales and to England and Europe on all modes on the international transport network.
3. More effective use of alternatives to the M4, including other parts of the transport network and other modes of transport for local and strategic journeys around Newport.
4. Best use of the existing M4, the local road network and other transport networks.
5. More reliable journey times along the M4 corridor.
6. Increased choice for journeys within the transport corridor by all modes between Magor and Castleton, commensurate with demand for alternatives.
7. Improved safety within the corridor between Magor and Castleton.
8. Improved air quality for areas adjacent to the M4 in Newport.
9. Reduced noise disturbance from traffic and transport within the corridor.
10. Reduced greenhouse gas emissions.
11. Improved travel experience into South Wales along the corridor.
12. Create an M4 attractive for strategic journeys whilst discouraging local traffic use.
13. Improved traffic management in and around Newport.
14. Easier access to local key services, residential and commercial centres.
15. A cultural shift in travel behaviours towards more sustainable choices.

1.2 Previous Work

1.2.1 Since the early 1990s, much assessment and consultation has been undertaken to develop a preferred solution to the problems on the existing M4 around Newport, including motorway options. In July 2014, taking into account social, economic and environmental assessment of the options, the Minister for Economy, Science and Transport decided to adopt 'the Plan' for the M4 Corridor around Newport, of which the main element would be a new section of motorway to the south of Newport.

1.2.2 A Health Impact Assessment (HIA) was prepared in 2014 (Welsh Government, 2014) to address the health issues in relation to the Plan. The 2014 HIA built on previous HIA work in 2012 including consultation and a HIA forming part of the M4 Corridor Enhancement Measures programme and the draft Plan.

1.2.3 A Health Action Plan was created as part of the 2014 HIA, providing an overview of the potential actions to be considered as part of the Scheme. The actions suggested aim to enhance potential beneficial impacts and minimise potential adverse impacts resulting from the Plan being implemented.

1.2.4 As recommended by the previous stage of HIA, the current HIA represents a more detailed Scheme-level assessment of the health impacts that builds on the previous work developed for the Scheme, whilst meeting the requirements of WelTAG. The previous HIA and Health Action Plan have been used to guide the current HIA and implement recommendations given, where appropriate.

1.3 Purpose of the Report

1.3.1 The Scheme has the potential to influence the local communities in various ways. It is designed to reduce journey times, improve road safety, reliability and resilience, improve air quality and reduce noise disturbance for the areas adjacent to the existing M4. However, it would introduce new or increased air and noise pollution in the area of the proposed new section of motorway, and would have effects on a number of other existing roads.

1.3.2 It may also affect local people by affecting the community they live in, influencing health and wellbeing through other environmental, social and economic pathways. By changing the distribution of road traffic within Newport, it would likewise affect the spatial distribution of environmental and social impacts across sections of the community, relevant to the assessment of equalities impacts.

1.3.3 This report documents the findings of an assessment of how the Scheme may influence public health and wellbeing in the areas surrounding the proposed new section of motorway and existing M4 corridor, through environmental and socio-economic pathways. The assessment also considers, where possible, the distribution of impacts within different social groups, and the potential equalities impacts of the Scheme. The Scheme has been assessed both during construction and operation.

1.3.4 Health Impact Assessment (HIA) and Equality Impact Assessment (EqIA) are part of transport appraisal for transport schemes within Wales, as set out by the Welsh Transport Planning and Appraisal Guidance (WelTAG) (Welsh Government, 2008). The Welsh Government has statutory duties to promote wellbeing (Welsh Government, April 2015) and racial, disability and gender equality (SI 2011 No. 1064 (W.155). The Equality Act 2010 (Statutory Duties) (Wales) Regulations 2011, 2011), and has set a Public Health Strategic Framework to improve the quality and length of life for all members of the community (Welsh Assembly Government, 2010). Social Impact Assessment (SIA) is often developed as an independent SIA report; however, social, health and equality impacts are intrinsically linked. For this reason the health, social and equality impacts of the Scheme have been considered within the one assessment under the broad heading of Health Impact Assessment (HIA), which meets the requirements of HIA, EqIA and SIA.

1.4 Report Structure

1.4.1 After this introduction, the report comprises the following chapters.

- Chapter 2: an overview of the guidance and methodologies used for health, social and equality impacts assessment.
- Chapter 3: a Scheme profile, which defines the Scheme, the construction and operational activities and the health pathways to be assessed.
- Chapter 4: a community profile that describes the demographic, health and social profiles of the local communities in the area of the development.
- Chapter 5: a discussion of the relevant health pathways and applicable health evidence base in each case.
- Chapter 6: an assessment of the health, social and equality impacts of the Scheme on local communities.
- Chapter 7: a WelTAG appraisal summary table of the whole assessment.

1.4.2 This HIA draws from and builds upon the technical information and assessment results provided in a number of the studies forming part of the Environmental Statement (ES) and supporting traffic and economic studies for the Scheme. That assessment work is not duplicated here, and for more information on the environmental assessment findings that inform this HIA, the reader should refer to the relevant ES chapters and supporting studies. Key chapters and studies are ES Chapter 7: Air Quality, ES Chapter 11: Geology and Soils, ES Chapter 13: Noise and Vibration, ES Chapter 14: All Travellers, ES Chapter 15: Community and Private Assets, and the separate Traffic Forecasting Report, Traffic and Collisions Report, Economic Appraisal Report, Wider Economic Impact Assessment report and Flood Consequence Assessment published alongside the draft Statutory Orders.

2 Guidance and Methodology

2.1 Introduction

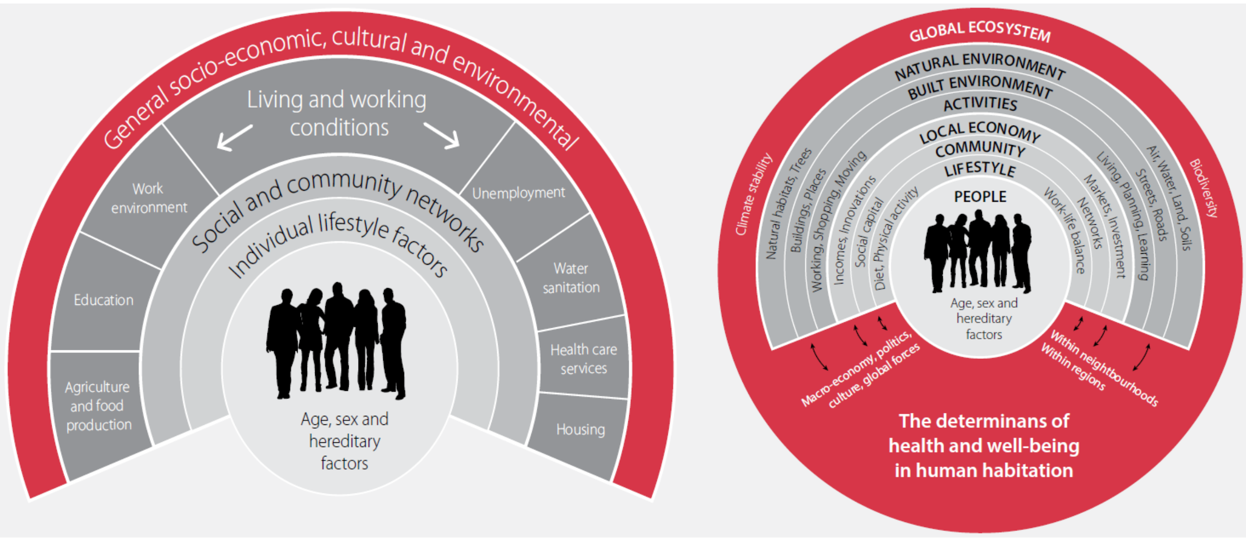
2.1.1 This section provides an overview of the guidance and methodologies applied in the assessment of social, health and equalities impact assessment under the broad heading of Health Impact Assessment (HIA).

2.2 Health Impact Assessment

2.2.1 HIA is a multidisciplinary process designed to identify and assess the potential health outcomes (both adverse and beneficial) of a proposed project, plan or programme and to deliver evidence-based recommendations that optimise health gains and reduce or remove potential negative impacts or inequalities.

2.2.2 The basis of this HIA is set on a broad socio-economic model of health that encompasses conventional health impacts such as disease, accidents and risk, along with wider health determinants vital to achieving good health and wellbeing such as employment and local amenity. It considers both physical and mental health, and also addresses equality and social impacts. The social and ecological determinants models of health are illustrated in Figure 2.1, below.

Figure 2.1: Social (left) and ecological (right) determinants of health



Reproduced from (Chadderton, et al., 2012), citing (Dahlgren & Whitehead, 1991) and (Barton & Grant, 2006).

2.2.3 'Health' is commonly defined as "*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1946) (the definition used by the World Health Organisation, WHO, since 1948).

2.2.4 Although not a statutory requirement of the UK planning process, in Wales there is a requirement for HIA driven through 'Our Healthy Future, a Public Health Strategic Framework' (Welsh Assembly Government, 2009), which is intended to improve the quality and length of life for all members of the community and to promote equality in health and wellbeing. Its action areas are shown in Figure 2.2.

Figure 2.2: Our Healthy Future: Six Areas for Action

Reproduced from (Welsh Assembly Government, 2010).

2.2.5 HIA is further driven by the Welsh Government through the provision of both overarching and sector-specific HIA guidance developed by the Wales HIA Support Unit (WHIASU) to facilitate the delivery of national strategic health objectives (Chadderton, et al., 2012; Elliott, 2002) adapting (Breeze & Hall, 2002). However, in the context of the Scheme, the HIA approach and methodology are primarily driven through the specific requirements within the Welsh Transport Planning and Appraisal Guidance (WelTAG) (Welsh Government, 2008) and the approach outlined in the previous stage HIA.

2.2.6 Section 9 of WelTAG sets out the process for completing an HIA and an Equalities Impact Assessment (EqIA), including appraisal summary criteria (AST) for each element. Section 8 of WelTAG sets out the assessment and appraisal criteria for a Social Impact Assessment (SIA).

2.2.7 This HIA has therefore been prepared to meet the requirements of the above policy document, WHIASU guidance, previous HIA and further specific methodological guidance for air pollution and noise exposure discussed below.

2.3 HIA Approach – Overview

2.3.1 A key aspect of the HIA approach has been to draw from and build upon the wider technical assessments of the ES and supporting studies (including air quality, noise, transport and socio-economic topics). Such integration ensures that the HIA is based upon realistic assessments of changes in environmental and socio-economic conditions directly attributable to the Scheme.

2.3.2 In this instance, the HIA has also been structured to include elements of EqIA and SIA, to fulfil the requirements of WelTAG, and ascertain if aspects of the Scheme may have a disproportionate impact upon specific sensitive/vulnerable community groups.

2.3.3 The HIA comprises six stages:

- a HIA screening and scoping exercise;

- a Scheme profile;
- a community profile;
- stakeholder engagement; and
- assessment and WelTAG appraisal.

1) HIA Screening and Scoping Exercise

2.3.4 The purpose of the HIA screening and scoping exercise is to define the initial scope and focus of the HIA. This is necessary to support the development of a more effective community profile, to establish the key appraisal criteria to be applied, and to ensure that the HIA meets local requirements and expectations.

2.3.5 In this instance, the HIA screening and scoping exercise has been modified to also form the phase one EqIA, to identify potentially vulnerable groups that may be disproportionately impacted during construction and operation of the Scheme, and to determine if any further EqIA is required. Further details of the EqIA requirement, guidance and specific methodology are provided below.

2.3.6 HIA screening and scoping has been undertaken initially through the process of the previous 2014 HIA conducted for the HIA of the Plan and two other earlier HIAs referenced in that document. In the course of this HIA, it has been further refined through consultation with WHIASU.

2) Scheme Profile

2.3.7 The purpose of the Scheme profile is to identify those relevant features of the Scheme that have the potential to influence key determinants of health. The profile has been compiled through a review of project information, technical environmental assessment outputs from the ES and through iterative consultation with the wider planning and assessment team.

2.3.8 The Scheme profile provides the primary means to identify potential causal pathways associated with the construction and operation of the Scheme, helps to refine an appropriate evidence base, and supports the development of a meaningful community profile. The Scheme profile also supports the EqIA, to establish whether any activities have the potential for disproportionate outcomes within sensitive/vulnerable community groups.

3) Community Profile

2.3.9 Evidence suggests that different communities have varying susceptibilities to health impacts and benefits as a result of social and demographic structure, behaviour and relative economic circumstance. A community profile therefore not only forms the basis of social and demographic evidence to inform the assessment and WelTAG appraisal, but also allows insight into how potential health pathways identified within the Scheme profile may act disproportionately upon certain communities and sensitive receptors.

2.3.10 It also provides the health and demographic baseline data used in the quantitative assessment of noise and air pollutant impacts on health.

4) Stakeholder Engagement

2.3.11 A route to the south of Newport has been protected for planning purposes since April 2006. The alignment of the proposed new section of motorway has been developed following extensive consultation, investigation and analysis.

2.3.12 Chapter 4 of the ES sets out the evolution of the Scheme, which incorporated consultation at key points. As set out in Chapter 5 of the ES, these included:

- April and May 2006 (including public exhibitions) in relation to selection of a route option.
- March – July 2012 in relation to the M4 Corridor Enhancement Measures Programme, including public consultation and engagement with internal and external specialists and expert stakeholders.
- September – December 2013 including public and stakeholder consultation on the draft Plan, including associated environmental, health and equality assessments.

2.3.13 A large-scale public consultation was undertaken on the draft Plan. This asked participants to comment on the draft Plan, its reasonable alternatives and the do-minimum scenario (which considered consequences of doing nothing above what is already planned) and ran for 12 weeks between September and December 2013.

2.3.14 Ten public drop-in exhibitions were held between October and November 2013. Exhibition boards were displayed and members of the project team, including technical experts, were available to answer any questions and explain how the public could express their opinions formally.

2.3.15 The process also centred on engagement with key stakeholders in order to establish the proposed scope and level of detail required for the draft Plan's associated environmental, health and equality assessments. Key stakeholders included statutory consultees and those with a particular stake or significant interest in transport issues relevant to the economy, environment and society in South Wales and beyond.

2.3.16 In addition, Environmental Liaison Group meetings were held with key consultees during the Scheme evolution.

2.3.17 Formal EIA scoping and further public consultation has been undertaken in 2015, including continuation of the Environmental Liaison Group and a series of 14 public exhibition events held during September 2015.

2.3.18 The previous HIA published in 2014 summarises public and key stakeholder consultation undertaken in 2013 specifically for the HIA through a variety of methods, including public events, stakeholder workshops and individual correspondence.

2.3.19 A key issue raised was the relatively high level appraisal (lack of detail) in the HIA, necessary given its strategic rather than scheme-specific nature. A further scheme-specific HIA was recommended. The Scheme-specific HIA is provided in in this document, which draws from the Scheme details provided in the ES and supporting documents.

2.3.20 Other stakeholder concerns were around the need to consider alternatives to the proposed route, scepticism about the positive (health benefit) score given to changes in noise and air pollution and lack of consideration given to increased car use stimulated by the new road, and need to consider wider effects on wellbeing and mental health (through pathways such as accessibility to green space), not just physical health.

2.3.21 We have considered this feedback to the extent possible within the defined scope of the Scheme and the information available from the ES and supporting documents.

2.3.22 For a detailed account of the engagement strategy, methodology and consultation outputs, please refer to the Chapter 5 in the ES.

5) Assessment and WelTAG Appraisal

2.3.23 The assessment stage maps the Scheme profile and technical outputs of the ES against the community profile to assess and appraise the magnitude, likelihood and distribution of potential health outcomes (both adverse and beneficial) that would be directly attributable to the Scheme.

2.3.24 To keep the HIA a concise and publicly-accessible document, the assessment draws upon the ES technical assessment outputs but does not seek to repeat or replicate them. Key inputs are, however, cross referenced to aid transparency, and enable readers to navigate to areas of specific interest. The final appraisal summary follows the structure and appraisal criteria outlined in WelTAG.

2.3.25 The assessment is undertaken on both a qualitative and quantitative basis, as appropriate to the health pathways under consideration. Socio-economic, safety, security, permeability, physical fitness and equality pathways are assessed qualitatively. Air quality and noise pathways are assessed quantitatively, with the methodology and guidance for doing so discussed further below.

2.4 Equality, Diversity and Human Rights Impact Assessment

2.4.1 The Welsh Government has a statutory duty to promote racial, disability, gender, age, sexual orientation, religious, reproductive and other equality under the Equality Act 2010 (Statutory Duties) (Wales) Regulations 2011 (SI 2011 No. 1064 (W.155). The Equality Act 2010 (Statutory Duties) (Wales) Regulations 2011, 2011), and produces four-year strategic equality plans and objectives (current strategy: 2012-2016 (Welsh Government, 2012)). Promotion of equality forms part of the Public Health Strategic Framework (referenced above) to improve the quality and length of life for all members of the community. Assessment of equality, diversity and human rights, defined as "*respecting and integrating diversity and equality of opportunity*", (Welsh Government, 2008) (page 161) forms part of the Wales Transport Strategy and the WelTAG assessment requirements.

2.4.2 Part of the work to achieve these national objectives involves connecting up actions already being undertaken across the different sectors that contribute to improvements in health and prevent poor health and inequality. This includes driving the use of tools, such as HIA and EqIA, that enable planners and decision makers to further consider whether and how policies and initiatives may affect people's health and wellbeing. In terms of promoting equity in health and wellbeing, HIA can also be applied to investigate and address the magnitude and distribution of potential health outcomes, including disproportionate outcomes or those that may contribute to the creation or widening of inequality.

2.4.3 The EqIA, diversity and human rights assessment of the Scheme has been undertaken in line with the general principles and guidance of NHS (Public Health Wales) Centre for Equality and Human Rights Equality Impact Assessment Guidance and Template Edition 3 (documents provided at (The NHS Centre for Equality and Human Rights, 2012) and guidance in (The NHS Centre for Equality and Human Rights, n.d.) and (Welsh Government, 2012)).

2.4.4 There are three formal stages in the EqIA process: Stage 1 of the EqIA comprises a high level appraisal (screening) to establish the likely aspects of the project with the potential to disproportionately impact upon sensitive community groups, thereby defining the requirement, scope and focus of any further assessment. In this instance, the initial EqIA has drawn from the outputs of previous engagement and has been integrated within the project profile stage of the HIA.

2.4.5 Should any likely impact upon a sensitive/vulnerable community group be identified, further assessment is required to investigate and address such impacts through an appropriately scoped assessment. In this instance, the EqIA section is integrated within the HIA assessment section.

2.4.6 The final stage of EqIA involves reporting outcomes and, where appropriate, defining appropriate key performance indicators and establishing a monitoring programme with on-going engagement and interventions where required.

2.5 Quantitative Assessment – Air Quality and Noise Exposure

Air Quality

2.5.1 Assessing the burden of health impacts due to environmental disease factors including air pollution, and using this to inform policy-making of decision-taking by analysing the effects of policies or developments, is an active area of research. A number of high-quality national and regional studies have been undertaken (e.g. (AEA Technology Environment for European Commission DG Environment, n.d.; COMEAP, 2009; COMEAP, 2010; Fann, et al., 2012; Pascal, et al., 2013; US EPA Office of Air and Radiation, 2011)). At a global level, World Health Organisation (WHO) researchers have published estimates of the global burden of disease (Cohen, et al., 2005; IHME, 2013) due to outdoor air pollution (among other factors).

2.5.2 In the UK, in addition to the national Committee on the Medical Effects of Air Pollutants (COMEAP) studies cited above, significant work has been and is being undertaken in London under the 'TRAFFIC' project (King's College London, n.d.) and through several iterations of studies for the London congestion charging zone, low-emissions zone (LEZ) and proposed ultra-low emissions zone (ULEZ) (Atkinson, et al., 2009; Beevers & Carslaw, 2005; Ellison, et al., 2013; Kelly, et al., 2011; Kelly, et al., 2011; ERM, 2006; Pye, et al., 2006; Jacobs in association with Ben Cave Associates and Ricardo-AEA, 2014). A number of LEZ studies, quantifying health benefits that may accrue from reducing road traffic air pollution, have also been undertaken for other cities in the UK (e.g. Bristol (Laxen, et al., 2014)).

2.5.3 There is therefore a rich field of methodological examples from which this HIA can draw, although many of the studies are more sophisticated in terms of the number of health outcomes considered and the level of statistical analysis and uncertainty quantification than can be achieved, given the more limited data available for this study. The Clean Air for Europe (CAFE) cost-benefit analysis and methodology documents and work by the COMEAP in the UK, referenced above, are particularly useful.

2.5.4 Public health bodies and expert researchers have also published a number of guidance and methodology documents for undertaking HIAs of this nature to inform public policy (e.g. (Pascal, et al., 2011; Amann, et al., 2004; Burnett, et al., 2014; Miller & Hurley, 2006)), including calculation templates for quantifying impacts (Aphekom, 2013; Miller, 2013). The methodological approaches detailed in the above-referenced studies are informative, as are more general conceptual and methodological papers (e.g. (Murray, et al., 2003; Fann, et al., 2011)).

2.5.5 The WHO 'Health Risks of Air Pollution in Europe' (HRAPIE) (WHO, 2013) guidance published in 2013, arising from its comprehensive 2013 'Review of Evidence on Health Aspects of Air Pollution' (REVIHAAP) (WHO, 2013) programme, provides a wide-ranging set of recommended concentration-response functions (CRFs) with guidance for their application and avoiding double-counting when using several functions to assess multiple health outcomes.

2.5.6 In the UK, Public Health England (PHE) has published with input from members of COMEAP a guidance document for estimating mortality burdens due to particulate matter air pollution exposure at a local level (Gowers, et al., 2014), which is very relevant to the scope and scale of this study, and offers a relatively streamlined approach including simplifying assumptions (such as an assumption of 12 life-years lost per death brought forward) to aid rapid analysis.

2.5.7 Defra's Interdepartmental Group on Costs and Benefits (IGCB) also publishes 'impact pathway' guidance (Defra, 2013) for use in analysis of policy interventions where the monetised value of air quality impacts is expected to be >£50m and air quality standards would not be breached. (A further simplified 'damage costs' approach is also available for use in cases where impacts would not exceed £50m.) Although the end-point of the analysis and hence focus of the guidance is a monetary valuation of health impacts (among a range of other air pollutant impacts), the guidance does provide a set of recommended CRFs on the basis of past advice from COMEAP.

2.5.8 The general approach common to these studies and guidance documents can be summarised as:

- Review health literature to evaluate the weight of evidence available, and from this select the pollutants and health outcomes of interest to the study;
- Choose the CRFs that will be used to relate change in population exposure to change in health outcomes;
- Use measured or modelled air pollutant data and spatial demographic data to estimate population exposure to the air pollutants of interest;
- Gather public health data showing the existing rates of mortality, disease, life expectancy or other health indicators relevant to the CRFs chosen;
- Calculate the existing burden of disease attributable to the air pollutant exposure and/or calculate changes in burden of disease (either in a future scenario or a present-day counterfactual);
- Communicate the findings, including uncertainty analysis, using public health metrics such as change in mortality rate, hospital admissions rate, life-years gained or lost, or value of health.

2.5.9 The studies and guidance documents also provide valuable examples and recommendations for how to frame the HIA's analysis and communicate its findings – i.e. what questions it seeks to answer, and how the impact on public health is presented. Key points include:

- How the analysis of a policy intervention or Scheme that will affect air pollution is framed – as a counterfactual analysis looking at two scenarios for the present-day, or a future-looking analysis considering a projected baseline and future scenario;
- The importance of the choice of CRFs to the analysis, and question of their applicability to the population and range of pollutant exposure under consideration;
- Different metrics by which population health impacts can be presented: e.g. change to annual mortality rate, change to adult life-expectancy, life-years lost (perhaps disability- or quality-adjusted), activity days lost, rates of morbidity incidence, or rates of hospital admissions; and
- Approaches to monetisation of impacts (if within the study scope), and the distinction between costs (e.g. of healthcare provision) and the value of lives or life-years, which cannot be summed.

2.5.10 The way in which health impacts at a population level are communicated is an important point. Looking at mortality, although a change in the death rate per year is the simplest outcome to calculate from mortality risk CRFs, it is more meaningful to present mortality impacts in terms of life-years or life expectancy changes. COMEAP (COMEAP, 2010) summarises this well:

"A reduction in air pollution impacts on future patterns of survival and death in the population by decreasing the mortality risk and associated age-specific death rates, leading to fewer deaths initially and a sustained increase in life expectancy. However, because everyone dies eventually, the total number of deaths in a given population cannot be changed by reducing levels of air pollution. Instead, a reduction in air pollution postpones deaths, so that on average people live longer… Consequently, the long-term mortality benefits of pollution reduction are best reflected either in terms of life expectancy or in terms of gains in population survival time ('life-years'), rather than in terms of annual deaths." (pp. 2-3).

2.5.11 The authors of other environmental burden of disease studies and guidance documents are broadly in agreement with this view. However, the recommended approach requires age-stratified mortality data and actuarial life tables for the population, and calculating changes to life expectancy when considering scenarios over time in which this changes due to other factors is complex. COMEAP does note that:

"Number of attributable deaths is a valid and meaningful way of capturing some important aspects of the mortality burden, across the whole population in any one particular year, of current levels of pollution, if we set aside some of the complexities of how quickly air pollution affects mortality risks." (ibid, p. 6).

2.5.12 This is the approach that we consider most appropriate to apply in this HIA study, given the data available and the intention to communicate potential health outcomes as a straightforward metric. However, it is essential to be clear in so doing that:

"…it is likely that air pollution contributes a small amount to the deaths of a larger number of exposed individuals rather than being solely responsible for a number of

deaths equivalent to the calculated figure of 'attributable deaths', although the distribution of mortality effect within the population is unknown" (Gowers, et al., 2014) p. 6.

2.5.13 COMEAP therefore recommends (COMEAP, 2010) that attributable deaths should be expressed using a form of works such as "*an effect on mortality equivalent to X deaths at typical ages*" (p. 61), which is the approach that will be adopted here. In addition, an indicative estimate of life-years lost can be generated by applying the standard assumption of 12 years per death brought forward from the PHE guidance referenced above, provided that the age structure and baseline life expectancy of the exposed population in the study area do not differ radically from the national average.

2.5.14 The choice of CRFs is crucial to the study outcomes, both in the sense that it sets the sensitivity of the calculations of morbidity/mortality to the changes in population pollutant exposure modelled, but also that the available CRF metrics determine what health outcomes the study is actually able to quantify, fundamentally affecting its scope and not just its calculation methodology. Studies such as that by COMEAP (COMEAP, 2009) and the guidance documents discussed above pay considerable attention to determining the most appropriate CRFs to use.

2.5.15 Choice of CRF is not just about considering the health evidence available and strength of statistical relationships between air pollutant exposure and a given set of health outcomes. The potential for double-counting health impacts if using several single-pollutant CRFs must be given attention, as must the potential for double-counting between short-term and long-term exposure effects in CRFs even for a single pollutant. In this latter case, CRFs derived from cohort studies, that should account for health outcomes from combined short- and long-term personal exposure, are of value.

2.5.16 Important to this study is the question of whether a given CRF, that is derived from population exposure and health data in one geographical setting, can meaningfully be applied to another. Much of the strongest epidemiological data on which CRFs are based is from the US and Europe, which have similar population structures and other relevant demographic characteristics to the study area in Wales (shown in the Community Profile in Section 4).

2.5.17 The European and US health impact studies referenced have concluded that it is appropriate to apply CRFs generally to settings across these regions, without modification for demographic factors (save using age-stratified CRFs in some cases), and assuming a linear exposure-response relationship with little or no requirement for extrapolation and, in the case of particulate matter (PM) exposure, no lower threshold for health impacts. On the other hand, WHO researchers did not consider this appropriate for generalising CRFs to much more varied global air pollution exposure, and instead derived a $PM_{2.5}$ exposure metric from a wider range of data, using a non-linear relationship (Burnett, et al., 2014). The use of these latter metrics is not required for this study, in which air pollution concentrations are within the range from other European and US cities used to derive the CRFs that have been applied.

2.5.18 The health impact study examples discussed also emphasise the importance of being transparent about the many sources of uncertainty in such an HIA. Uncertainties arise from the measurement or modelling of changes in traffic, resulting air pollution concentrations, the estimation of population exposure, and the derivation of CRFs used to quantify health outcomes, among other factors. The

CRFs used in this study are given with 95% confidence intervals, but this captures only the uncertainty in the CRFs themselves; the multiplicative uncertainty arising from traffic modelling, air pollutant dispersion modelling, population exposure, and future trends is likely to be very substantially greater. For this reason, only the central estimate CRFs have been used in this study.

2.5.19 Several approaches for monetary valuation of health impacts are available, and are sometimes used in HIA. However, this assessment does not include a monetary cost-benefit analysis and monetary valuation of health impacts (with its associated significant uncertainties and methodological controversy) is outside the scope of the assessment and has not been undertaken.

Noise

2.5.20 Less work has been undertaken, and less guidance is available, on the burden of disease attributable to environmental noise exposure. Nevertheless, this is an active field of research and sufficient information is available to enable quantification of some noise health impacts as part of this HIA.

2.5.21 Overall, the approach to quantitatively assessing environmental noise impacts on public health follows the principles set out above for air pollution: change in population noise exposure is quantified using appropriate averaging periods; baseline health data are collected; and the change in health outcomes is calculated using exposure-response metrics for risk of disease and/or mortality.

2.5.22 A Europe-wide study (Fritschi, et al., 2011) and supporting methodological guidance paper (Hellmuth, et al., 2012) published by WHO provide a useful starting point, and demonstrate a significant burden of adverse health impacts associated with environmental noise exposure, drawing from earlier WHO publications summarising health evidence and recommending guidelines for community noise exposure (Berglund, et al., 2000; WHO Working Group, 2009). A review of noise exposure across Europe in 2014 by the European Environment Agency (EEA) likewise recommends and applies metrics for various health outcomes (Nugent, et al., 2014; Houthuijis, et al., 2014), and an earlier EEA guidance technical paper (Expert Panel on Noise, 2010) is informative regarding exposure-response curves and thresholds for health endpoints.

2.5.23 In the UK, the former Health Protection Agency (HPA, now part of Public Health England, PHE) published in 2010 a report giving the views of an ad-hoc expert group on environmental noise and health in the UK (Ad-Hoc Expert Group on Noise and Health, 2010), which was generally cautious about effects on physical and psychological health, and indeed on whether causality underlies the associations observed. However, in the same time period the IGCB on noise (IGCB(N)) commissioned further research on evidence and methods for estimating dose-response relationships between noise exposure and health impacts (Berry & Flindell, 2009; Berry & Flindell, 2009; Berry & Flindell, 2009) and accepted the findings, recommending that assessment of risk of acute myocardial infarction (AMI), hypertension and sleep disturbance be used in appraisal of impacts to inform policy decisions (Intedepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)), 2010). Defra subsequently published the IGCB(N)'s methodological guidance for doing so in 2014 (Defra and IGCB(N), 2014), which includes recommended dose-response metrics.

2.5.24 In the above-referenced studies and guidance, and the health evidence discussed in Section 5, there is variation in the health outcomes that researchers consider quantifiable, though the common focus is on cardiovascular disease and sleep disturbance. The WHO and EEA studies also assess cognitive impairment in children, although in the IGCB(N) guidance this is not recommended, due to the limited evidence available at the time the guidance was being developed. A lack of clearly established evidence of causality to explain the observed correlations between noise exposure and adverse health outcomes is commonly noted, although biologically plausible stress/allostatic load health pathways are described. Both WHO and the work in the UK note the difficulty in separating road noise exposure from road air pollutant exposure, and possible double-counting if they are assumed to be independent effects.

2.5.25 However, recent evidence reviews have indicated some evidence of an independent association, with noise impacts on cardiovascular morbidity and mortality significant after adjustment for air pollution as a confounder. This is discussed further in Section 5 Health Pathways and Evidence Base.

2.5.26 The evidence also indicates differences in perceptions and health outcomes of aircraft and road traffic noise, which influences the choice of an appropriate exposure-response metric.

2.5.27 Some studies and the Defra guidance cited above also include quantification of sleep disturbance and annoyance as outcomes from noise exposure, both of which can be pathways to adverse health outcomes. However, it is preferable to estimate adverse health outcomes directly (using exposure-response metrics for increased disease or mortality risk) rather than via the intermediate step of estimating physiological or mental health effects. In addition, the noise impact assessment in chapter 13 of the ES has considered the significance of noise exposure with regard to policy based on thresholds for annoyance, so that is not repeated in this HIA.

3 Scheme Profile

3.1 Scheme Summary

3.1.1 The Scheme consists of a proposed new three-lane motorway to the south of Newport, 23 kilometres in length, connecting with the existing Junction 29 at Castleton and Junction 23 at Magor. In addition to the new section of motorway, the Scheme would incorporate Complementary Measures. Details of the Scheme and Complementary Measures are set out below.

3.1.2 The Scheme has been put forward as a solution to the existing traffic and congestion, resilience and reliability problems between Magor and Castleton, which is the most heavily trafficked portion of the M4 in Wales. The existing motorway between Castleton and Magor does not meet modern motorway standards. The Scheme aims to address the current issues of capacity, resilience, reliability, safety and sustainable development, which are predicted to worsen into the future in the absence of the Scheme.

3.1.3 For the purpose of this HIA, the Scheme is defined as the new section of motorway and Complementary Measures, changes to other road links connecting with either motorway, and the construction activities, land take and operation associated with these changes.

3.1.4 A detailed description of the proposed Scheme can be found in Volume 2, Chapter 2 of the ES (Scheme Description).

New Section of Motorway

3.1.5 The new section of motorway would pass through parts of the local authority areas of Monmouthshire and Newport. Approximately two kilometres to the west of where the new section of motorway has re-joined the existing M4 at junction 29 at Castleton, the M4 passes into the Cardiff local authority area. Due to the changes anticipated to transport associated with the development within these areas, these three local authority areas are the primary focus of the community profile and the impact assessment, although it is recognised that the Scheme would also have some effects (e.g. on traffic on other sections of the M4 and major feeder roads) in a wider area of Wales and England.

3.1.6 Junction 29 at Castleton would be modified to incorporate the new section of motorway, providing a free flowing interchange prioritising traffic on the new M4 motorway with three lanes in both directions. The junction would also allow access for the A48 (M) and the existing reclassified M4 carriageway. At Junction 29 at Castleton, the proposed new section of motorway would pass south and east of Newport and Duffryn, before bisecting the eastern part of the Wentlooge Levels. From here it would cross the River Ebbw and the River Usk, crossing the docks and continuing past the southern extent of the Tata Llanwern steelworks and through the northern edge of the Calidicot Levels, before re-joining Junction 23 of the existing M4 at Magor. The proposed route would also cross the South Wales to London Mainline railway south of Duffryn and to the west of Magor.

3.1.7 In addition to the existing junctions at Castleton and Magor, a further two junctions would be constructed on the new section of the motorway: the Docks Way and Glan Llyn junctions. The Docks Way junction would be located east of the River Ebbw crossing at the Newport Docks, to provide access to the docklands, and the Glan

Llyn junction would be situated south of the A4810, to allow entry to Glan Llyn and the A4810 for the Tata steel site. Areas of existing highway, public rights of way and private access routes that are affected by the Scheme would be diverted or re-provided.

Complementary Measures

3.1.8 In addition to the new section of motorway, the Scheme would incorporate Complementary Measures, including the following.

- Improvements to safety, access arrangements and the ability to manage traffic by reclassifying the existing M4 between Magor and Castleton as a trunk road.
- Relief to Junction 23 of the existing M4 and the local road network with a new M4/M48/B4245 connection.
- Providing cycle and walking friendly infrastructure.

3.1.9 Reclassification of the existing M4 around Newport as a trunk road, or ‘A’ road, would allow changes to be made to traffic management, safety and revised access arrangements, such as reopening the Caerleon junction.

3.1.10 Reclassification would include works to re-open the west facing slip roads of Junction 25 (Caerleon), improving access to Caerleon and St. Julian’s areas along the northern fringe of Newport.

3.1.11 The existing Variable Speed Limit would continue to operate along the existing M4 between Junction 24 (Coldra) and Junction 28 (Tredegar), but with a maximum speed limit of 60 miles per hour imposed at the Brynglas Tunnels.

3.1.12 The existing number and widths of lanes would be changed as follows.

- From Junction 23 to Junction 24 the cross section would be reduced to two lanes in both directions. The existing Lane 1 and hard shoulder would be hatched out of use by road markings.
- From Junction 24 to Junction 25, the cross section on the westbound carriageway would be reduced to two running lanes. The existing Lane 1 would be hatched out of use by road markings. The eastbound carriageway would have three lanes to accommodate climbing vehicles on the steep gradient of St Julian's Hill.
- Through Junction 28, the cross section would be reduced to two lanes in both directions. The existing Lane 1 and hard shoulder would be hatched out of use by road markings.

3.1.13 The two lane sections would take the form of a dual carriageway, with two lanes in each direction. In addition, there would be a hard shoulder in each direction of 3.3 m width. Safety barriers would be provided on either side of the road and in the central reservation.

3.1.14 Some works would be required to the existing diverge and merge slips to accommodate the predicted changes in traffic flow. Such works would generally be located within the existing built footprint.

3.1.15 The east facing connections from Junction 25A to the M4 would be closed and traffic would be routed through Junction 25 to join/leave the motorway via the east facing slip roads of Junction 25. The westbound diverge slip road for Junction 25 would be widened (within the highway boundary) to provide additional capacity, via a new retaining wall built within the footprint of the existing motorway.

3.1.16 On the western side, new connecting slip roads would be constructed between the Junction 25-25A link roads and the motorway. These new slip roads would allow eastbound traffic using the existing motorway to access Junction 25 and Caerleon Road and would allow westbound access to the existing motorway from Junction 25 and Caerleon Road. The slip roads and link roads would continue to be subject to a 40 mph speed limit. The circulatory carriageway of Junction 25 would be signalised at all entries.

3.1.17 The reclassification of the existing M4 would require changes in the signage strategy, including the removal and/or replacement of some existing signs.

3.1.18 In addition to Public Rights of Way (PRoW) implemented to re-provide those lost or diverted through scheme construction, a number of additional PRoW resources will be developed around both the new section of the motorway and the existing M4, as follows.

- A new public footpath would be created along the fence line of the proposed new section of motorway, running from public footpath 400/1 eastwards to meet Pound Hill to the north of the existing M4.
- A new public bridleway would be created from Green Lane, to the south of the proposed new section of motorway, to run along the same alignment as the private means of access to Maerdy Farm to meet Percoed Lane on the southern side of the Percoed NMU Bridge.
- A new public bridleway would be created along the fence line of the proposed new section of motorway from public footpath 372/86/1 to the north of the existing M4 to meet St Bride's Road to the west.
- A new public bridleway would be created from public footpath 372/12/4 to the south of the existing M4 to meet St Bride's Road to the west.
- A new public bridleway would be created from public footpath 372/12/4 to the south of the existing M4 to meet Grange Road to the east.

3.2 Construction Activities

Construction Overview

3.2.1 If the Welsh Ministers decide to confirm the Orders, it would be intended to start construction in spring 2018 and the new section of motorway would open in autumn 2021. The reclassification works to the existing M4 would be complete in autumn 2022. However, programmed dates and construction periods may be subject to change depending on factors such as the progression of statutory procedures, actual start date, weather conditions and unforeseen engineering conditions experienced on site.

3.2.2 Following on from the construction phase, there would be a five-year landscape aftercare period, as part of the environmental mitigation for the Scheme.

3.2.3 The normal working hours would be 07.00 to 19.00 hours (Monday to Friday), and 07.00 to 17.00 hours on Saturdays. In certain circumstances, specific works may have to be undertaken outside the normal working hours. Night working would also be required in some cases. On a few occasions, weekend closures of the highway would be required where 24 hour working is needed for some essential and complex operations. A number of road diversions would be required during the construction programme. These diversions would vary in duration from a few hours for a total motorway closure to a number of months for a strategic side road closure.

New Section of Motorway

Phasing

3.2.4 The general sequence of works during construction of the new section of motorway would depend on the location and engineering needs. However, the general activities would typically include:

- enabling works, including pre-construction ecological mitigation, pre-construction archaeological investigation, provision of access points, temporary fencing and fencing to protect sensitive sites;
- remediation of contaminated land or groundwater where required;
- site clearance and water management works;
- demolition works;
- temporary highway diversions and traffic management;
- diversion/protection of utilities;
- earthworks;
- construction of structures, pavement, road works and surfacing;
- street furniture, including lighting columns, road signs and safety barrier;
- accommodation works (for example, provision of new field access points where the existing entrances and fencing are affected); and
- landscaping.

Temporary Land Requirements

3.2.5 As with most major infrastructure projects, temporary land would be required during the construction phase to facilitate the works. Temporary land would be required for the following.

- Site compounds to house offices, welfare facilities, fuel and provide parking for construction workers.
- Storage areas for topsoil, subsoil stockpiles and other excavated material.
- Borrow pits to provide general fill material used for constructing highways embankments.
- Haul roads for construction vehicles (where these are not located within the permanent land take for the new section of motorway).
- Three types of compounds would be provided during the construction of the new section of motorway:
  - main compound;
  - section offices; and
  - satellite compounds.

3.2.6 In addition, temporary structures such as bridges and reen crossings would be required to facilitate the construction works.

3.2.7 The main compound would be established to the south of Imperial Park close to the A48 at Coedkernew. The main compound would accommodate approximately 100 staff and would provide car parking, office and welfare facilities, overnight plant storage, small tool and material stores and areas for traffic management.

Traffic Management

3.2.8 The key objective of a construction traffic management strategy would be to avoid the use of the existing M4 and local road network where possible. There would be instances where this is unavoidable, for example early in the construction programme for the transport of materials and plant until construction access points have been established; during tie-in works with the existing highways and junction remodelling at Castleton and Magor; and during pavement laying operations.

3.2.9 The early establishment of haul roads is essential to delivering the programmed earthworks as they provide a direct route between each section of work along the route. In addition to the earthworks haul road along the route of the new section of motorway, there would also be a dedicated earthworks haul road to connect the works to Ifton Quarry. This would be used to haul rock from the quarry.

3.2.10 Some deliveries would be categorised as abnormal loads. These are likely to be associated with major earth moving plant, cranes and the steel and pre-cast concrete bridge beam elements. Temporary holding areas would be required to control the deliveries of abnormal loads to the works areas.

3.2.11 A number of road diversions would be required during the construction programme. These diversions would vary in duration from a few hours for a total motorway closure to a number of months for a strategic side road closure.

Demolition Works

3.2.12 In order to create the new section of motorway and provide links to the existing route, several demolition works would be to be undertaken. Twelve residential properties would need to be demolished (with compensation):

- The Conifers, Coedkernew, Newport;
- White Cottage, Newport Road, Coedkernew, Newport;
- San Remo, Coedkernew, Newport;
- The Glen, Coedkernew, Newport;
- Quarry Cottage, Coedkernew, Newport;
- Myrtle House, Pound Hill, Coedkernew, Newport;
- Berryhill Cottage, Coedkernew, Newport;
- Berryhill Farm, Coedkernew, Newport;
- Barecroft House, Barecroft Common, Magor;
- Woodland House (Magor Vicarage), Newport Road, Magor;
- Undy Farm, Undy; and
- Dunline, Knollbury, Magor.

3.2.13 Of these, five are currently in Welsh Government ownership. One, Magor Vicarage, is a Listed Building.

3.2.14 These residential properties are mostly located within Castleton and Magor, with five under the ownership of the Welsh Government. Eight of the properties to be demolished are individual houses, located outside of a settlement, therefore the impacts of removing these properties on the remaining properties within the area would be minimal. Four of the properties are located together to the northwest of Castleton, which is a cluster of around ten properties adjacent to the existing M4. Woodland house is a listed Grade 2 house, of historic importance, more information is provided within the Cultural Heritage Chapter (Chapter 8). Loss of four houses within this small number of dwellings has the potential for a reduction in the sense of community and community support available for the remaining residences, especially for more vulnerable groups, such as the elderly who may rely on local support to a greater degree.

3.2.15 The loss of twelve residential dwellings is not anticipated to have a significant impact on the housing stock within the area. The 2011 census shows that there are in excess of 63,000 dwellings in Newport and over 40,000 in Monmouthshire, therefore loss of these buildings would only constitute a loss of 0.018% and 0.03% of the housing stocks within the local planning authorities respectively. Therefore, it is concluded that demolition of these properties would not affect the integrity of settlements in the surrounding of Castleton, Newport and Magor. In addition to the above properties to be demolished there would be a further five properties that would experience some effect from land take from their land area for the scheme:

- The Croft, Coedkernew – land take to the rear of the property including outbuildings and garden;
- Spring Cottage, Coedkernew – land take to the rear of the property including garden and access track;
- Longhouse Farm, Coedkernew – field to rear of property partially taken for the Scheme and some effect to the access track;
- The Old Rectory, Coedkernew – part of the garden required for laying drainage pipes; and
- The Beeches/Rowan House and residential caravan park – land required for construction.

3.2.16 Highway works at the Castleton Interchange would also require some demolition work. The existing A48(M) overbridge and Park Farm footbridge would be demolished once the new structures to the west have been opened and the Pound Hill Overbridge would be demolished once no longer required. Furthermore, the River Usk Crossing would require demolition of several buildings within the Newport Docks area.

3.2.17 Existing commercial properties would require demolition in the following locations.

- Buildings located at Newport Docks to allow for construction of the River Usk Crossing, the Docks Way Junction and the link to the A48.
- Buildings located within the Stevenson Industrial Estate owned/operated by Marshalls Mono Ltd.

3.2.18 No doctor's surgeries, hospitals, care facilities, shops, post offices, places of worship, parks, play areas or sports centres would require demolition or be directly affected by the construction of the new section of motorway.

3.2.19 Demolition works would be undertaken by a specialist contractor in accordance with method statements approved by the local planning authority and pre-demolition surveys would be carried out as required.

Pre-Construction Environmental Management Plan

3.2.20 A Pre-Construction Environmental Management Plan has been developed during the EIA process. This sets out the means by which the various construction activities would be managed to comply with the relevant environmental legislation and best practice to minimise efforts on local residents and environmental receptors. It includes measures to protect the water environment and existing resources, such as rights of way, and to reduce noise, air quality and ecological impacts.

Complementary Measures

3.2.21 Construction activities would be limited due to most of the measures being undertaken within the existing highway boundary. Key construction activities include alteration of road markings to reduce number of lanes, widening of the westbound diverge slip road at Junction 25 through construction of a new retaining wall and construction of new connecting slip roads between Junction 25-25A link roads and the motorway.

3.2.22 Existing road elements including emergency roadside telephones, gantries and street lighting would be retained and also there would be no enhancement to existing road drainage for the old section of the M4.

Construction Stage Employment and Investment

3.2.23 A Wider Economic Impact Assessment (Bussell, 2016) estimates that the construction period would require an average 700 people per month employed on the scheme over the four year construction phase, which would peak at around 1,000 per month employed.

3.2.24 Throughout the construction phase a range of occupations and skill sets would be required. The extent to which these jobs may be filled by people for the local area is dependent of the availability of suitably skilled workers, as well as other factors; however, where possible, local recruitment would be favoured.

3.2.25 Under 'targeted recruitment and training' the Joint Venture Contractor has committed to 20% of the total labour costs to be covered by employment of new entrant trainees with an apprenticeship, trainee or employment contract with the contractor or subcontractor and who are engaged in an appropriate training programme.

3.2.26 In addition to recruitment, construction would require procurement of approximately £543 m of goods and services, including equipment and materials. Local procurement would be favoured, but would be on a case by case basis.

3.2.27 An Economic Appraisal Report (Pritchard, 2016) evaluating the costs and benefits of the Scheme accrued over a 60-year period concluded that overall the Scheme represents value for money with a benefit to cost ratio of 2.67, indicating that the scheme would generate both direct and wider economic benefits, that represent value for money in relation to the investment needed to deliver the Scheme.

3.3 Operational Activities

3.3.1 The purpose of the Scheme is to support the delivery of the Welsh Government's transport strategy 'One Wales: Connecting the Nation', which sets out the long term environmental, social and economic outcomes to which the transport system contributes. The Scheme should assist in meeting these outcomes by improving access between key settlements and sites, enhancing connectivity within the region and beyond and increasing safety, security and economic prosperity.

3.3.2 The Traffic Forecasting Report (Pritchard, et al., 2016) highlights that in the 2014 base situation, the most heavily trafficked sections of the existing M4 are between Junctions 27 and 29, with 4,300 to 5,300 vehicles travelling in each direction during peak hours.

3.3.3 It predicts that in the do-minimum scenario (without the Scheme), future traffic growth would result in severe congestion on the existing road and therefore would lead to increased journey times. However, in the do-something case with the Scheme, the new section of motorway is predicted to reduce traffic flows on the existing alignment by 30% to 45%. Reduction in traffic on local roads within Newport is also predicted, while through traffic travelling between Junction 23 and 29 would be able to use the new section of motorway, making use of a shorter route.

3.3.4 Journey times between Junction 30 of the M4 and the toll plaza at the Second Severn Crossing have been modelled to gauge the impact of the new Scheme on journey time. With implementation of the Scheme in 2022, travel time along this existing route is predicted to be reduced in both directions at peak times by up to 1.5 minutes, and by 2037 journey times would be reduced by up to 4.5 minutes at all times of day. However, due to the speed limits and capacity reductions as a result of reclassification of the existing M4, journey times between peak hours on the existing route and intermediate junctions are predicted to increase slightly with the Scheme 2022.

3.3.5 Through traffic using the new section of motorway would experience a greater reduction in journey times, due to shorter distances and reduced congestion. Journey time reductions during the inter-peak hours would range from 2.5 minutes in 2022 to up to 3 to 4 minutes by 2037 and during peak hours the reduction could be up to 9 minutes by 2037.

3.3.6 The changes in traffic flows and journey times experienced from implementation of the Scheme should help to improve access to services both around the existing route and further afield through reduced congestion and journey times, enabling quicker access to services and amenities.

3.3.7 The journey time benefits and vehicle operating cost savings are considered to provide significant economic benefits to consumers and businesses in the Economic Appraisal Report (Pritchard, 2016). The traffic changes are also considered in the Wider Economic Impact Assessment (Bussell, 2016) to provide further cost savings to businesses and improved commuting by car (widening the area over which firms can recruit workers).

3.3.8 Traffic has been predicted using a variable demand model using several zones, taking into account predicted future background demand growth and traffic contributed by specific development proposals in the Newport, Monmouthshire and Cardiff areas. In total, around 9% – 10% traffic growth from 2014 to 2022 without the Scheme is forecast, with a further 15% – 16% growth from 2022 to 2037. However, almost no change (<1%) in total traffic demand and flows in the future year with-Scheme compared to do-minimum is predicted – i.e. overall the Scheme is not predicted to increase total road travel demand or growth in vehicle flows, with changes to traffic instead being a redistribution of flows.

3.3.9 Growth in public transport demand has also been predicted, but this is used as an input to the road traffic predictions, rather than providing a forecast of the effects (if any) of the Scheme on public transport or indicating that additional public transport would be facilitated.

3.4 Health Pathways

3.4.1 A health pathway can be described as the way in which an activity influences a known determinant of health. As an example of how the health pathway concept is applied, construction activities are known to influence environmental determinants of health including air quality, noise and traffic. A health pathway is identified when such influences have the opportunity to impact on communities with the potential to cause a response or health effect.

3.4.2 Identification of potential health pathways helps to define the scope of the study, from which it is possible to develop a suitable evidence base and a more informed community profile. The distribution, magnitude and significance of the health pathways can then be investigated at the assessment stage.

3.4.3 It is important to note that the potential health pathways identified do not at this point take into account Scheme design features or construction, operation or traffic management plans designed to remove or reduce potential influences, and are solely intended to identify potential health pathways for further investigation.

Tailoring the HIA Scope to the Scheme Profile

3.4.4 Table 3.1 provides a summary of the potential health pathways associated with the Scheme, presents particularly sensitive/vulnerable community groups (as defined in WelTAG), and represents the scope of health topics to be addressed as part of the HIA and EqIA.

3.4.5 The health evidence base for these pathways, with particular reference to the metrics available for quantitative assessment of health outcomes from air pollution and noise exposure, is discussed in Section 5.

Table 3.1: Health Pathway Summary

Health Pathway	Health Determinant (WelTAG)	Potential Outcome	Geographic Distribution	Sensitive/ Vulnerable Groups
Construction phase				
Temporary and transient changes to local air quality from construction activities and plant	Environment	Adverse	Local	Socio-economically deprived Elderly Infirm Children
Temporary and transient changes in noise	Environment	Adverse	Local	Socio-economically deprived

Health Pathway	Health Determinant (WelTAG)	Potential Outcome	Geographic Distribution	Sensitive/ Vulnerable Groups
				Elderly Infirm Children
Change in land contamination exposure risk or flood risk	Environment	Adverse or beneficial	Local	Socio-economically deprived Children
Scheme impacts potentially effecting access and accessibility (to services, facilities, amenities, recreation, employment and social networks)	Transport (personal security) Physical fitness (lifestyle)	Adverse	Local and regional	Children Elderly Infirm Disabled Socio-economically deprived
Increased direct, indirect and induced income and employment opportunities	Socio-economic	Beneficial	Local and regional	Socio-economically deprived
Demolition of 12 residential properties	Social inclusion Physical fitness (lifestyle)	Adverse	Local	Children Elderly Infirm Disabled Socio-economically deprived
Operation phase				
Improved access and accessibility (between settlements, to services, facilities, amenities, recreation, employment and social networks)	Transport (personal security) Physical fitness (lifestyle) Social inclusion	Beneficial	Local / regional / national	Socio-economically deprived Elderly Infirm Disabled
Improved road safety	Transport (personal security)	Beneficial	Local / regional / national	Children Elderly Infirm Disabled Socio-economically deprived
Changes in cycle and footpaths and public transport (physical activity)	Transport (personal security) Physical fitness (lifestyle)	Beneficial or adverse	Local and regional	Children Elderly Infirm Disabled Socio-economically deprived
Change in air quality and noise emissions	Environment	Beneficial or adverse	Local	Socio-economically deprived Elderly Infirm Children (noise)

4 Community Profile

4.1 Introduction

4.1.1 As noted above, communities or groups within them may have varying sensitivities to health outcomes (adverse and beneficial), as a consequence of demographic factors, relative socio-economic status, deprivation, and existing health, which may all affect susceptibility and resilience to health effects.

4.1.2 A community profile is therefore used to establish the baseline, and identify unequal distributions in existing factors such as deprivation or burden of poor health, in order that changes in community exposure to certain health pathways and their degree of impact on the population or groups within it can be assessed.

4.1.3 Data obtained from the Office for National Statistics (ONS) are licensed under the Open Government Licence v3.0.

4.2 Local Demography

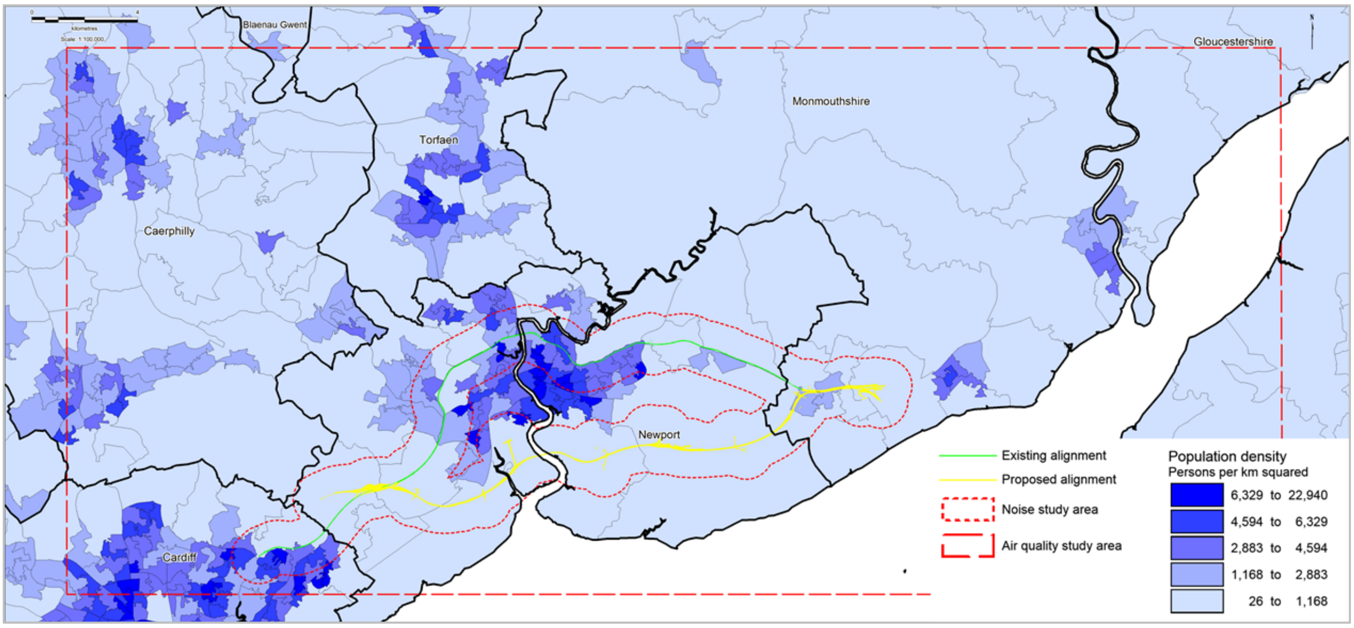
4.2.1 Local demography encompasses a range of parameters that help to define the composition of a given population. These include the size of the population, age profile, gender split, ethnicity and inward/outward migration. This provides a basis for understanding local circumstance and can provide an insight as to how this may change over time and the subsequent link with health outcomes. For example, the health requirements of an ageing population are different to those of a younger demographic.

Population Density

4.2.2 Figure 4.1 shows population density at the Lower Super Output Area (LSOA) level along the route of the development and the wider air quality study area. The figure highlights a low population density for much of the area surrounding the new section of motorway, reflecting the rural and predominantly agricultural nature of the surroundings. This suggests that impacts adjacent to the new route are likely to affect a relatively small number of people. Furthermore, areas of low population density are likely to have a low density of community services, amenities and employment opportunities which may influence health need and access to services relevant to community health in surrounding populations.

4.2.3 For a large part of the area surrounding the existing M4, the population density also remains fairly low. However, much of the section of road forming part of the Scheme borders the urban edge of Newport, where the population becomes very dense (up to 6,912 people per km^2 squared). Due to the large population adjacent to the existing road, there is potential for changes to the existing road that occur as part of the whole development to impact on community health in these densely populated areas. Hence the health impacts must be considered for both the new section of motorway and changes to the existing M4.

Figure 4.1: Population Density



Source: (ONS, 2015). Contains Ordnance Survey Data © Crown copyright and database right 2015.

Population Structure

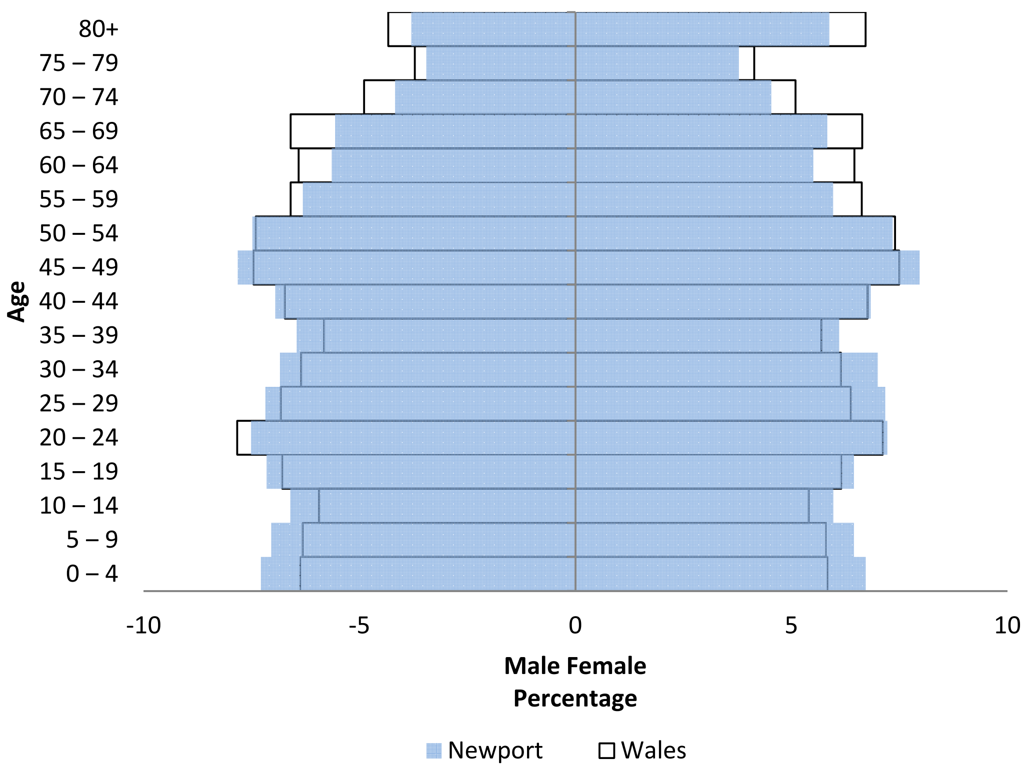
4.2.4 Population estimates for the UK for mid-2014 (ONS, 2015) (the latest estimate available at the time of writing) can be used to illustrate the age and gender split for the communities surrounding the development, as well as the wider area. The gender split in Wales is fairly even with 49% of the population male and 51% female. A similar gender distribution can be found for the three local authorities surrounding the development: Newport, where the majority of the works would take place; Monmouthshire, the easternmost extent of development and finally Cardiff, all of which display a gender split of 49% male to 51% female.

4.2.5 A detailed age and gender profile for each of the authorities assessed within this HIA are given in the following figures, which present the local authority population data against the profile for Wales. Figure 4.2 illustrates that Newport has a similar profile to Wales, but with a slightly greater proportion in the younger age brackets compared to the older aged brackets (55+). This differs from Monmouthshire (Figure 4.3), which has an older population compared to the Wales average, with fewer residents aged between 20 and 39 and a greater proportion in the older aged groups, from 45 years onwards. The older age profile for Monmouthshire is an important consideration for this HIA due to increased age being related to an increasing requirement for healthcare services and changes to wellbeing and mobility associated with advancing age.

4.2.6 The age structure for Cardiff, by contrast, varies greatly from that of Wales, with a very large number of residents in the younger adult age brackets, particularly between the ages of 20 to 34, and commensurately fewer from the 45 years onwards brackets. This is due in significant part to Cardiff being a university town (Cardiff university being the largest in Wales by student numbers; full-time student numbers in Cardiff are shown below). The substantial 25-40 population may also suggest that Cardiff has attracted many younger working-age people through employment opportunities, but this is not borne out clearly in the employment data (discussed further below).

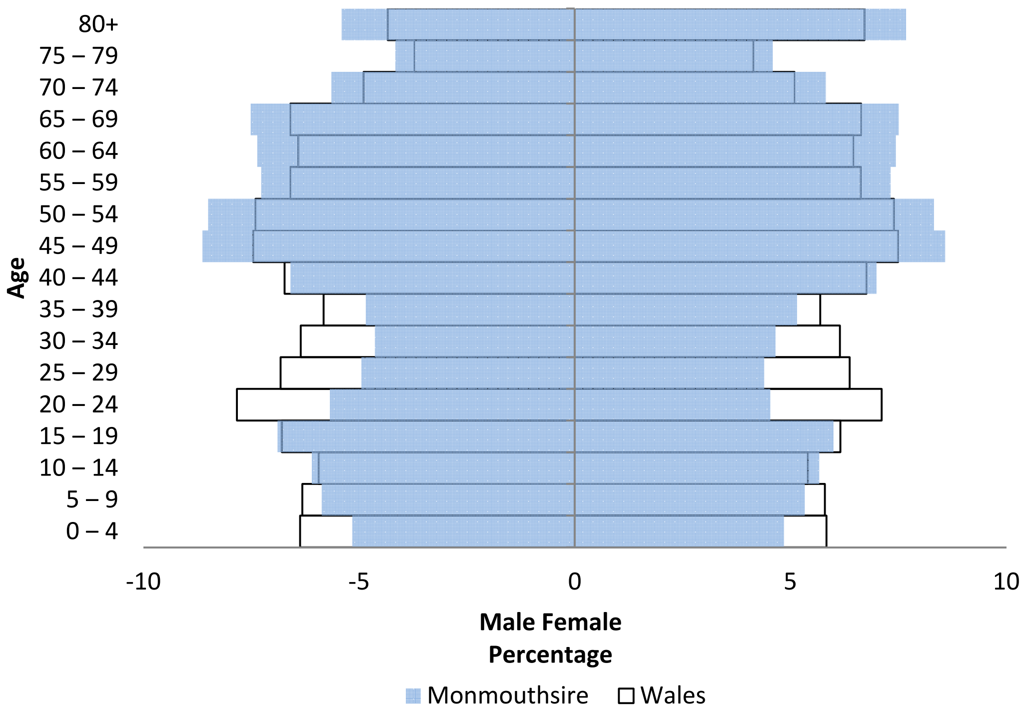
4.2.7 In terms of total population from the mid-2014 population estimates, in 2014 Wales had a total population of approximately 2,914,400. Cardiff's population totalled approximately 331,300, compared to around 137,200 for Newport and 87,900 for Monmouthshire.

Figure 4.2: Age Structure, Newport Compared with Wales



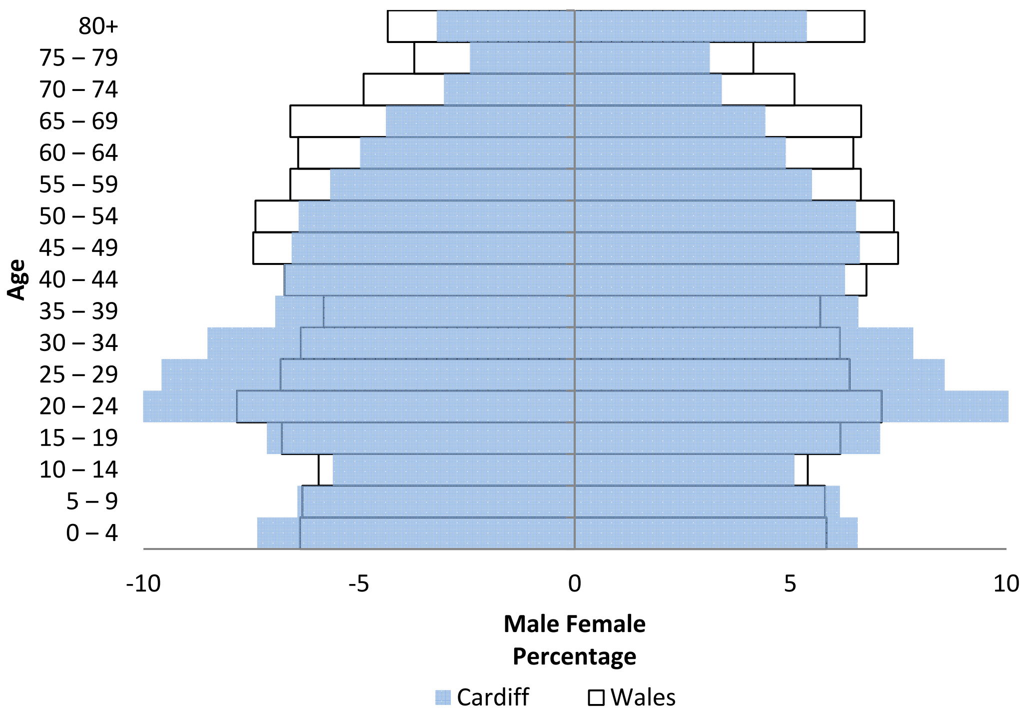
Source: adapted from (ONS, 2015)

Figure 4.3: Age Structure, Monmouthshire Compared with Wales



Source: adapted from (ONS, 2015)

Figure 4.4: Age Structure, Cardiff Compared with Wales



Source: adapted from (ONS, 2015)

Migration

4.2.8 Migration statistics from 2015 indicate that in the period 2011-2013, Wales overall has had a net inflow of migrants both internally (Welsh Government, 2015) (from other regions in the UK) and internationally (Welsh Government, 2015). Only internal migration data were available at a local authority level, but for Wales overall, internal migration was far greater than international.

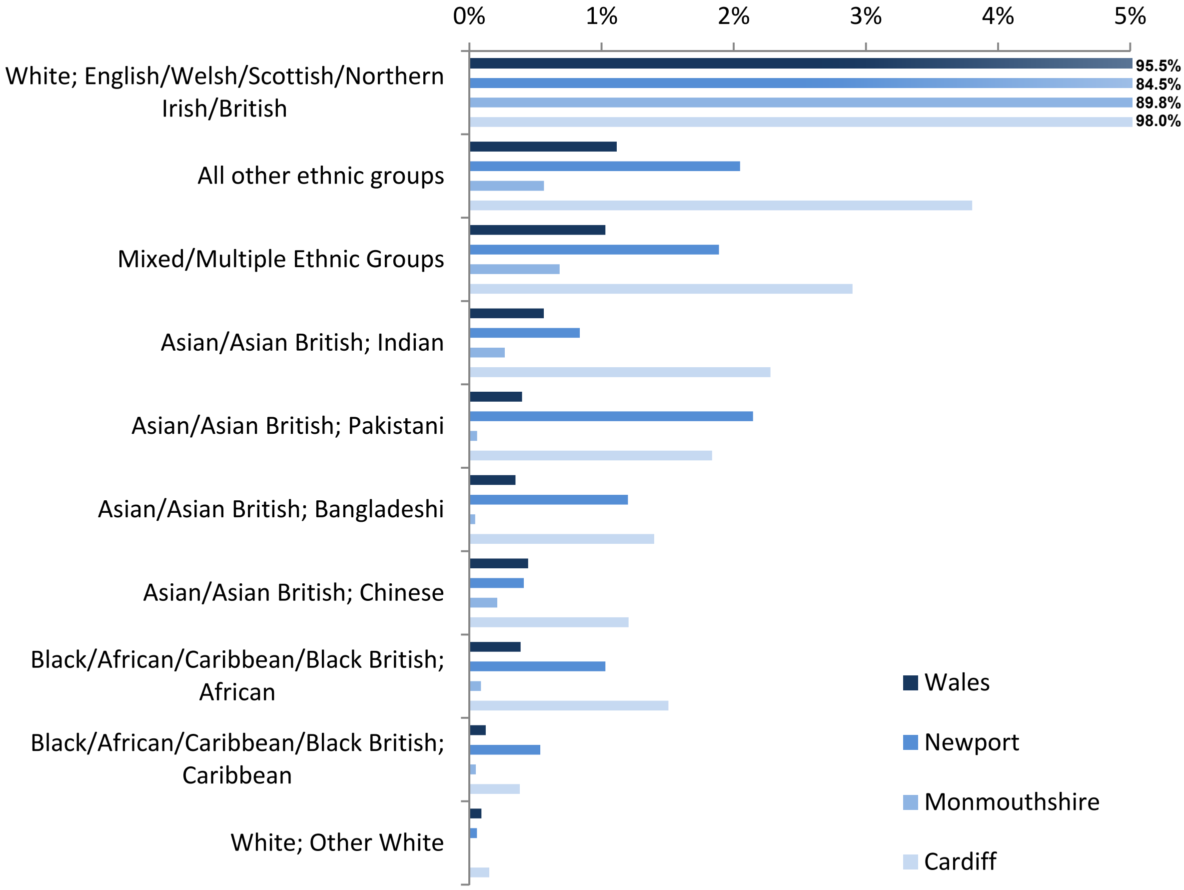
4.2.9 At the local authority level, between 2001 and 2014 Monmouthshire experienced a net inflow of 5,650 internal migrants (6.7% of the population in 2001). This contrasts greatly with Cardiff which had a trivial net inflow of 370 people (0.1% of the population) and Newport with a net outflow of 500 people (0.4% of the 2001 population). The population change due to migration in Cardiff and Newport is insignificant, but the inward migration rate in Monmouthshire, if sustained, could result in a greater contribution to population growth within the local authority.

Ethnicity

4.2.10 Data from the 2011 census (ONS, 2012) indicates that the three local authorities have varying ethnic diversity, although the majority of the populations of these areas are White (White: English / Welsh / Scottish / Northern Irish / British), as illustrated in Figure 4.5. Monmouthshire has very low ethnic diversity (98% White), while Newport and Cardiff have substantially greater diversity, with 84.5% and 89.8% of the population White, respectively. In comparison to the average for Wales, Cardiff and Newport have a greater percentage of their respective population in other ethnic groups, whereas Monmouthshire has a smaller percentage when compared to Wales.

4.2.11 Ethnic diversity remains relatively evenly balanced between the remaining ethnic groups for Monmouthshire, all of which represent 0.7% or less of the population. Newport and Cardiff conversely have greater variation between the proportion of the population in the various groups given below, although none is greater than 4% of the overall population.

Figure 4.5: Ethnicity, Cardiff, Monmouthshire and Newport Compared with Wales

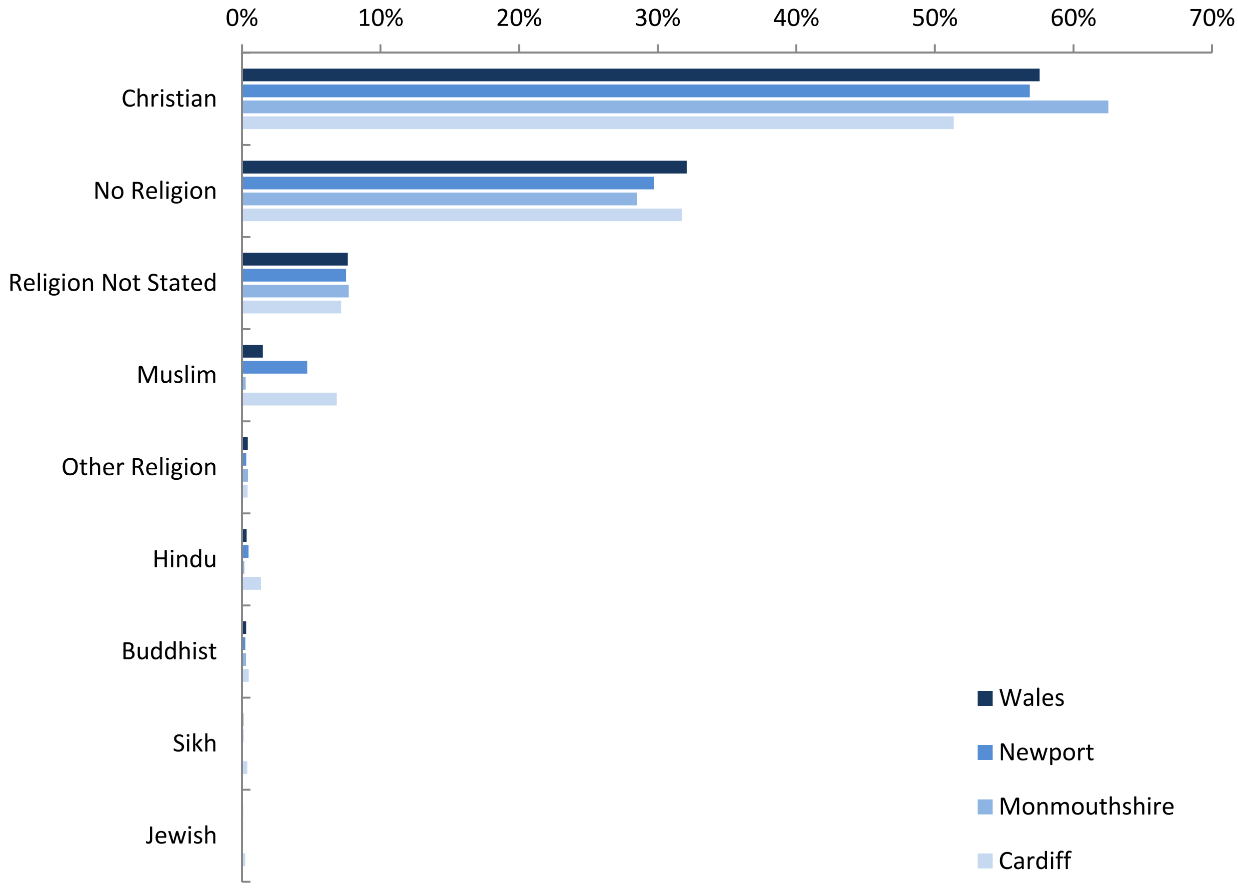


Source: adapted from (ONS, 2012)

4.3 Religion

4.3.1 The 2011 census (ONS, 2012) indicates that there is low religious diversity for the three local authorities, which mirrors the religious profile for the whole of Wales. A considerable number of the population for the areas assessed state no religion, ranging from 28.5% in Monmouthshire to 32.1% for the Wales average. For those who do state a religious preference, the majority of the population (>50%) state their religion to be Christian for the three local authorities and for the whole of Wales. The largest religious minority group identify themselves to be of the Muslim faith, which tends to be more common within Newport and Cardiff, compared with Monmouthshire and the Wales average. The remaining religious groups are represented by a very small proportion of the population, which account for 1.37% or less of the population for the areas assessed.

Figure 4.6: Religious Preference, Cardiff, Monmouthshire and Newport Compared with Wales



Source: adapted from (ONS, 2012)

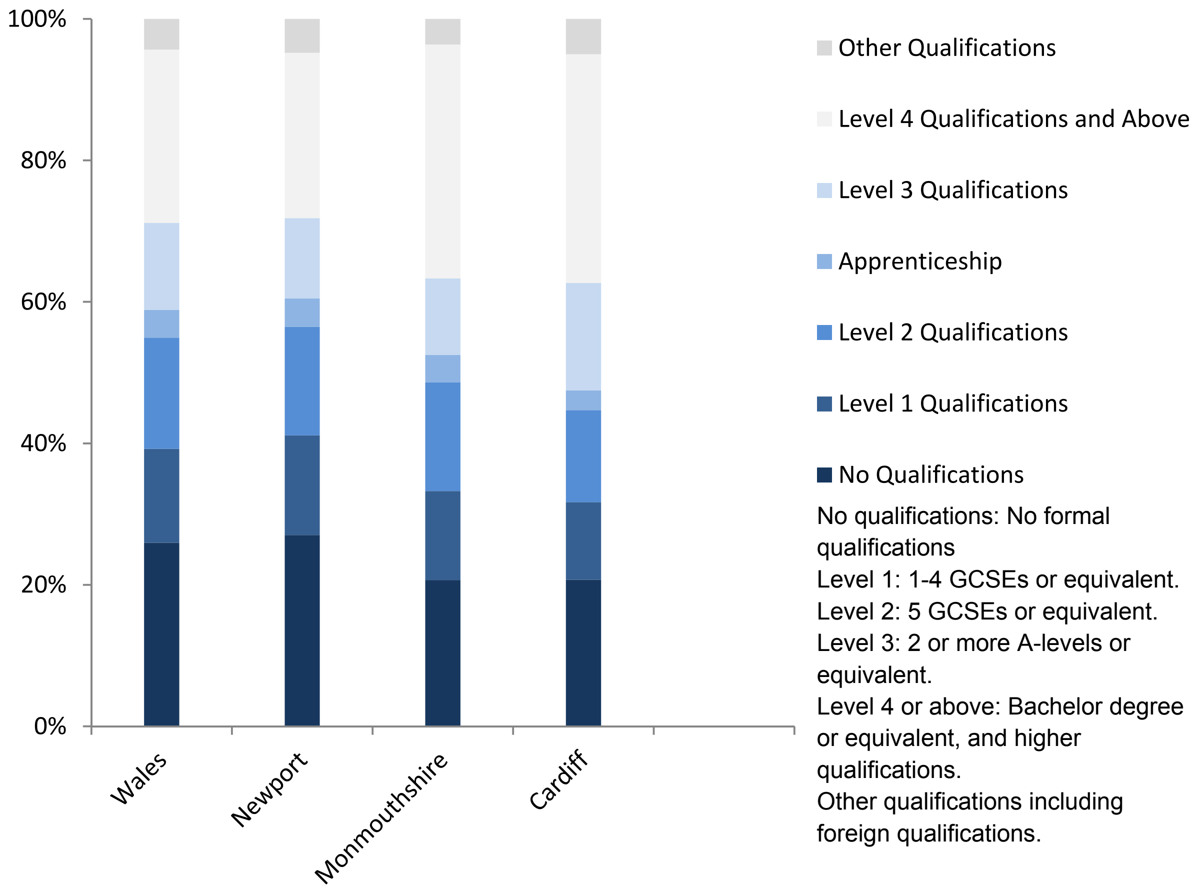
4.4 Education

4.4.1 The 2011 census data for highest qualification levels attained by the population (ONS, 2013), shown in Figure 4.7 below, highlights variation in the educational attainment of the areas assessed. The greatest levels of educational attainment can be found in Cardiff and Monmouthshire, where approximately one third of the populations have a Level 4 qualification or above (equivalent to a bachelor degree). This is substantially above the Wales average of 24.5%, which is mirrored by Newport, where 23.4% of the population have Level 4 qualifications or above.

4.4.2 Overall, Newport tends to display a profile similar to that of the Wales average. The largest proportion of the population have no formal qualifications at 27.0%, slightly greater than the Wales average of 25.9%. Likewise out of the four areas Newport has the greater proportion of people with only Level 1 qualifications (equivalent to 1-4 GCSEs) at 14.1% of the population, similar to the Wales average of 13.3%.

4.4.3 This suggests useful scope for greater uptake of basic qualifications and training in the Cardiff and Monmouthshire areas, which may be an opportunity for the proposed development in offering construction apprenticeship and training schemes.

Figure 4.7: Educational Attainment, Cardiff, Monmouthshire and Newport Compared with Wales



Source: adapted from (ONS, 2013)

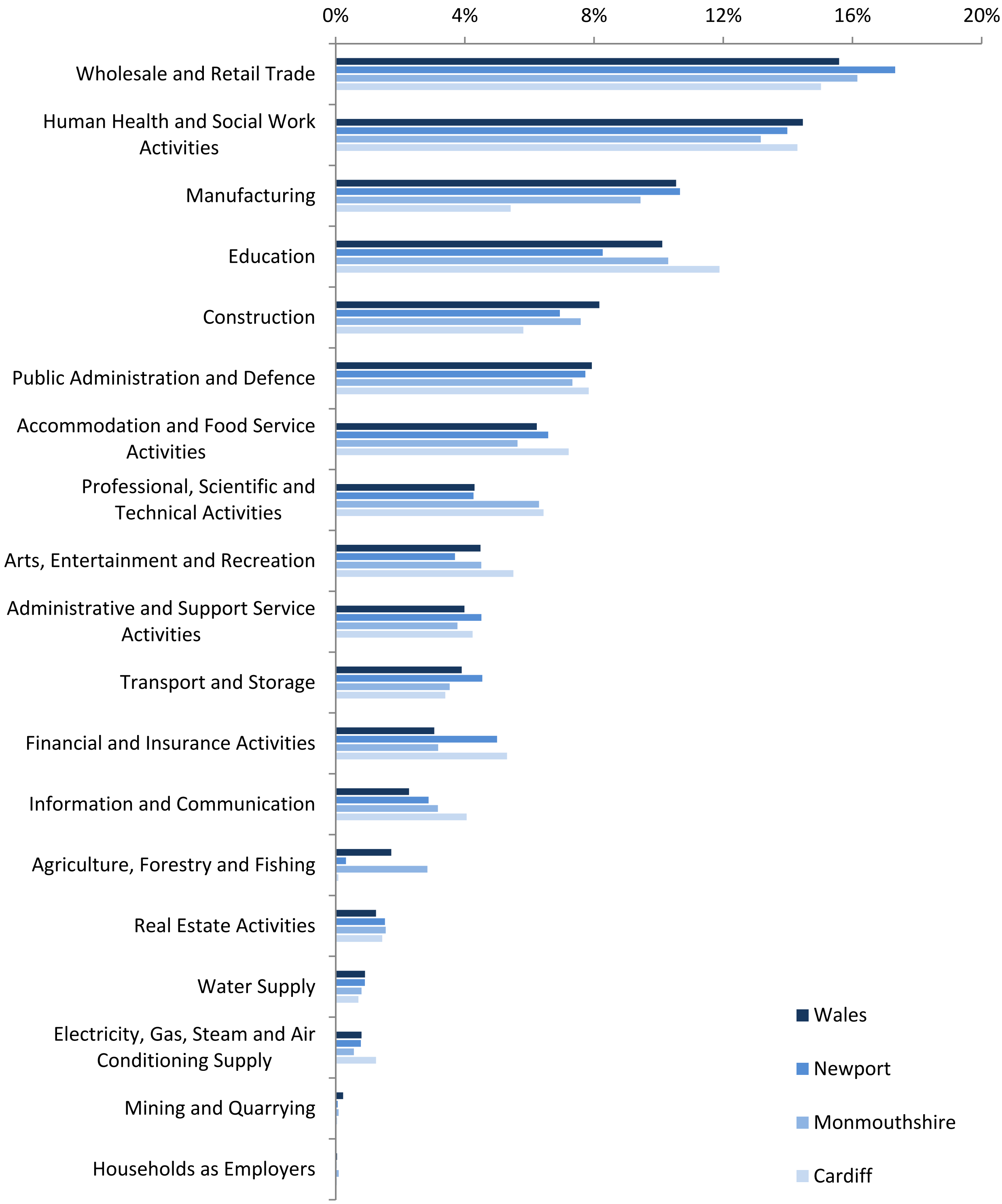
4.5 Economic Activity

Industry of Employment

4.5.1 Data from the 2011 census (ONS, 2013) for occupation by sector for the three local authorities and for the whole of Wales is shown below in Figure 4.8. The largest sector of employment with the three local authorities and Wales as a whole is the wholesale/retail sector, with 15% or more of the population occupying roles in the sector. Other significant sectors include health and social care, manufacture, education, construction and public administration, which employ between 5.4%-14.5% of the population for the above areas.

4.5.2 The employment sector data presented indicates that the communities of Newport and Monmouthshire in particular have an existing construction and manufacturing skills base, which may prove beneficial for the Scheme. These and other industries may benefit from the development once operational, through improved access and accessibility to wider opportunities upon completion.

Figure 4.8: Employment by Sector, Cardiff, Monmouthshire and Newport Compared with Wales.



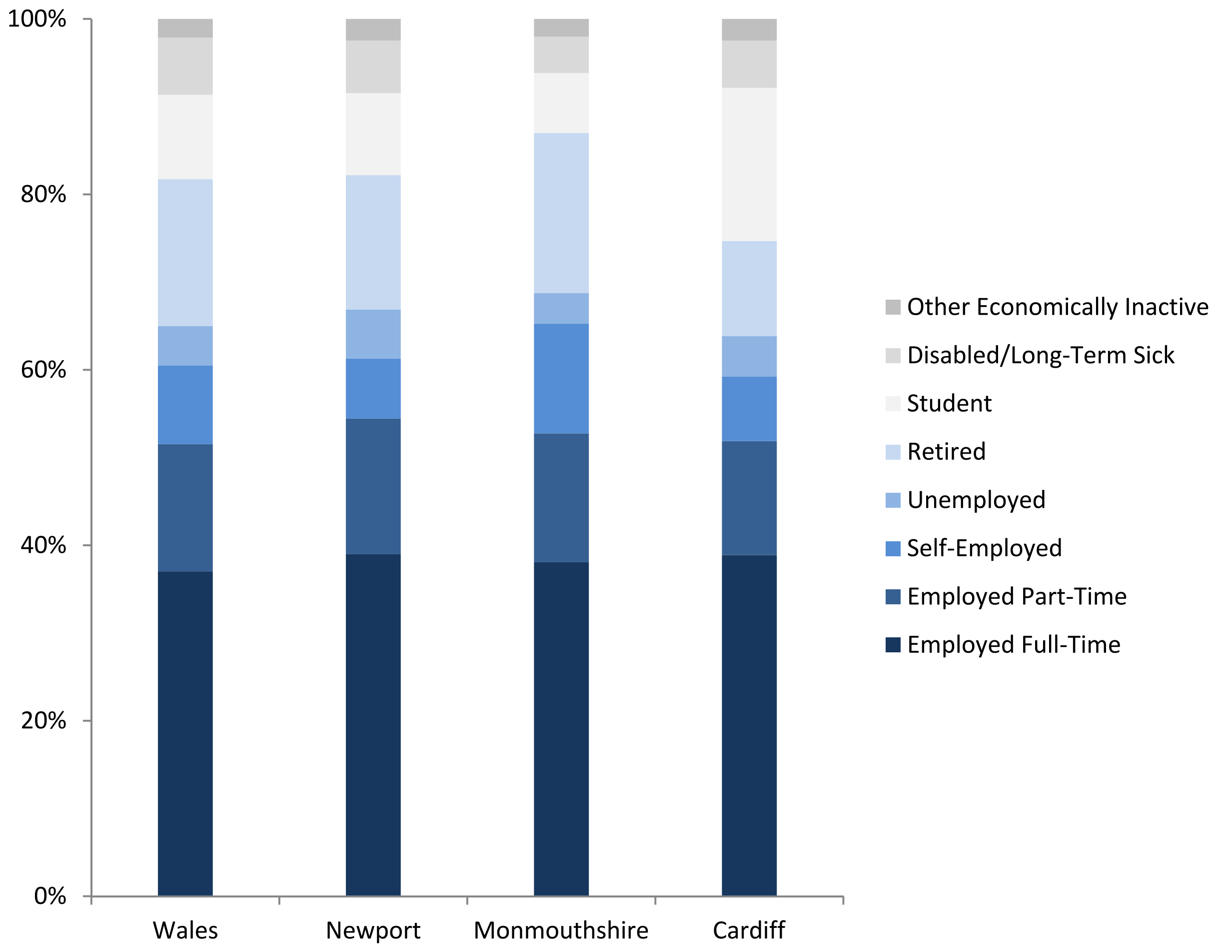
Source: adapted from (ONS, 2013)

Unemployment

4.5.3 The employment profiles for each of the local authorities against the profile for Wales are given in Figure 4.9, which illustrates that the employment status for the four areas is broadly similar. The data indicate that just over one third of the population is in full time employment for all areas assessed, and between 12%-15% of the population are in part-time employment for all areas. Variations exist between the areas for numbers of people self-employed, with a disability / long-term illness, and students; however these variations are represent only a few percent of the overall population; generally 10% or less in difference.

4.5.4 Cardiff has a considerably larger number of students, 17% of the population, compared to the average in Wales of 9%. It also has a smaller than average retired population at 10%. This contrasts with the average for Wales of 16% of the population retired and 18% for Monmouthshire, which reflects Monmouthshire's aging population demographic.

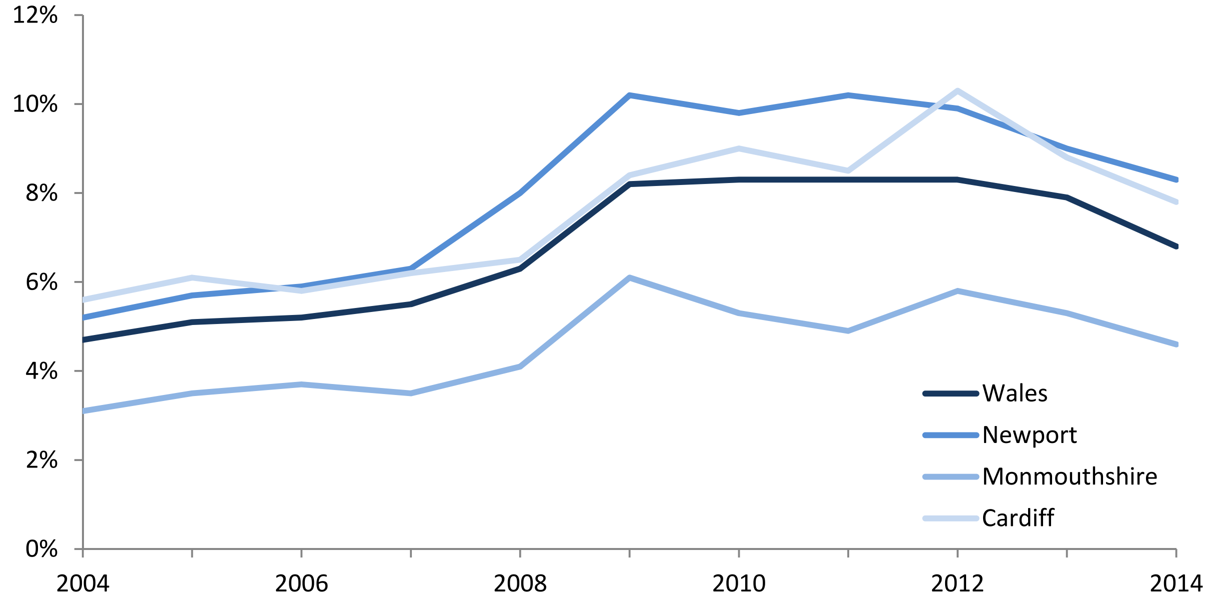
Figure 4.9: Proportions of Population Aged 16-74 in Economically Active and Inactive Groups



Source: adapted from (ONS, 2013)

4.5.5 The trend in unemployment over time as shown in Figure 4.10 reveals that both Newport and Cardiff have maintained a higher rate of unemployment compared to the average for Wales over the 10 year time period measured. Monmouthshire conversely has experienced a consistently lower rate during the same period, ranging between 1.5-3% lower a level of unemployment.

Figure 4.10: Percentage of Adults Unemployed, 2004-2014



Source: adapted from (ONS, n.d.)

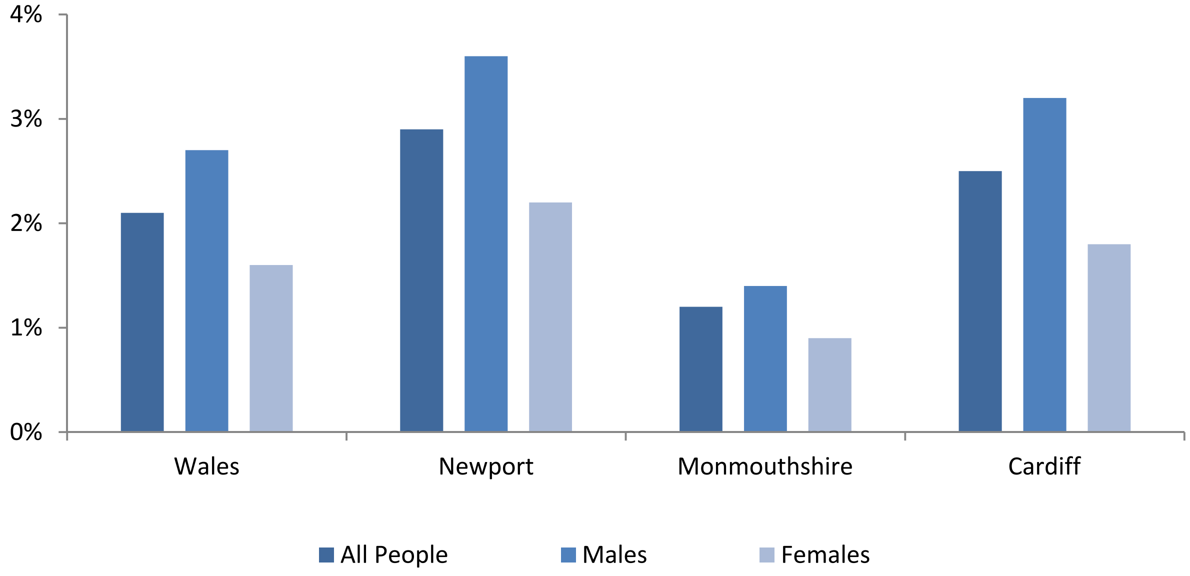
4.5.6 Figure 4.10 also illustrates that the proportion of the population unemployed for all four areas has been increasing over time to a peak between 2007-2012. Since this period unemployment numbers have been in decline, but still remain greater than those of 2004.

4.5.7 Data for the number of people claiming Job Seeker's Allowance (JSA) during 2015 (ONS, 2015) is shown in Figure 4.11. Consistent with the unemployment levels illustrated in Figure 4.10, Newport has the greatest proportion of working age people claiming JSA in the study area, with 2.9% claiming JSA, greater than the 2.1% average for Wales. Similarly, Cardiff has a greater level of JSA claimants compared to the Wales average, with 2.5% of the population, whereas Monmouthshire has only 1.2%. This demonstrates one important element of disparity in socio-economic status between the local authorities. The data also illustrate that in all three local authorities in the study area, the proportion of working age males claiming JSA is greater than equivalent proportion of females, which reflects the trend seen throughout Wales.

4.5.8 A breakdown of JSA claimants by age for the study area is given in Figure 4.11, which illustrates that the greatest proportion of those claiming JSA are within the 18-24 age bracket for Wales (3.2%), but also Newport and Monmouthshire, ranging from 2.6% of the working aged population in Monmouthshire to 4% in Newport. Job creation and training targeted at this age bracket is therefore likely to be most beneficial.

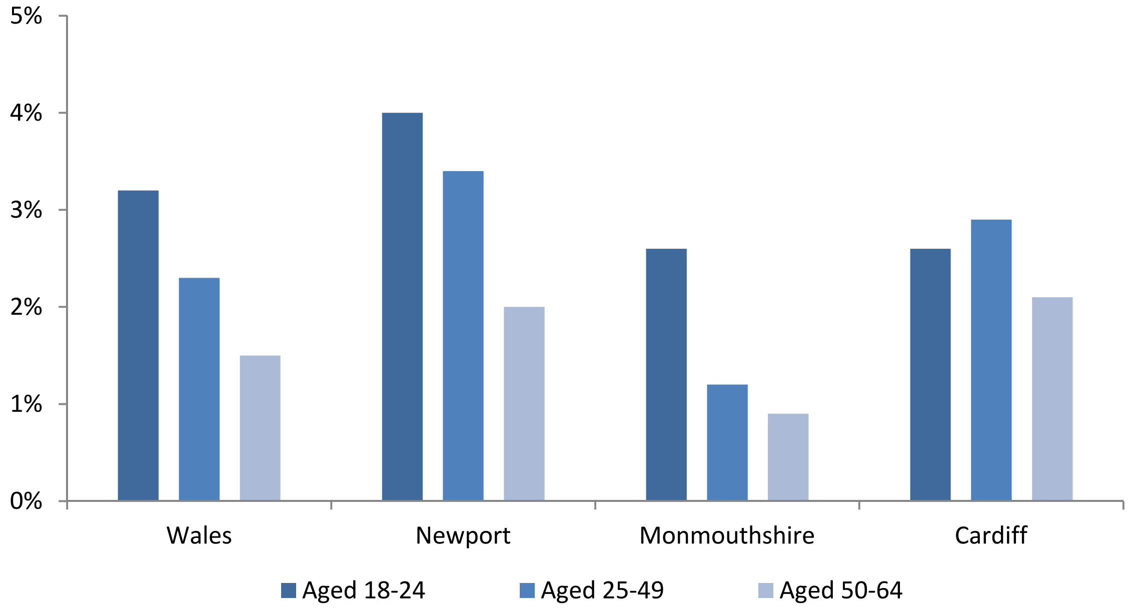
4.5.9 The profile of JSA claimants for Cardiff differs from the above, with the greatest proportion of JSA claimed by the 25 to 49 age bracket, representing 2.9% of the working aged population, compared to 2.6% for 18-25 year olds and 2.1% for 50-64 year olds. This is again likely to be influenced by Cardiff's large student population, who are in full-time education rather than claiming JSA.

Figure 4.11: Claimants of Job Seeker's Allowance, September 2015



Source: adapted from (ONS, 2015)

Figure 4.12 Job Seeker's Allowance Claimants in September 2015 by Age Group



Source: adapted from (ONS, 2015)

4.5.10 The number of Year 11 school leavers known to be not in education, employment or training (NEET) in Wales has gradually declined in recent years from 5.4% in 2010 to 3.1% in 2014 (Welsh Government, 2015). This trend is mirrored for the three local authorities assessed, to varying degrees. Newport has the highest level of school leaver NEET for 2014 at 4.7%, followed by Cardiff at 4.3%, both above the average for Wales. Monmouthshire has maintained the lowest level of school leaver NEET over the five year period, declining from 3.9% to 1.7%, considerably lower than the values for Newport. Low educational attainment combined with elevated levels of unemployment can potentially be a significant issue contributing to socio-economic deprivation and the associated burden of poor health in certain areas.

4.6 Deprivation

4.6.1 'Deprivation' may be defined as a lack of resources of all kinds (not just financial), encompassing a range of aspects of individuals' living conditions (Lad, 2011).

4.6.2 The Welsh Government produced the Welsh Index of Multiple Deprivation (WIMD) in 2011, which ranks the 1,900 LSOAs in Wales based on eight domains quantifying deprivation. The 2011 Index was subsequently revised in 2014, modifying the way the income indicator data is utilised and making use of the most up-to-date data (Welsh Government, 2015). The eight domains and their weighting are as follows: employment (23.5%); income (23.5%); education (14%); health (14%); community safety (5%); geographical access to services (10%); housing (5%); and physical environment (5%) (Welsh Government, 2014).

4.6.3 Deprivation within each domain is established using national statistics, such as rates of violence and burglary (crime), people claiming income support (income) or JSA (employment), homelessness, access to owner-occupation, and distance to services such as GP surgery, school or shops (barriers to housing and services), air quality and road traffic accidents (outdoor living environment), and many other indicators.

4.6.4 Collectively, these indications of the relative deprivation of a community (expressed through factors relating to individuals, such as rate of disability and employment, and through factors of the living environment, including crime and access to services) strongly influence health and wellbeing (Marmot, et al., 2010). Scores for deprivation therefore offer a useful way to show a summary profile of the community, and characterise the urban fabric of the areas in which this Scheme is located, in a way that focuses on the residents' needs and barriers to good health and wellbeing.

4.6.5 LSOAs were designed to allow reporting of small area statistics and are a consistent geographical unit used for the WIMD. The area is defined by the population present: the area must have a minimum population of 1,000 inhabitants and the mean size of all the LSOAs must be close to 1,600 (Welsh Government, 2014).The area is usually built from grouping between four to six Census Output Areas.

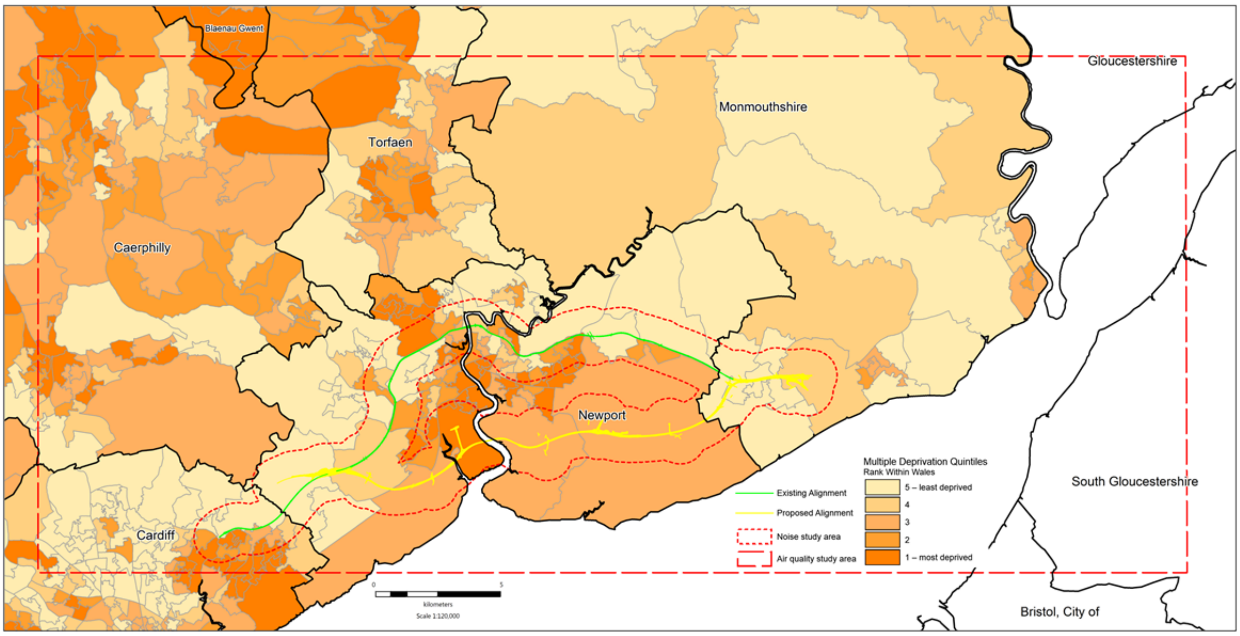
4.6.6 Multiple deprivation within LSOAs for the development study area compared to multiple deprivation values for the rest of Wales is shown in Figure 4.13. Deprivation values are split equally into five quintiles, where 1 represents the least deprived LSOAs and 5 represents the most deprived.

4.6.7 As can be seen in Figure 4.13, levels of deprivation vary for the LSOAs surrounding the proposed M4 route; from the least deprived areas at the eastward edge of the development in Monmouthshire to the most deprived towards the centre of Newport. On a local authority basis, LSOAs in Monmouthshire generally have the least levels of deprivation in comparison with the rest of Wales. This contrasts with deprivation levels within Newport, which range from the least deprived LSOAs towards the outer edges of the authority boundary, to the most deprived areas within Newport city centre, close to the proposed location of the new section of motorway and adjacent to the existing M4 alignment. Cardiff likewise varies greatly in levels of deprivation dependent on location, with some of the most deprived areas in comparison with Wales found to the central and eastern part of the city, adjacent to where the existing A48(M) route connects to the city.

4.6.8 Overall, Figure 4.13 illustrates that much of the urban area of Newport that would be affected by changes to both the existing M4 and the proposed new section of motorway is ranked within the 40% of LSOAs with greatest multiple deprivation in Wales.

4.6.9 Figure 4.14 compares multiple deprivation levels ranked within the study area alone, allowing local geographical patterns of relative deprivation to be differentiated more clearly. The LSOAs included comprise of all those within Newport, together with LSOAs in Monmouthshire, Caerphilly and Cardiff that intersect the boundary of the noise study area[1]. As with the multiple deprivation values for the entirety of Wales, when comparing values within the study area it is clear that there is significant variation in levels of deprivation across the area of the proposed and existing alignments. The LSOAs located towards the eastern extents of the proposed alignment remain the least deprived areas, reflecting their rural location. The more deprived areas tend to be located towards the centre of Newport, a cluster near the boundary with Torfaen, and the north-eastern areas of Cardiff adjacent to where the existing A48(M) route extends.

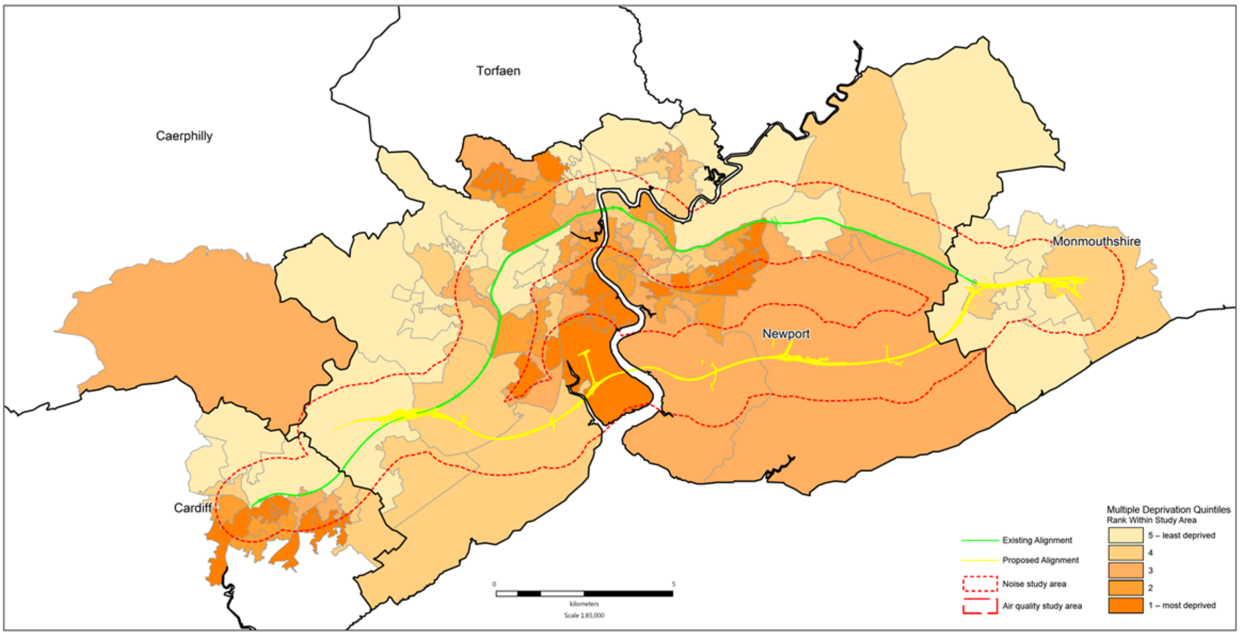
Figure 4.13: Index of Multiple Deprivation, Quintiles Within Wales



Source: (Welsh Government, 2015). Contains Ordnance Survey Data © Crown copyright and database right 2015.

[1] A similar exercise for the larger air quality study area shows deprivation rank patterns within that geographical area essentially unchanged from the rank within the whole of Wales geographical area, so has not been presented.

Figure 4.14: Index of Multiple Deprivation, Quintiles Within Study Area

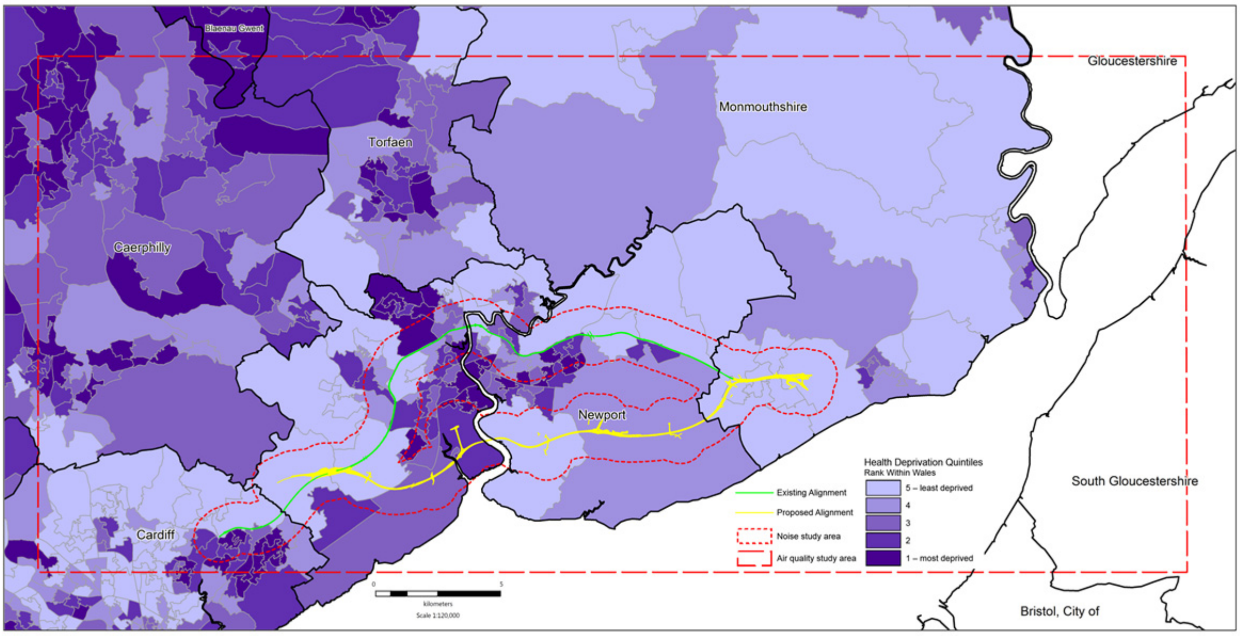


Source: (Welsh Government, 2015). Contains Ordnance Survey Data © Crown copyright and database right 2015.

4.6.10 Index of health deprivation values for the LSOAs compared with levels throughout Wales are given in Figure 4.15, which rank the health domain order from 5 representing the least deprived to 1 representing the most deprived for the health indicators measured. Monmouthshire at the easternmost extent of the proposed development has the lowest levels of health deprivation, while Newport displays a range of values with the least deprived areas located towards the peripheries and the most deprived towards the centre of the city. The westernmost extent of the existing M4 around the north-eastern corner of Cardiff shows a trend similar to that of the multiple deprivation analysis, whereby some of the more deprived areas in terms of health are located within the adjacent LSOAs to the south of the motorway.

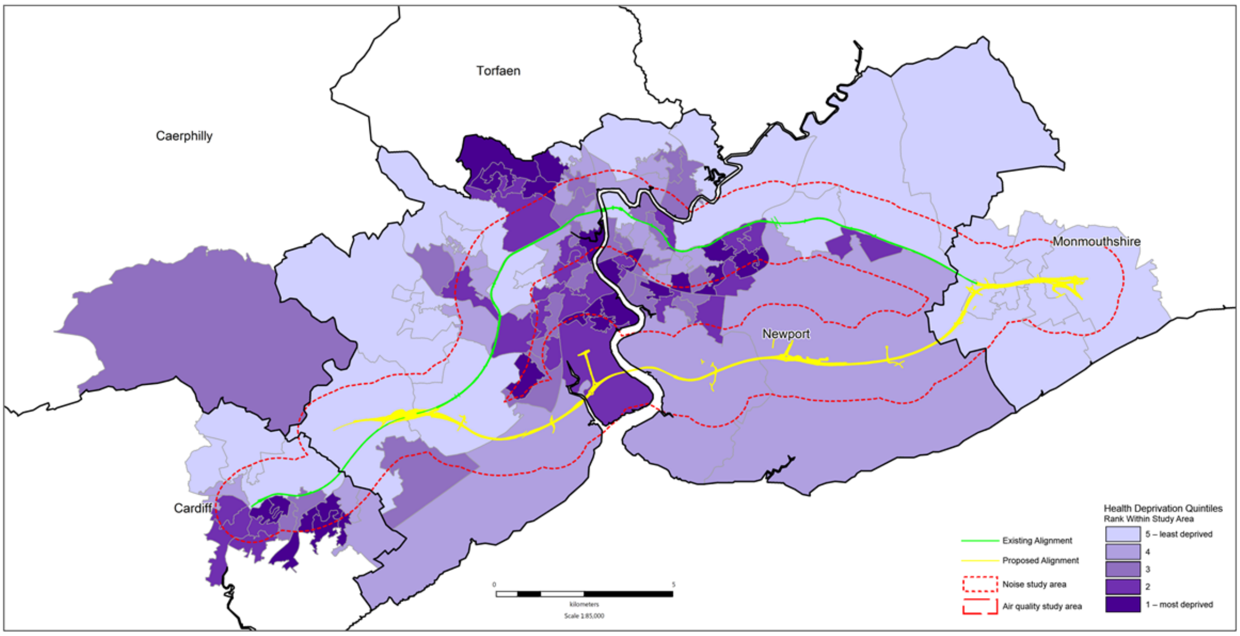
4.6.11 These trends are reflected when comparing health deprivation values within the study area only (Figure 4.16), which similarly displays the greatest levels of health deprivation in Newport city centre and the north-eastern area of Cardiff, close to where the existing M4 route extends. From the figure it can be seen that the existing M4 and new section of motorway passes through areas that encompass a range of health deprivation levels. In many areas, the existing M4 seems to provide a boundary, whereby the more deprived LSOAs are located adjacent to the least deprived LSOAs on the other side of the motorway.

Figure 4.15: Index of Health Deprivation, Quintiles Within Wales



Source: (Welsh Government, 2015) Contains Ordnance Survey Data © Crown copyright and database right 2015.

Figure 4.16: Index of Health Deprivation, Quintiles Within Study Area



Source: (Welsh Government, 2015) Contains Ordnance Survey Data © Crown copyright and database right 2015.

4.7 Health

Life Expectancy and Mortality

4.7.1 From the period 2012-2014, the life expectancy at birth for the whole of Wales was approximately 78.5 years for males and 82.3 for females (ONS, 2015). Life expectancy has been slowly increasing over the previous 5 year period, as illustrated in Table 4.1, increasing by 0.9 years for men and 0.6 years for women in total over the time period.

4.7.2 Of the three local authority areas, Monmouthshire has the third highest life expectancy for males in the whole of Wales at 80.7 years. Newport and Cardiff, however, remain slightly beneath the Wales average with a life expectancy of 78.2 years for men in Cardiff and 78.1 years in Newport. Similarly Monmouthshire has the highest female life expectancy out of the 22 local authorities in Wales at 84.1 years, compared with 82.9 years for Cardiff and 82.4 years for Newport. All three local authorities have female life expectancy above the Wales average, unlike the male life expectancy.

4.7.3 Mortality data for local authorities within Wales from 2014 (Health Solutions Wales, 2015) indicate that Newport has the highest age-standardised mortality of the three local authorities at 1,052 deaths per 100,000 population. Cardiff has a mortality rate of 1,011, similar to the Wales average of 1,017 deaths per 100,000. Monmouthshire has the lowest mortality with 846 deaths per 100,000 population.

4.7.4 Except where otherwise noted, all mortality and disease or hospital admission rates given in this and the following health subsections are for age-standardised populations.

Table 4.1: Life Expectancy and Mortality Data for Wales and the Local Authorities Within the Study Area

Life expectancy at birth					
Year	**2008-2010**	**2009-2011**	**2010-2012**	**2011-2013**	**2012-2014**
Wales - Male	77.6	78.0	78.2	78.3	78.5
Wales - Female	81.8	82.2	82.2	82.3	82.3
Newport - Male	76.9	77.7	77.9	78	78.1
Newport - Female	82.1	82.2	82.1	82.3	82.4
Monmouthshire - Male	80.4	80.5	80.1	79.9	80.7
Monmouthshire - Female	83.8	83.9	83.9	84.2	84.1
Cardiff - Male	77.8	78.2	78.2	78.2	78.2
Cardiff - Female	81.9	82.4	82.7	82.9	82.9
All-cause mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	1080	1035	1051	1060	1017
Newport	1095	1039	1106	1095	1052
Monmouthshire	933	886	907	890	846
Cardiff	1059	1010	1033	1059	1011

Sources: (ONS, 2015; Health Solutions Wales, 2015)

4.7.5 Cause-specific mortality data that would allow the natural cause mortality rate to be calculated (i.e. subtracting external causes of death) is only available from the StatsWales and Health Maps Wales sources up to 2011 (with the exception of certain selected diseases, shown in the following sections). The average ratio of natural-cause to all-cause mortality from 2007–2011 for each area (shown in Table 4.2) has therefore been applied to adjust the all-cause mortality rate shown in Table 4.1 where necessary in the impact assessment calculations.

Table 4.2: Average Ratio of Natural-Cause to All-Cause Mortality, 2007–2011

Area	Ratio
Wales	0.962
Newport	0.971
Monmouthshire	0.967
Cardiff	0.959

Source: calculated from (StatsWales, n.d.)

Cancer

4.7.6 As illustrated in Table 4.3, during 2013 the age-standardised incidence of cancer (detection rate) in Wales stood at 291 incidences per 100,000 population. Newport had the highest rate of detection at 341 per 100,000, compared with 326 and 298 per 100,000 for Cardiff and Monmouthshire respectively. When analysing the age standardised death rate from all cancers for 2014, a similar picture can be seen: Cardiff has a death rate of 290 per 100,000, similar to the level for the whole of Wales at 289 deaths per 100,000. Monmouthshire has the lowest death rate at 237 per 100,000; however, Newport has the highest of the three local authorities with 320 deaths per 100,000 population (Health Solutions Wales, 2015). Trends in mortality rate from cancer over a five year period as illustrated in Table 4.3, indicates that cancer mortality rate has remained fairly constant between 2010 to 2014 for the whole of Wales and likewise for Cardiff, but has increased within Newport and decreased for Monmouthshire for the time period.

Table 4.3: Cancer Incidence and Mortality Data for Wales and the Local Authorities Within the Study Area

Cancer incidence per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	290	288	284	291	-
Newport	319	299	274	341	-
Monmouthshire	287	261	262	298	-
Cardiff	324	327	320	326	-
Mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	290	291	289	286	289
Newport	299	307	307	304	320
Monmouthshire	267	244	265	212	237
Cardiff	292	284	289	291	290

Source: (Health Solutions Wales, 2015)

Respiratory Disease

4.7.7 Analysis of emergency hospital admissions for respiratory disease between 2014/15 (Health Solutions Wales, 2015), as shown in Table 4.4, illustrates that

Monmouthshire and Cardiff have admission rates lower than the Wales average of 1,579 per 100,000. Newport had the greatest emergency admission rates of the local authorities with 1,678, compared with 1,219 admissions for Monmouthshire and 1,504for Cardiff. These findings differ compared with the age-standardised death rate for all respiratory diseases, also given in Table 4.4, with Cardiff having the greatest mortality at 167 deaths per 100,000, greater than the Wales average of 144 deaths. Monmouthshire recorded levels far below the average at 116 deaths, whilst Newport was also slightly below the average at 141 deaths per 100,000 population.

Table 4.4: Respiratory Disease Data for Wales and the Local Authorities Within the Study Area

Respiratory disease emergency admissions per 100,000 population					
Year	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**
Wales	1508	1432	1518	1480	1579
Newport	1548	1462	1538	1602	1678
Monmouthshire	1347	1075	1121	1172	1219
Cardiff	1403	1279	1409	1520	1504
Respiratory disease mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	152	152	154	165	144
Newport	161	146	170	180	141
Monmouthshire	114	107	124	126	116
Cardiff	153	166	175	179	167

Source: (Health Solutions Wales, 2015)

Cardiovascular Disease

4.7.8 Links have been established between cardiovascular disease and poor health behaviour, lifestyle choice and relative socio-economic deprivation, hence variation can be seen within incidence and mortality for the different cardiovascular diseases within the local authorities analysed. Comparison of the mortality rates and hospital admissions rates for all cardiovascular disease (shown in Table 4.5) (Health Solutions Wales, 2015) reveal that for 2014, Monmouthshire had the lowest number of deaths due to cardiovascular disease at 243 per 100,000 population, but also a lower than average hospital admission rate at 1,690, compared with the Wales average of 285 deaths and 1,807 admissions per 100,000 population. Cardiff likewise had lower than average rates with 1,455 admissions and 247 deaths per 100,000 population. Newport however, had 1,881 hospital admissions in 2014 and a mortality rate of 300 deaths, greater than the average for Wales. When comparing the changes in cardiovascular disease mortality and emergency hospital admissions over time (Table 4.5) it is clear that for Wales, as well as the three local authorities, both mortality rates and hospital admission levels have been decreasing gradually over the five year period analysed, however the rate of change experienced varies between the local authorities.

4.7.9 Age-standardised death rates from acute myocardial infarction (AMI) during 2014 vary between the three local authorities with death rates of 33, 50 and 54 deaths per 100,000 for Cardiff, Monmouthshire and Newport respectively, as shown in Table 4.5. The average for Wales during 2014 was 44 deaths per 100,000 population. A similar trend can be seen for coronary heart disease deaths rates, with death rates per 100,000 of 102 for Cardiff, 108 for Monmouthshire and 141 for Newport, compared to the Wales average of 126 deaths per 100,000 population.

4.7.10 A different picture is presented for deaths rates from stroke, also shown in Table 4.5, which highlights Newport as the area with the greatest death rates at 83 per 100,000, greater than the average for Wales of 75 deaths per 100,000. Cardiff and Monmouthshire have death rates lower than the Wales average at 69 and 55 deaths, respectively (Health Solutions Wales, 2015).

4.7.11 The age-standardised proportion of patients with hypertension on GP practice registers during 2012 varies significantly between the three authorities. Approximately 11.5% of Newport's population has hypertension, slightly more than the Wales average of 11.1%. Monmouthshire conversely has a significantly lower proportion of the population, 9.6%, and Cardiff displays no significant difference from the Wales average, with 11.0% of the population suffering from the condition (Public Health Wales Observatory , 2013).

Table 4.5: Cardiovascular and Cerebrovascular Disease Data for Wales and the Local Authorities Within the Study Area

All cardiovascular disease hospital admissions per 100,000 population					
Year	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**
Wales	2015	1933	1877	1890	1807
Newport	2047	1910	1801	1793	1881
Monmouthshire	1783	1767	1709	1622	1690
Cardiff	1715	1526	1706	1637	1455
All cardiovascular disease mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	359	311	310	308	285
Newport	391	304	325	311	300
Monmouthshire	329	264	265	294	243
Cardiff	313	278	278	270	247
Acute myocardial infarction hospital admissions per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	145	135	147	151	133
Newport	174	147	137	116	117
Monmouthshire	139	117	119	88	94
Cardiff	99	77	100	113	109
Acute myocardial infarction mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	56	53	47	47	44
Newport	77	47	53	52	54
Monmouthshire	43	49	37	46	50
Cardiff	39	58	46	41	33

Coronary heart disease (ischaemic heart disease) hospital admissions per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	605	570	544	523	478
Newport	725	624	529	506	477
Monmouthshire	556	558	476	380	448
Cardiff	485	430	462	460	397
Coronary heart disease (ischaemic heart disease) mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	164	149	144	144	126
Newport	185	139	155	156	141
Monmouthshire	122	141	113	136	108
Cardiff	130	116	118	123	102
Stroke hospital admissions per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	223	199	197	206	197
Newport	192	147	168	161	156
Monmouthshire	154	132	143	145	156
Cardiff	180	150	210	219	211
Stroke mortality rate per 100,000 population					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	98	77	77	76	75
Newport	96	79	85	89	83
Monmouthshire	89	53	62	72	55
Cardiff	95	85	81	72	69
Proportion of patients with hypertension					
Year	**2010**	**2011**	**2012**	**2013**	**2014**
Wales	-	-	11.1%	-	-
Newport	-	-	11.5%	-	-
Monmouthshire	-	-	9.6%	-	-
Cardiff	-	-	11.0%	-	-
Hypertension data available for 2012 only					

Sources: (Health Solutions Wales, 2015; Public Health Wales Observatory , 2013)

Access to Health Services

4.7.12 The Aneurin Bevan Health Board provides health care for the local authorities surrounding the proposed development including Newport, Monmouthshire Caerphilly and Torfaen. The area of Cardiff adjacent to the proposed development is served by the Cardiff and Vale University Health Board.

4.7.13 During 2012 there were 595,684 and 498,005 registered patients within the Aneurin Bevan and the Cardiff and Vale University Health Boards (Welsh Government, 2013). During that period there were approximately 6.5 GPs per 10,000 population for both boards (StatsWales, 2015). Aneurin Bevan has a total of two district general and two local general hospitals, as well as a number community and mental health hospitals (Aneurin Bevan University Health Board, 2014), whilst the Cardiff and Vale Health Board is served by eight major community, general and mental health hospitals (Cardiff and Vale University Health Board, 2015).

4.7.14 The Scheme does not directly impact upon health care services, however does potentially have implications for access, accessibility and response time to facilities.

4.8 Transport and Travel

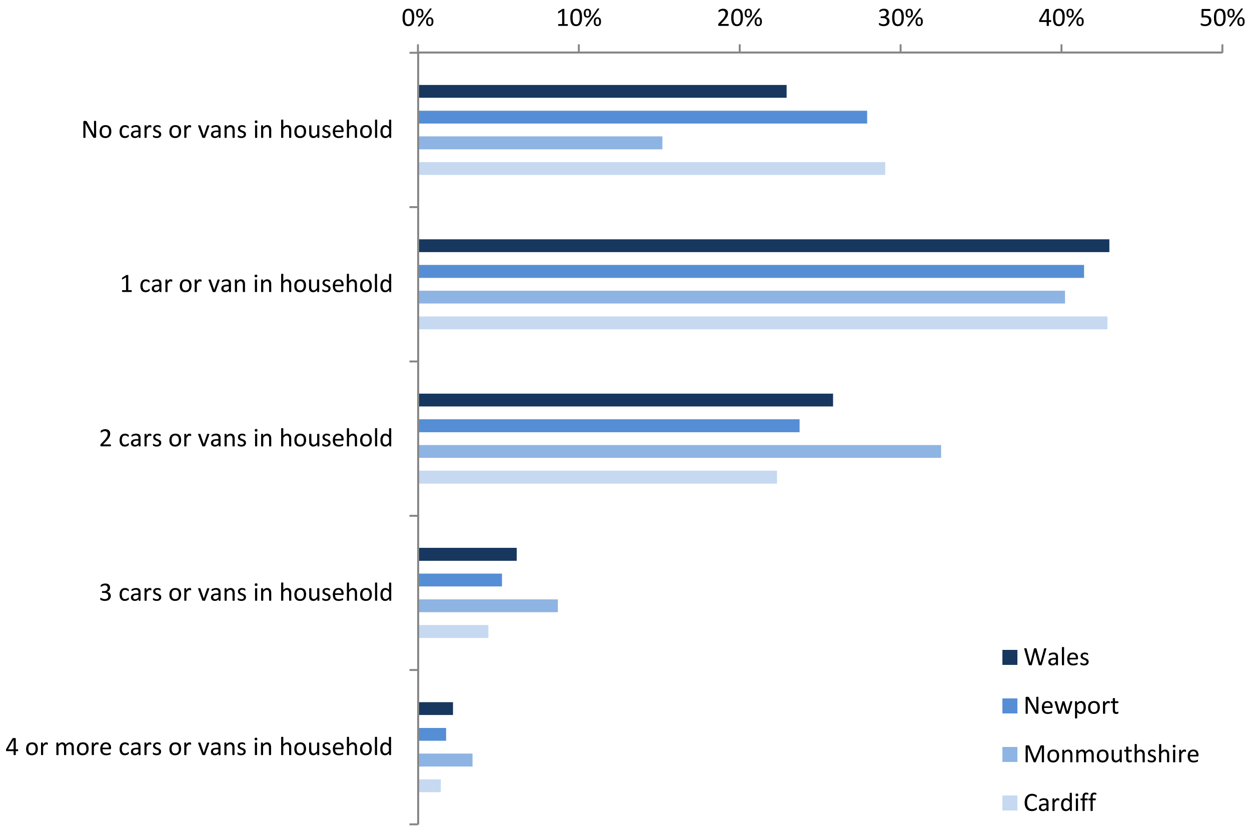
4.8.1 Data from the 2011 census regarding car ownership and method of travel to work (for those in employment) can indicate the predominant mode of transport for the local authorities within the study area.

4.8.2 Figure 4.17 illustrates that fewer residents in Newport and Cardiff own a car within their household than compared with Monmouthshire and the Wales average: approximately 28-29% of households in these two authorities have no car, compared to only 15% for Monmouthshire and 23% in Wales. This may be a reflection of the economic differences between the areas, with Monmouthshire generally the more affluent area, and the fact that Monmouthshire is more rural.

4.8.3 The greater number of households in Newport and Cardiff with no access to a privately owned car is mirrored in the method of transport that residents use to get to work as shown in Figure 4.18. A greater proportion of the populations in these two areas travel to work by alternate means, either public transport, as a passenger or on foot, compared to Monmouthshire. The greater proportion of people using public transport or alternative means of transport for Newport and Cardiff could also result from a limited demand for private transport in these areas, especially for city centre areas, where there may be adequate public transport available. However, in light of the economic deprivation and employment levels discussed above, it also seems likely that the modes of travel and car ownership reflect the limited financial means for certain areas within Newport and Cardiff, which may act as a barrier to employment and services.

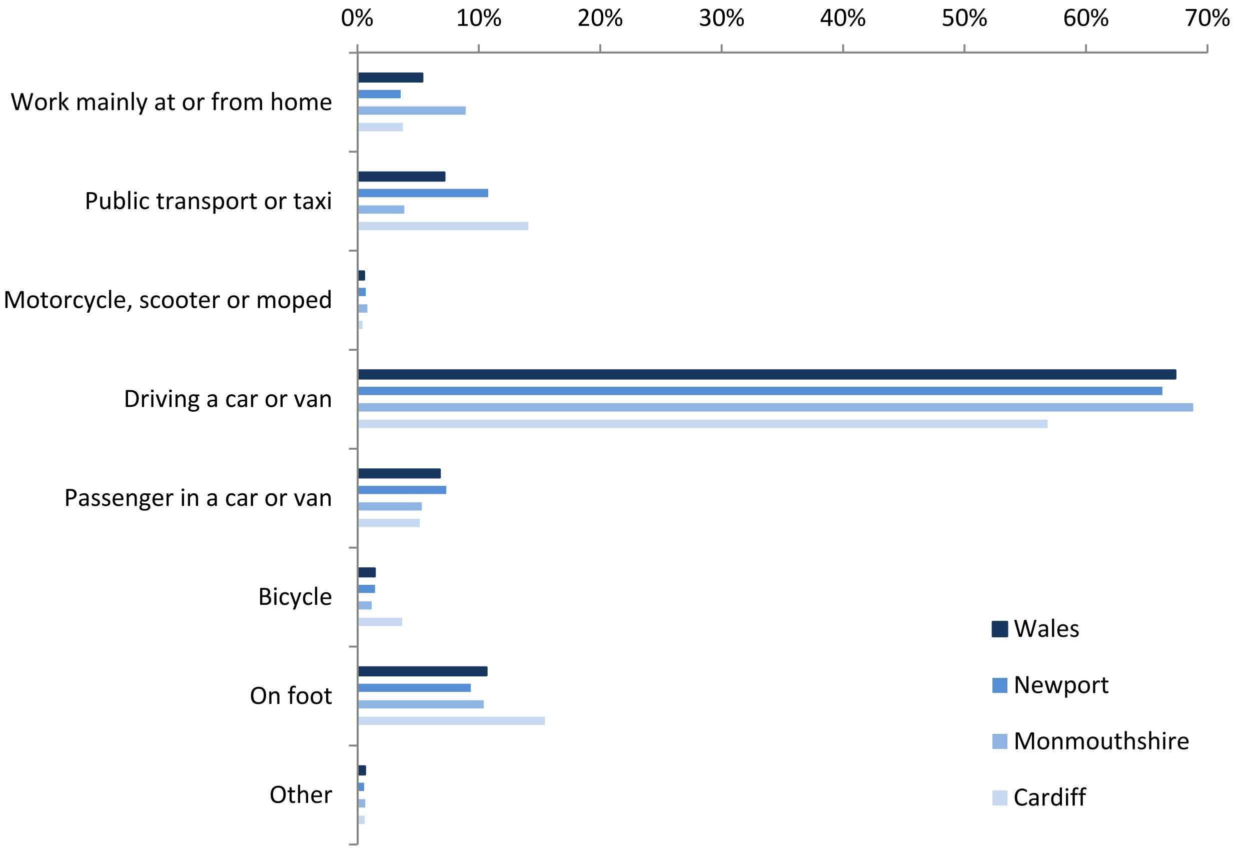
4.8.4 Car travel remains the primary method of travel for work for all three local authorities, with over 55% of the population using in this method, highlighting the importance of the road network for these communities.

Figure 4.17: Car Ownership, Cardiff, Newport and Monmouthshire Compared with Wales



Source: adapted from (ONS, 2013)

Figure 4.18: Method of Travel to Work, Cardiff, Newport and Monmouthshire Compared with Wales



Source: adapted from (ONS, 2013)

4.9 Health Behaviour and Lifestyle

4.9.1 Poor health behaviour can have a wide ranging influence on overall health and well-being. Elements such as diet and the level of physical activity a person undertakes, and also the degree of risk-taking behaviour, alcohol consumption and smoking, are directly correlated with a range of adverse health outcomes.

Alcohol

4.9.2 Alcohol consumption is key health concern, due to it being a major cause of death and illness in Wales, being the attributed cause of around 4.9% of all deaths in Wales (Public Health Wales , 2014). In Newport and Monmouthshire, around 47% and 45% of adults consume alcohol above the guideline amounts, similar to the average for Wales at 45%. However, hospital admission rates vary greatly with Newport displaying hospital admission rates during 2014 to 2015 greater than the average with 1,953 per 100,000 compared to 1,739 per 100,000 population in Wales. Monmouthshire and Cardiff conversely, have far fewer hospital admissions attributed to alcohol consumption with 1,412 and 1,454 admissions per 100,000 people, respectively (Aneurin Bevan Health Board, 2011).

4.9.3 Alcohol-related mortality rates (Health Solutions Wales, 2015) show further disparity between the local authorities. Between 2009-2011 Monmouthshire had an alcohol-related mortality rate of 10 deaths per 100,000 population, less than the Wales average of 14 deaths. Newport and Cardiff had mortality rates greater than the average at 15 and 16 alcohol-related deaths, respectively.

4.9.4 Public Health Wales (2014) states that mortality and hospital admissions associated with alcohol are strongly related to deprivation levels, where rates in the most deprived areas in Wales are significantly higher than those of the least deprived areas. Furthermore there has been no improvement in the disparity in mortality rates between the most and least deprived areas over time.

Smoking

4.9.5 The Welsh Health Survey (Public Health Wales, 2013) found that between 2013-2014, 21% of Welsh people identified themselves as current smokers. Similar levels were documented for the three local authorities, with 19% of the population of Monmouthshire and 22% of the populations of Newport and Cardiff classed as smokers.

4.9.6 In terms of smoking-attributable mortality, there is greater disparity between the areas studied. From 2008-2010, Cardiff had an age-standardised smoking-attributable mortality rate equivalent to that of the average for Wales at 227 deaths per 100,000. Newport on the other hand had a greater number of deaths at 244 and Monmouthshire fewer than the average with 158 per 100,000 population (Public Health Wales Observatory , 2012).

4.9.7 There is an association between higher rates of smoking and factors such as age, socio-economic group, deprivation, housing and education. Smoking rates tend to be greatest in the most deprived areas of Wales and caused around one third of the inequality in mortality between the least and most deprived areas (Public Health Wales Observatory, 2015). Rates of deaths from smoking are falling in part due to increasing restrictions on smoking; however, socio-economic equalities are increasing due to faster reductions in the least deprived areas, compared to the most deprived.

4.9.8 Smoking causes approximately 27,700 hospital admissions each year in Wales, presenting a significant burden on Wales's health services (*ibid*). Smoking therefore represents a key health concern and challenge in Wales as well as the areas through which the new section of motorway would pass. Although there is little opportunity for the Scheme to directly influence smoking, there is potential for an indirect influence through changes to other associated socio-economic factors.

Obesity and Physical Activity

4.9.9 Being overweight (body mass index 25–30) or obese (body mass index >30) increases the risk of a range of adverse health outcomes including cardiovascular disease, diabetes, and hypertension.

4.9.10 The Welsh Health Survey (Public Health Wales, 2013) has also collected data regarding levels of physical activity and obesity throughout Wales. Data from 2013-2014 indicate that in Wales overall, 58% of people are classed as overweight or obese, with only 30% of the population meeting the recommended exercise guidelines (a minimum of 30 minutes, five or more times a week) and 33% of the population eating the recommended five or more portions of fruit and vegetables per day.

4.9.11 Of the three local authorities, Newport has the more unhealthy profile, with 60% of the population overweight or obese, greater than the Wales average, and 31% of the population undertaking regular physical activity and consuming the recommended five portions of fruit and vegetables per day. Monmouthshire, however, has a healthier profile when compared to Newport and the Wales average, with 52% of the population overweight or obese, 33% meeting the physical activity and 36% eating the recommended 'five-a-day'. Cardiff maintains a profile similar to Wales for the indicators measured, with 28% and 34% meeting the physical activity and 'five-a-day' recommended guidelines and significantly fewer levels of people overweight or obese at 51% of the population.

Crime and Antisocial Behaviour

4.9.12 The police forces covering the areas where the Scheme is proposed are the Gwent constabulary for Newport and Monmouthshire, and the South Wales constabulary for Cardiff. Statistics from Her Majesty's Inspector of Constabulary's (HMIC) crime and policing comparator (HMIC, 2015) show that there were 64 and 68 crimes per 1,000 people for Gwent and South Wales respectively, between 2013-2014, which were both above the average for England and Wales (61 crimes per 1,000 population).

4.9.13 Particularly significant offences in comparison to the average for England and Wales were anti-social behaviour crimes and criminal damage for Gwent, and victim-based crime for South Wales. Frequent opportunistic and nuisance crime can be indicative of poor natural community surveillance (e.g. lacking frequent pedestrian traffic). Crime and the perception of high crime rates can have an influence on mental health and wellbeing.

4.10 Community and Health Profile Summary

4.10.1 The Scheme affects three local planning authorities, Newport, Monmouthshire and Cardiff, which despite being neighbouring geographic authorities, display varying community profiles in terms of demographics, health, employment, education and equality of the population.

4.10.2 Newport has an age structure similar to that of Wales, but for socio-economic indicators tends to fare slightly worse than the average for Wales, with a greater proportion of residents unemployed, claiming JSA or with lower educational achievement. Levels of multiple and health deprivation vary across Newport, with the most deprived areas tending to be located in the central urban areas within the authority boundary, between the existing M4 and proposed new section of motorway. Health indicators such as life expectancy and mortality generally tend to be worse than the average for Wales. Furthermore mortality from specific illnesses most relevant to noise and air quality (respiratory and cardiovascular disease) is greater than average. In terms of health behaviour, Newport again has indicator levels similar to or slightly worse than the Wales average. These communities are likely to be sensitive to socio-economic health pathways, where improvements in education, income, employment and lifestyle present significant opportunities to address local circumstance and reduce existing inequality.

4.10.3 In contrast to this, Monmouthshire has more of an aging population than the Wales average, with a greater proportion of the population in the 55+ age bracket, which is reflected by the proportion of retired people relative to the other local authorities and the Wales average. Monmouthshire tends to display better than average socio-economic indicators, including a greater proportion of people with the highest level of educational achievement, as well as lower school leaver NEET, unemployment over time and JSA claimants. Deprivation levels likewise remain lower compared with the other regions of the study area, with much of the geographic area consisting of the least deprived LSOAs. Life expectancy, mortality and morbidity levels were also consistently better than the Wales average and Monmouthshire had the healthiest lifestyle profile of the local authorities analysed. These indicators suggest that the area may generally be less sensitive and may have greater resilience to environmental health pathways; however suitable consideration must be given to the aging population of Monmouthshire to ensure that the development does not adversely impact on the elderly community.

4.10.4 Cardiff's age structure varies significantly from the Wales average, having a large highly youthful population with a greater proportion of young adults, and relatively fewer older aged residents, which is due in part to the proportion of students resident. Socio-economic indicators tend to show Cardiff to be worse than the average in terms of unemployment, out-of-work benefits and school leaver NEET, but better in terms of educational attainment with a large proportion of residents with the highest level of qualifications and comparatively fewer than average with no qualifications. Deprivation levels in the study area vary; however, some of the more deprived areas can be found adjacent to the existing A48(M). Health and lifestyle indicators appear more varied, but generally mortality rates from specific cardiovascular disease are lower than the Wales average, with cancer mortality and age standardised death rate comparable to the average.

4.10.5 Therefore in terms of equality, the main sensitive groups for the proposed development are the socio-economically deprived, which is particularly the case for Newport, as well as the elderly and infirm. These groups may have a greater sensitivity or lower resilience to changes in environmental health pathways and temporary disruption that the Scheme may cause. In terms of ethnic and religious diversity, Monmouthshire has fairly low diversity, whereas Cardiff and Newport have relatively high ethnic diversity levels in comparison to the average for Wales. Therefore, there is potential for the Scheme to impact disproportionately on minority ethnic groups, if ethnic groups tend to be located areas to be impacted by changes to the existing route or implementation of the new section of motorway.

5 Health Pathways and Evidence Base

5.1 Introduction

5.1.1 Road traffic is associated with a number of environmental and social effects that have the potential to be health impact pathways. Direct impacts are principally people's exposure to air pollutant emissions and noise from vehicles, and collision danger. Of these, collision danger is by far the most significant in terms of mortality and injury worldwide[2] (Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation, 2014), but there is strong evidence of a significant public health burden in terms of illness and premature death associated with air pollution generally (COMEAP, 2009; Cohen, et al., 2005; IHME, 2013; WHO, 2013) and from road traffic specifically (Krzyzanowski, et al., 2005; HEI Panel on the Effects of Traffic-Related Air Pollution, 2010; Sundvor, et al., 2012).

5.1.2 Evidence for health impacts from environmental noise has also been established, including sleep disturbance, cognitive impairment in children, hypertension and stroke, and cardiovascular disease (particularly ischaemic heart disease) (Fritschi, et al., 2011). Sleep disturbance in turn is associated with obesity, diabetes, cardiovascular disease and all-cause mortality, and is "*usually considered the most severe non-auditory effect of environmental noise exposure*" (Münzel, et al., 2014) (page 831, citing (Fritschi, et al., 2011) and (Muzet, 2007); see also (Hume, et al., 2012)), a view re-emphasised in almost the same terms in a recent 2014 summary of noise effects on health (Basner, et al., 2014).

5.1.3 Sufficient evidence of heart disease risk is available to allow quantification of heart disease risk from road noise exposure (Fritschi, et al., 2011; Münzel, et al., 2014; Babisch, 2008), albeit arguably with a lower level of confidence than with the air quality health risk evidence base. Other potential health outcomes in susceptible groups (children and the elderly), such as birth weight, cognitive performance, diabetes and cancer, are the subject of the ongoing 'QUIET' research programme in Europe, using data from the population of Denmark. The QUIET programme summary notes that "*noise effects on* [diseases] *other than the cardiovascular diseases are virtually unexplored*" (Sørensen, 2014) (page 1).

5.1.4 Separating the effects of noise and air pollution exposure is difficult, as both tend to be linked to road traffic in urban areas, but recent research on populations in two Danish cities (as part of the QUIET project) suggests that stroke risk is increased by combined exposure to noise and air pollutants from road traffic, possibly with the stress effect of noise exposure creating stroke risk at a relatively low level of air pollution exposure (Sørensen, et al., 2014). A recent study of mortality and hospital disease outcomes in London found increased risks associated with noise exposure after adjustment for $PM_{2.5}$ exposure among other potential confounding factors (Halonen, et al., 2015).

5.1.5 There is also a range of potential indirect road traffic health pathways, such as community severance and barriers established by busy roads (Kavanagh, et al., 2005; Buroni & Jones, 2011); lifestyle effects of vehicle-oriented urban design and service provision, and the disincentive to active, healthier transport modes (Sustrans, 2007; Dora, et al., 2011); inequalities in the distribution of exposure to

[2] Although when considering specifically mortality, the burden from air pollutant exposure in total, and from road traffic, may be significantly greater than that from road traffic accidents in developed countries (Dora & Phillips, 2000).

adverse environmental effects of traffic and access to socio-economic benefits of road transport (Albrecht, et al., 2011); and the contribution of fossil-fuelled vehicles to climate change with associated long-term population health risks (WHO, 2003; Confalionieri, et al., 2007; Woodward, et al., 2014).

5.1.6 These other health pathways are considered qualitatively in the assessment of impacts (Section 6). However, the primary health pathways that this study considers quantitatively are population exposure to traffic-generated air pollutants and noise, the health evidence base for which domains is explored further in the following sections.

5.1.7 Socio-economic status and deprivation are strong determinants of health (Wilkinson & Marmot, 2003; Marmot, 2005; CSDH, 2008; Commission for Strategic Review of Health Inequalities in England Post-2010, 2010), so the distribution of health pathway changes associated with the Scheme, and whether these may fall disproportionately to groups with better or worse existing health, resilience to health impacts, and higher or lower socio-economic status, is also significant to the net health outcome and any inequalities in health impacts that this may conceal.

5.2 Air Pollutants and Health

Overview

5.2.1 Human activities in the realms of resource extraction and processing, industrial production, waste management, energy generation and transport cause the release of a diverse range of outdoor air pollutants with potential adverse environmental and health impacts. Adverse health outcomes may range from immediate death due to exposure to toxic material in high concentrations (e.g. in an industrial accident), to more subtle increases in mortality rate across large populations exposed to lower pollutant concentrations (e.g. due to increased risk of long-term diseases such as cancer), to disease effects triggered by acute air pollutant exposure (e.g. asthma attack), or to increased burdens of long-term disease (e.g. reduced lung function or bronchitis).

5.2.2 Pollutants of interest can include oxides of nitrogen, sulphur dioxide, particulate matter, volatile organic hydrocarbons (VOCs), ozone, polycyclic aromatic hydrocarbons (PAHs), heavy metals such as cadmium or lead, dioxins and furans, and asphyxiant gases such as carbon monoxide.

5.2.3 Ambient outdoor air pollution to which populations are exposed on a day-to-day basis is associated both with long-term burdens of disease across the whole population, and with short-term changes in mortality due to acute exposure in vulnerable populations such as elderly people or those already suffering from cardiovascular or respiratory disease.

5.2.4 This is an area of active scientific research (see, for example, recent reviews of cardiovascular disease and air pollutant exposure evidence (Shah, et al., 2013; Lee, et al., 2014)), but given the strong link to public policy, is also characterised by frequent reviews of the evidence base, including summaries published by health protection bodies that are designed to bring the evidence base together for use by those applying research to policy formulation or decisions, as in the case of this study.

5.2.5 Of particular use is the World Health Organisation (WHO)'s Review of Evidence on Health Aspects of Air Pollution (REVIHAAP) (WHO, 2013). This is a comprehensive summary of the air pollution and health evidence base undertaken by WHO on behalf of the European Union, published in 2013, and is structured around answering the key questions that policy makers have regarding the state of scientific knowledge when seeking to devise evidence-based health protection policies. It is therefore very well-suited to underpin this HIA study, and the air pollutant health evidence summary given below is largely drawn from the evidence brought together in the REVIHAAP publication, save where otherwise referenced. Other useful summaries of the evidence base are found in the US Environmental Protection Agency (EPA) Integrated Science Assessment documents (EPA, 2009; EPA, 2015), and in the UK in the work of the Committee on the Medical Effects of Air Pollutants (COMEAP), with the latter discussed in in the guidance and methodology section (2) above.

Air Pollutants from Traffic

5.2.6 A critical synthesis of research in 2010 (HEI Panel on the Effects of Traffic-Related Air Pollution, 2010) concluded that exposure to air pollutants specifically from road traffic sources is likely to be associated with all-cause mortality, cardiovascular disease incidence and mortality, and reduced lung function, albeit with weaker evidence (due to fewer and smaller studies) than the wider air pollution health evidence base. There is good evidence for exacerbation of asthma symptoms in children, and some evidence of exacerbation of other respiratory disease symptoms in adults and children and the incidence of asthma in children.

5.2.7 WHO's earlier 2005 review of the health effects of transport-related air pollution (Krzyzanowski, et al., 2005) concluded that health effects include increased cardiopulmonary mortality risk and respiratory morbidity risk. It noted greater incidence of respiratory disease symptoms, exacerbation of asthmatics' allergic reactions, increased risk of myocardial infarction, and some evidence for adverse outcomes in pregnancy. It included an important reminder that those with lower health resilience – children, elderly people, and those already suffering from chronic disease – are more susceptible than the general population to health effects from traffic air pollutants.

5.2.8 The International Agency for Research on Cancer (IARC) defines diesel engine exhaust as carcinogenic to humans, based on known causation of lung cancer and possible causation of urinary bladder cancer (IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, 2013). The main epidemiological data are drawn from occupational exposure studies. Gasoline (petrol) engine exhaust is classified by IARC as possibly carcinogenic, as there is inadequate evidence to form a firmer conclusion.

5.2.9 Overall, the data from WHO Global Burden of Disease 2010 study suggest that road transport makes a contribution to global health burdens (as expressed in Disability Adjusted Life Years [DALYs] lost) through its contribution to disease incidence, but this is quite a small fraction of the health risks due to ambient PM from all sources, at least on a global scale, and the health risks from road transport are dominated by road traffic injuries (Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation, 2014).

5.2.10 The main traffic-source air pollutants are summarised below[3]. Research into health effects typically considers pollutants individually or in small groupings; however, population exposure is to a mix of these pollutants (and those from other sources), and the total burden of disease and mortality is a complex picture of pollutant exposure and susceptibility. Metrics for evaluating and quantifying the health outcomes from changes in pollutant exposure were discussed in Section 2.

Particulate Matter

5.2.11 Particulate matter refers to an aerosol of small solid particles and liquid droplets. It is commonly differentiated by size fraction as PM_{10}, $PM_{2.5}$ and $PM_{0.1}$ (coarse, fine and ultrafine particulate matter), where the subscript indicates mean aerodynamic diameter in microns. Dusts coarser than PM_{10} typically do not penetrate beyond the upper respiratory tract, whereas finer particles penetrate further into the lungs, although this is affected by breathing pattern (mouth or nose), among other factors (WHO, 2000; WHO, 2006).

5.2.12 Epidemiological studies have shown that long-term $PM_{2.5}$ exposure is associated with mortality even at low concentrations (below current WHO public exposure guidelines and the UK's Air Quality Standards and Objectives), and a number of studies link it to specific causes of death such as ischaemic heart disease. Short-term exposure to PM_{10} and $PM_{2.5}$ is linked to small changes in daily mortality and hospital admission rates for cardiovascular and respiratory diseases. These observed health outcomes are supported by the toxicology evidence base, which indicates that exposure to $PM_{2.5}$ is associated with a number of inflammation and stress effects on the heart. There is also some limited evidence of neurological effects and an association with diabetes.

5.2.13 In addition to the strong evidence that long- and short-term PM exposure is associated with health risks, there is also likely to be variation in vulnerability of sub-populations. There is consistent evidence from studies in the US and Europe that the risk of hospitalisation or mortality is substantially greater for older populations than younger (though specific age ranges varied across studies), and limited or suggestive evidence of a greater risk for women than men and for people with lower socio-economic status (Bell, et al., 2013). The exposure-response coefficients established for ‘old’ or ’young’ age groups could potentially be used in this study to modify general all-age coefficients, although this would add the uncertainty of applying these to age groups that are not exactly defined.

5.2.14 Of the traffic-source air pollutants considered, $PM_{2.5}$ has the strongest dose-response evidence base for mortality and disease incidence (WHO, 2013; EPA, 2009; Pope III, et al., 2002; Anderson, et al., 2012; Bell, 2012). However, evidence of an independent effect of NO_2 exposure has strengthened in recent years; this is discussed in the NO_2 section below.

5.2.15 PM is a catch-all term for number of different substances, with both anthropogenic and natural sources. In the study of air pollution, PM is categorised by size fraction and typically measured in terms of mass per unit volume in air, but for the smallest ‘ultrafine’ $PM_{0.1}$ fraction the particle mass is negligible and the number of particles may be more significant to health outcomes (HEI Review Panel on Ultrafine Particles, 2013).

[3] Note: as discussed in paragraph 5.2.5, this summary is drawn from the REVIHAAP review of evidence published in 2013, except where otherwise cited.

5.2.16 The actual mechanisms by which PM causes adverse effects on the body may be very different depending on both the size and nature of the particles in question. This is the subject of ongoing toxicological and epidemiological research, investigating potential causal mechanisms (see e.g. (Strak, et al., 2012), papers and research priorities in (WHO, 2007), and summarised in (EPA, 2009)) or testing for association of particular health effects with variance in PM speciation (e.g. (Bell, 2012; Atkinson, et al., 2015)). A recent COMEAP statement (COMEAP, 2015) concludes that the evidence remains mixed, and that the current approach to estimating health effects (based on total $PM_{2.5}$ concentration) remains appropriate.

5.2.17 The speciation (composition and chemical nature) of PM is of interest not only because it may determine the type and severity of health effect caused and the population that is vulnerable, but also because it is key to source apportionment of PM – that is, identifying the emissions sources that contribute to the total measured PM concentration, based on PM characteristics identified with particular sources. Road traffic PM is emitted not only in vehicle exhausts, but also generated by brake, clutch and tire wear and re-suspension of dust on roads. The COMEAP statement (*ibid*) notes that black carbon, in particular, is a good marker for road traffic emissions and could potentially form the basis of a traffic-specific air quality guideline.

5.2.18 In the case of this study, however, the air quality modelling provides PM emissions from changes in road vehicle flows directly, so it is not necessary to disentangle these from other PM sources in the data for this HIA.

Nitrogen Dioxide (NO_2)

5.2.19 The close correlation of NO_2 exposure with exposure to other traffic air pollutants makes distinguishing clear NO_2 effects in epidemiological studies difficult, but both long- and short-term high NO_2 exposure is associated with increased mortality risk, including after adjusting for PM (and sometimes other pollutant) exposure in short-term and some long-term studies. Associations between high short-term NO_2 exposure and respiratory disease and to a lesser extent cardiovascular disease hospital admissions are also found. Toxicological and chamber studies show that short-term exposure to high NO_2 concentrations causes respiratory inflammation.

5.2.20 NO_2 is also an important source for ground-level ozone formation (in a photochemical reaction), and of nitrate aerosol that comprises part of the $PM_{2.5}$ fraction.

5.2.21 The adverse health impacts of high short-term NO_2 exposure are relatively robustly shown in the evidence base, but it has previously been considered less clear whether long-term NO_2 exposure is a cause of increased health risk or is a proxy for other (less easily or commonly measured) air pollutants also released by traffic.

5.2.22 Evidence of long-term NO_2 exposure health impacts independent of PM exposure has strengthened in recent years, however: a 2015 review of the evidence by the US EPA (EPA, 2015) (building on the previous draft review from 2013 (EPA, 2013)) suggests that the strongest evidence concerning long-term NO_2 exposure is for respiratory effects (asthma incidence), and the WHO REVIHAAP review (WHO, 2013) likewise found support in the evidence for health effects attributable to long-term NO_2 exposure (albeit of lesser certainty than for short-term exposure), including epidemiological studies providing risk ratios for mortality and respiratory or cardiovascular morbidity.

5.2.23 An important meta-analysis study is that of Hoek *et al* (Hoek, et al., 2013), which provides the basis for the long-term NO_2 mortality metric recommended in WHO's HRAPIE guidance (WHO, 2013). Since the publication of that study, REVIHAAP and HRAPIE in 2013, a number of further studies have provided further evidence to indicate that NO_2 exposure is associated with increased mortality risk and various adverse health outcomes including asthma and diabetes. A meta-analysis by Faustini *et al* (Faustini, et al., 2014) indicating that NO_2 exposure has an effect on cardiovascular and respiratory mortality independently of other air pollutant exposure is of particular interest, providing exposure-response metrics without the 20 $\mu g.m^{-3}$ lower exposure threshold of Hoek *et al*.

5.2.24 COMEAP published a statement in 2015 (COMEAP, 2015) briefly reviewing recent evidence in this area and making further recommendations for research. It concludes (page 5) that:

"Evidence of associations of ambient concentrations of NO_2 with a range of effects on health has strengthened in recent years. These associations have been shown to be robust to adjustment for other pollutants including some particle metrics.

Although it is possible that, to some extent, NO_2 acts as a marker of the effects of other traffic-related pollutants, the epidemiological and mechanistic evidence now suggests that it would be sensible to regard NO_2 as causing some of the health impact found to be associated with it in epidemiological studies."

5.2.25 After further work during 2015, COMEAP published a second statement (COMEAP, 2015), reporting on recommendations made by the Committee in July 2015 regarding an appropriate exposure response co-efficient for mortality risk due to long-term NO_2 exposure (1.025 [95% CI 1.01–1.04] and 33% reduction to account for double-counting with $PM_{2.5}$) and concluding that as an interim measure while COMEAP undertakes a meta-analysis and develops a more detailed statement, this recommendation should be used in cost-benefit analysis. COMEAP's statement also included further discussion of double-counting likelihood if summing effects from both $PM_{2.5}$ and NO_2 exposure using risk co-efficients from single-pollutant models (potentially greater than the 33% overlap mentioned in the recommendation), various options for a lower exposure cut-off in assessments, and the necessary spatial scale of assessment to account for changes in NO_2 exposure close to sources such as roads.

5.2.26 The REVIHAAP report notes that the implementation of increasingly strict PM emission standards for vehicle exhausts and reduction in sulphur in fuel, together with the fact that NO_2 levels are not observed to be being reduced in real-world driving conditions, means that the ratio of NO_2 to PM emissions and hence exposure is rapidly increasing, citing a doubling in the ratio of NO_2 to particle number at a London roadside site over just two years as one example (page 108). COMEAP is still considering if and how it is appropriate to assess NO_2 health impacts, but does also note the importance of this issue for policy in the UK, given that the UK has been subject to legal proceedings for failing to meet European Limit Values for NO_2 and has recently been required to produce a plan for achieving the necessary NO_2 concentration reductions (Defra, 2015).

5.2.27 Although assessing long-term NO_2 exposure health impacts was not included as part of the 'core' analysis when following the standard UK practice approach under the Defra 'impact pathway' guidance (Defra, 2013), a recent update in September 2015 (Defra, 2015) following the COMEAP recommendation now recommends its inclusion, stating that "*the evidence linking NO_2 concentrations with mortality should* *not be ignored*" (page 4), albeit noting the significant uncertainties that remain. Conversely, in its most recent 2016 policy guidance on local air quality management (Defra, 2016), Defra acknowledges COMEAP's recommendation but makes clear that the Public Health Outcomes Framework air pollution indicator continues to be based only on $PM_{2.5}$ mortality.

5.2.28 In agreement with Defra's impact pathway guidance, we consider that it is important to assess NO_2 in this HIA, given the weight of evidence discussed above and availability of metrics from several studies indicating an independent effect of long-term NO_2 on mortality of similar magnitude to that of $PM_{2.5}$, while noting the importance of avoiding double-counting by using appropriate adjustments for combined $PM_{2.5}$ and NO_2 exposure.

5.2.29 Indeed, the potential importance of not overlooking NO_2 exposure in the core analysis is highlighted by the recent HIA of London's proposed ultra-low emissions zone (ULEZ) (Jacobs in association with Ben Cave Associates and Ricardo-AEA, 2014), which predicted relatively modest health benefits from implementation of the ULEZ due to change in PM_{10} and $PM_{2.5}$ exposure in its core analysis (a reduction in 123 life years lost and 4 hospital admissions avoided, relative to the base case in 2020), but a more substantial health benefit of a reduction of 4,123 life years lost when considering change in NO_2 exposure as a sensitivity analysis.

5.2.30 Similarly, a study published in 2015 by King's College London on behalf of the Greater London Authority and Transport for London (Walton, et al., 2015) provided a new estimate of the mortality burden of long-term NO_2 exposure alongside $PM_{2.5}$ exposure (assuming a 30% overlap in effects) in London, finding a greater impact from NO_2 exposure (88,113 life-years lost, equivalent to 5,879 deaths at typical ages) than $PM_{2.5}$ exposure (52,630 life-years lost, equivalent to 3,537 deaths at typical ages). This study also provided discussion and justification for not necessarily applying the WHO HRAPIE NO_2 CRF recommended 20 $\mu g.m^{-3}$ lower exposure threshold as a cut-off for health outcomes when undertaking the analysis (see Annex 7.1).

Ozone (O_3) and Sulphur Dioxide (SO_2)

5.2.31 There is well-established evidence both from epidemiological and toxicology studies of the adverse health impacts of short-term ozone exposure, in terms of mortality and hospital admissions rates for respiratory and cardiovascular diseases.

5.2.32 Recent epidemiological studies also suggest a link between long-term ozone exposure and mortality risk and asthma incidence in children; there is also limited evidence of association with other respiratory disease and cardiovascular disease admissions, and pre-term birth, and (from the toxicology evidence base), impaired cognitive function in populations experiencing ozone exposure.

5.2.33 The importance of sunlight availability (UV) and NO_x to the photochemical process of ground-level ozone generation complicates separating the effects of ozone exposure from temperature and other air pollutant exposure as confounding factors.

5.2.34 The evidence for SO_2 exposure and adverse health outcomes indicates that high SO_2 concentrations experienced even for a short (<1 hour) period can affect lung function and cause respiratory symptoms for people with asthma. There is evidence for increased cardiac disease and mortality risk for short-term high daily SO_2 exposure. Overall the evidence for health risk from SO_2 exposure at typical urban ambient air concentrations is less clear than for the other pollutants discussed, although assessment of short-term exposure health effects is recommended in the Defra impact guidance. However, road traffic is not a significant source of SO_2 emissions.

5.2.35 Changes in SO_2 and ozone concentrations have not been modelled as part of the EIA, and therefore cannot be assessed in this HIA.

5.3 Noise and Health

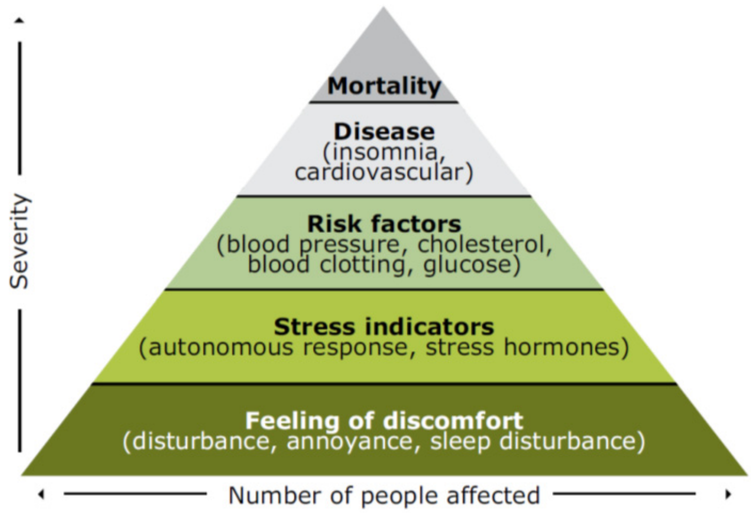
Overview

5.3.1 Noise may be defined as 'sound that is undesired by the recipient' and as with air pollution, is generated by many human activities including most forms of transport. Unlike air pollution, which can be measured as mass or concentration of specified chemical compounds, what constitutes 'noise' is dependent on the context of the receiving environment and the character of the sound. This is discussed further in Chapter 13: Noise and Vibration and its supporting appendices in the ES.

5.3.2 Noise as discussed here is environmental noise (i.e. unwanted or harmful outdoor sound, as defined in the Environmental Noise Directive (Directive 2002/49/EC of the European Parliament and of the Council relating to the assessment and management of environmental noise., 2002)), as opposed to workplace noise, and likewise the health impacts discussed are those other than direct auditory damage (as environmental noise is below the threshold for such damage).

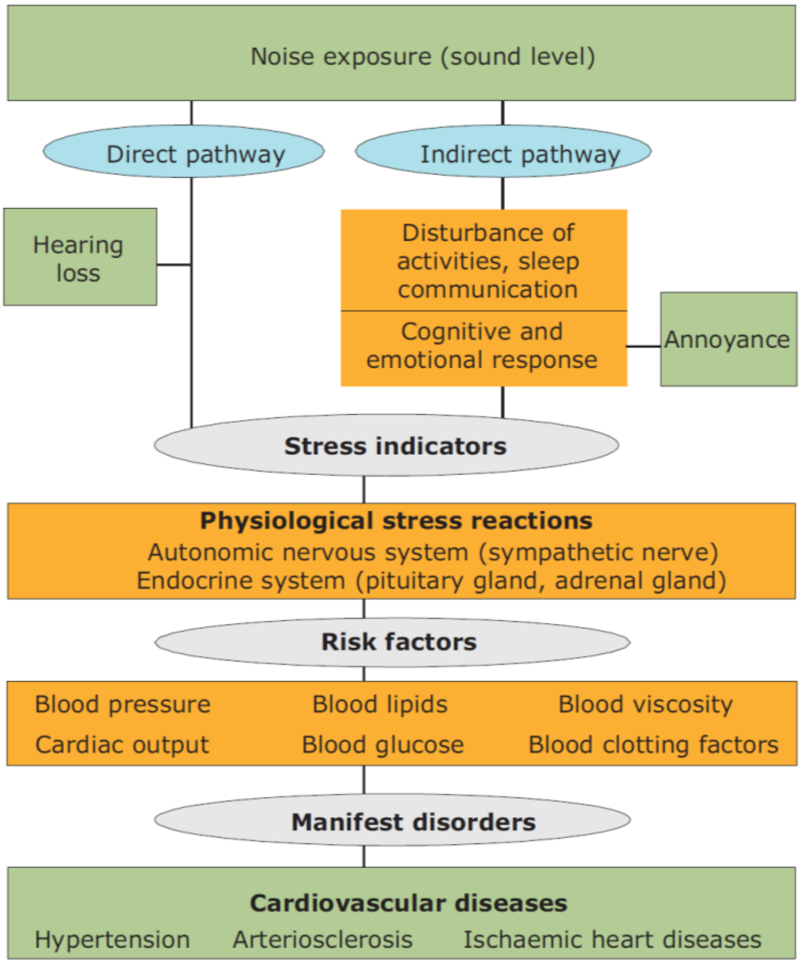
5.3.3 The non-auditory effects of noise, as summarised above, can include annoyance or sleep disturbance, in turn with potential to cause stress and health risk factors such as increased blood pressure, resulting in health outcomes such as cardiovascular disease. Figure 5.1 and Figure 5.2 illustrate these pathways, albeit noting that the 'direct' pathway (hearing loss) is not relevant in this case. This also illustrates the fact that adverse health outcomes (disease or mortality) would affect only a small proportion of those experiencing noise.

Figure 5.1: Summary of Noise Health Effects



Source: (Nugent, et al., 2014), from (Babisch, 2002)

Figure 5.2: Noise Health Pathways



Source: (Expert Panel on Noise, 2010), from (Babisch, 2002)

5.3.4 Perceptible vibration (e.g. from construction activities) also has the theoretical potential to cause annoyance or sleep disturbance and hence adverse health outcomes in the same way as airborne noise; however, the health evidence base regarding vibration is focused upon occupational health and safety (e.g. workers using power tools) and on the use of vibration in medical treatments.

5.3.5 Some noise health research and HIAs of environmental noise exposure take noise from all sources into account as a single exposure metric; however, as discussed above, the specific characteristics of noise (e.g. impulsivity, tonality) and people's perceptions of its source, not just the absolute noise levels over a given averaging period, affect the perceived or actual impact, and hence factors such as annoyance or sleep disturbance. Of transport-related noise, aircraft noise has been studied in particular (see, for example, (Jones & Rhodes, 2013; Clark, 2015; Hansell, et al., 2013) and other evidence being produced in the ongoing debate regarding the impacts of a third runway at Heathrow). However, it is not necessarily appropriate to apply the aircraft noise health evidence base to road traffic noise, and road-traffic-specific evidence is preferable where available.

Noise from Road Traffic

5.3.6 As discussed in the introduction to this section, above, the main non-auditory effects of road noise that have been studied are annoyance, sleep disturbance, cardiovascular disease, stroke, and memory/concentration effects (affecting workers' productivity or children's learning).

5.3.7 Regarding road noise specifically, several meta-analyses of cardiovascular disease risk published by W. Babisch have been influential: his 2006 (Babisch, 2006) and 2008 (Babisch, 2008) publications were cited as the basis for Defra's IGCB(N) guidance on using a cubic exposure-response function to quantify acute myocardial infarction (AMI) risk from transport noise exposure (Berry & Flindell, 2009; Defra and IGCB(N), 2014), and a review in 2014 (Babisch, 2014) uses subsequently published evidence to provide a risk ratio for all ischaemic heart disease (IHD, also known as coronary heart disease, CHD) risk. (A meta-analysis published by Vienneau *et al* (Vienneau, et al., 2015) used many of the same studies to establish an IHD risk ratio that was used in the 2014 EEA quantification of noise health impacts across Europe (Nugent, et al., 2014), but this also included non-road noise sources.)

5.3.8 A 2012 meta-analysis by van Kempen and Babisch (van Kempen & Babisch, 2012) provides a risk ratio for hypertension associated with road noise exposure, which was adopted in the EEA 2014 assessment. The risk ratio is the same in its central estimate as that recommended by the IGCB(N), although the latter recommends using AMI as the health endpoint, rather than hypertension per se. It is lower than previous hypertension risk ratios for aircraft noise exposure (see e.g. the recommended function in (Expert Panel on Noise, 2010)).

5.3.9 A limited number of studies of stroke risk associated with environmental noise exposure have also been published. Houthuijis *et al* undertook an 'ad hoc' meta-analysis (Houthuijis, et al., 2014) of six studies published by 2014 to derive a risk ratio for use in the EEA 2014 assessment referenced above, although due to the small number of studies, it mixes road and aircraft noise and both incidence and mortality health outcomes.

5.3.10 The recent ecological study of road traffic noise and cardiovascular disease/mortality in London (Halonen, et al., 2015) mentioned above is also useful, despite being just one study, due to its large size, UK-based traffic and demographic context, and tests for co-association with road traffic air pollutant exposure. The two statistically significant health outcomes associated with road noise exposure that the study quantified were all-cause mortality and hospital admissions for stroke, although a number of other positive but non-significant associations were also discussed.

5.3.11 Of the non-cardiovascular and cerebrovascular health effects, there is substantial evidence for annoyance and sleep disturbance (see citations in the introduction to this section); however, these are considered to act as pathways to the health outcomes discussed, which can be quantified directly. The noise impact assessment in the ES has considered the significance of noise exposure with regard to policy based on thresholds for annoyance, so that is not repeated in this HIA.

5.3.12 There is also evidence for effects on cognitive performance in children such as lower reading performance (see e.g. (Klatte, et al., 2013)), and this is quantified in the assessments and guidance for general environmental noise exposure effects cited above. However, with regard to road traffic noise, the major 'RANCH' study (Stansfeld, et al., n.d.; Stansfeld, et al., 2005) found no association between road traffic noise and adverse changes in children's cognitive functions studied (reading comprehension, episodic memory [in fact, an association with improved episodic memory was found], working memory, prospective memory or sustained attention), nor with sustained attention, self-reported health, or mental health, although a relationship was found for aircraft noise exposure and impaired reading comprehension and recognition memory. Further papers and follow-up studies using the RANCH data or cohort have not changed this conclusion with respect to road noise.

6 Assessment of Impacts

6.1 Introduction

6.1.1 In the subsections below, potential health, social and equality impacts of the Scheme are assessed under each environmental pathway or WelTAG heading. Effects from changes in air quality and the noise environment are considered quantitatively, based on the modelled change in exposure set out in Chapter 7 and Chapter 13 of the ES, respectively. The other impact categories are considered qualitatively, drawing principally from evidence in the ES, including the All Travellers chapter (14), Community and Private Assets chapter (15), Geology and Soils chapter (11) and the separate Traffic Forecasting Report, Traffic and Collisions Report, Economic Appraisal Report, Wider Economic Impact Assessment report and Flood Consequence Assessment published alongside the draft Statutory Orders.

6.2 Noise Impacts

6.2.1 The noise and vibration impact assessment in the ES has predicted noise and vibration levels during construction and operation of the Scheme, comparing these to the baseline environment (measured in 2015) and a future without-development baseline in its opening year (2022) and year of full operation (2037). These future with- and without-development scenarios are referred to as ‘do minimum’ (DM) and ‘do something’ (DS), respectively. Operation of the Scheme (i.e. noise from road traffic flows) has been predicted including the effects of committed mitigation (CM) and additional noise barriers (B2).

6.2.2 The noise predictions have been made at the most-affected façades of all properties within 1 km of the existing M4 and proposed new section of motorway that are recorded in the OS AddressBase dataset, a total of 20,743 properties. Of these, 20,666 properties are classified as residential, leaving 20,654 residential receptors to be assessed after the 12 demolished due to the Scheme have been removed.

6.2.3 During construction, it is predicted that 492 residential properties and seven sensitive non-residential properties would be significantly adversely affected by construction noise, but that further mitigation to reduce these effects including temporary noise barriers where practicable would be offered through the Construction Environmental Management Plan. The effectiveness of such screening is described as “inherently uncertain” at this stage, but on the assumption that -10 dB attenuation is achieved, the number of significantly adversely affected residential properties would be reduced to 166. Construction phase impacts would be temporary, limiting the potential for any adverse health and wellbeing effects.

6.2.4 No significant effects due to construction road traffic noise or construction vibration are predicted.

6.2.5 Operational noise impacts are predicted to range from ‘major beneficial’ to ‘major adverse’. Although more noise-sensitive receptors are likely to experience a noise decrease rather than a noise increase, the magnitude of the increases tends to be greater, as the change occurs from a relatively low-noise baseline environment. Conversely, where noise decreases are predicted, these tend to be in the higher baseline noise environment around the existing M4.

6.2.6 With regard to nuisance, the assessment concludes that 480 to 277 residential receptors (in 2022 and 2037) would experience a significant (>10%) decrease in nuisance and 32 to 27 would experience a significant increase, based on the committed mitigation plus noise barriers scenario vs do-minimum 2022 scenario.

6.2.7 Overall, the assessment concludes that there would be a moderate or major adverse impact on 1,868 residential receptors in 2022 due to operational road noise, but a moderate or major beneficial impact on 2,683 residential receptors. This indicates that there is potential for quantifiable health impacts due to the Scheme, and the noise change at all residential receptors has therefore been assessed. The spatial distribution of beneficial and adverse effects has also been considered, to provide an indication of potential inequality in the beneficial or adverse impacts of the Scheme on community groups.

6.2.8 The operational noise assessment also considers impacts at specified sensitive non-residential receptors including schools, colleges, nurseries, places of worship and libraries. This identifies significant adverse impacts at eight receptors, but significant beneficial impacts at 52 receptors. Health impacts due to these changes are not quantifiable (with the available evidence not indicating an association between road noise exposure and children's learning in the affected schools). There is potential for minor negative wellbeing impacts if the nuisance is unmitigated and sufficient to disrupt use of these services.. Minor positive wellbeing impacts at the 52 receptors with beneficial impacts are also likely.

6.2.9 As discussed in section 5.3, metrics to relate long-term residential road noise exposure to hypertension, ischaemic (coronary) heart disease (IHD), stroke, acute myocardial infarction (AMI) and all-cause mortality are available. These are shown in Table 6.1.

Table 6.1: Noise Exposure-Response Metrics

Health outcome	Relative risk (95% CI)	Per increase (dB)	Exposure range (dB)*	Source
Hypertension incidence	1.07 (1.02 – 1.12)	10	47 – 77	(van Kempen & Babisch, 2012)
IHD incidence	1.08 (1.04 – 1.13)	10	52 – 77	(Babisch, 2014)
AMI incidence	Cubic function: 1.629657 – 0.000613 x [noise]^2 + 0.000007356834623455 x [noise]^3	Non-linear	>60	(Babisch, 2006)
Stroke incidence and mortality** (a)	1.04 (1.00 – 1.09)	10	>50	(Houthuijis, et al., 2014)
Stroke hospital admissions (b)	1.04 (1.02 – 1.07)	Within range shown	55 – 60	(Halonen, et al., 2015)
	1.05 (1.02 – 1.09)		>60	
All-cause mortality	1.03 (1.01 – 1.05)		55 – 60	
	1.04 (1.00 – 1.07)		>60	

* The metrics apply to noise expressed using the L_{den}, L_{dn} and $L_{Aeq,16hr}$ averaging periods. For the purpose of this assessment, these have all been treated as equivalent and obtained using a -2.2 dB correction from the noise model results in $L_{A10,18hr}$ (Scott, 03 December 2015).

** This is derived from an "*ad hoc analysis*" of mixed studies of incidence and mortality, including aircraft and road noise. The studies assessing mortality specifically used aircraft noise rather than road nose exposure. Therefore this metric has been applied only to stroke incidence (hospital admissions), not mortality, both to avoid double-counting and because the mortality evidence is weaker.

6.2.10 The limited evidence and metrics available mean that it is difficult to establish a single preferred health outcome or set of outcomes to quantify, and all of the CRFs listed above have therefore been used. These overlap (e.g. AMI falls within IHD, and both fall within all-cause mortality; stroke is one potential outcome of hypertension; etc) and should not be summed. Rather, they provide a range of effect estimates, illustrating the rough order of magnitude of likely health effects due to the Scheme.

6.2.11 Although there is some evidence that these effects are not confounded by co-exposure to road traffic air pollutants, there is potential for double-counting with the effects of air pollution exposure quantified below, and caution should therefore also be used if summing the air pollution and noise health effects predicted in this assessment.

6.2.12 Noise health impacts have been calculated at each residential receptor within the relevant exposure range using the following equation, and then summed for each health outcome and each scenario as follows. The results are shown as total effects in the study area population.

$$PAF = \frac{RR - 1}{RR} \times P \times B$$

where:
PAF is the population attributable fraction (health outcome within the exposed population due to noise)
RR is the relative risk, from which an attributable fraction is calculated as shown. Where RR is given per 10 dB increase, it is scaled linearly using:

$$RR_{dB} = 1 + \left((RR_{10} - 1) \times \frac{dB}{10} \right)$$

where:
dB is the noise exposure
P is the population exposed, assumed to be 2.34 per residential receptor in this case
B is the baseline annual rate of health outcome per person

6.2.13 Baseline health data are as specified in the community profile (section 4). Data for Newport have been used, as the majority of the noise study area lies within Newport. Where available, the average of the last five years' data has been used, to smooth year-to-year fluctuations. The population per household is assumed to be 2.34, the Newport average in 2013 (Statistics for Wales, 2014). Although some noise health metrics refer to effects among the adult (25+) population, total population count has been used; in practice this would have very little effect as the incidence of the health outcomes in the under-25 population is very low. The upper limit on the exposure range for some metrics implies that there is no effect above this exposure limit, which is unlikely in reality, and is an artefact of the available data that informed the metric (i.e. studies that did not assess exposure above that threshold). In all scenarios, four or fewer properties are predicted to be exposed to noise above the 77 dB upper threshold, so this has no material effect on the health outcome calculations. Hospital admission rates are treated as 'incidence', with the exception of hypertension, which is based on reported prevalence among GP patients.

6.2.14 The assessment considers only existing receptors, present-day population and present-day baseline annual hospital admission or mortality rates. It is presented as the change in annual rates of health outcomes for the existing population were they to be exposed instantaneously to the predicted changes in long-term noise exposure and were this to be (and to have been) maintained as a steady state over the exposed population's lifetimes. For hypertension, it is presented as the number of people with the condition rather than an annual rate of hospital admissions or mortality.

6.2.15 Strategic road links tend to encourage development and settlement, and it is possible that in the future, additional noise-sensitive receptors would be introduced into the area affected by noise from the new section of motorway, increasing the burden of disease attributable to it (much as has happened in the north-west of Newport around the existing M4, itself originally built as a bypass to the A48 through Newport). Some potential development land north of the new section of motorway is allocated in the Newport and Monmouthshire Local Plans. This is not quantified in the assessment, consistent with the approach in the noise and air quality impact assessments.

Table 6.2: Noise Exposure Health Outcomes

Health outcome*	Population attributable fraction					
Scenario**	**22DM**	**22B2**	**22 change**	**37DM**	**37B2**	**37 change**
Hypertension incidence	241	188	-53	248	207	-41
IHD hospital admissions	6.64	4.80	-1.84	6.91	5.36	-1.55
AMI hospital admissions	0.73	0.49	-0.24	0.77	0.56	-0.21
Stroke hospital admissions (a)	1.35	0.99	-0.37	1.40	1.10	-0.30
Stroke hospital admissions (b)	1.14	0.82	-0.32	1.18	0.91	-0.26
All-cause mortality	5.69	4.09	-1.60	5.87	4.56	-1.31

* Only results using the central estimate RR are shown. Use of the 95% confidence interval RR would give a misleading impression of precision, given the many other uncertainties in the assessment that cannot be quantified.
** 22 and 37 are 2022 and 2037, the years of opening and full operation respectively. DM = do minimum, the future baseline scenario. B2 is the Scheme including committed mitigation and noise barriers in the do-something future scenario.

6.2.16 Overall, the results in Table 6.2 show that residential noise exposure from the existing M4 within the Scheme study area contributes little to measurable health outcomes in terms of hospital admissions and mortality, and that the health benefit created by a reduction in population noise exposure due to the Scheme would therefore be correspondingly minor, estimated to be fewer than two hospital admissions or premature deaths avoided per year across the entire exposed population.

6.2.17 It should be borne in mind that the health outcomes predicted in Table 6.2 are based on a number of modelling assumptions (predicted traffic, predicted noise, average household size and baseline health indicator rates), and are indicative of the order of magnitude of likely changes rather than being precise figures. The order of magnitude, however, is clearly low relative to the assumed exposed population within the study area (around forty-eight thousand people).

6.2.18 Hypertension is a relatively common disease, affecting 11.5% of GP-registered patients in Newport in 2012 (the latest available data). The estimated number of hypertension cases attributable to road noise exposure in the future scenarios is therefore more substantial, and a reduction of 53 or 41 cases (in the opening year or fully operational year) with the Scheme is predicted.

6.2.19 The health outcomes shown above would not be distributed evenly across the exposed population. The estimated reduction of 1.84 annual IHD hospital admissions in 2022 is the balance of an additional 0.14 admissions among the population exposed to increased noise (mainly around the new section of motorway to the south of Newport) and a decrease of -1.98 admissions in the population exposed to a decrease in noise (mainly around the existing M4 in the north). For AMI in 2022 this is an increase of 0.02 balanced by a decrease of -0.26; for stroke, 0.03 and -0.39. For hypertension incidence, the increase is estimated to be 7 cases and the decrease, -60. A similar pattern is seen for the 2037 predictions, as shown in Table 6.3 and Table 6.4. (Stroke (b) and all-cause mortality are not broken down in this way due to the 5 dB exposure bins rather than individual exposure increments used in the metrics.)

Table 6.3: Health Outcomes from Increased Noise Exposure

Health outcome	Population attributable fraction					
Scenario	**22DM**	**22B2**	**22 change**	**37DM**	**37B2**	**37 change**
Hypertension incidence	28	35	7	29	36	7
IHD hospital admissions	0.86	1.00	0.14	0.78	0.90	0.12
AMI hospital admissions	0.12	0.14	0.02	0.12	0.14	0.02
Stroke hospital admissions	0.16	0.19	0.03	0.15	0.18	0.03

Sums may not equal parts due to rounding.

Table 6.4: Health Outcomes from Decreased Noise Exposure

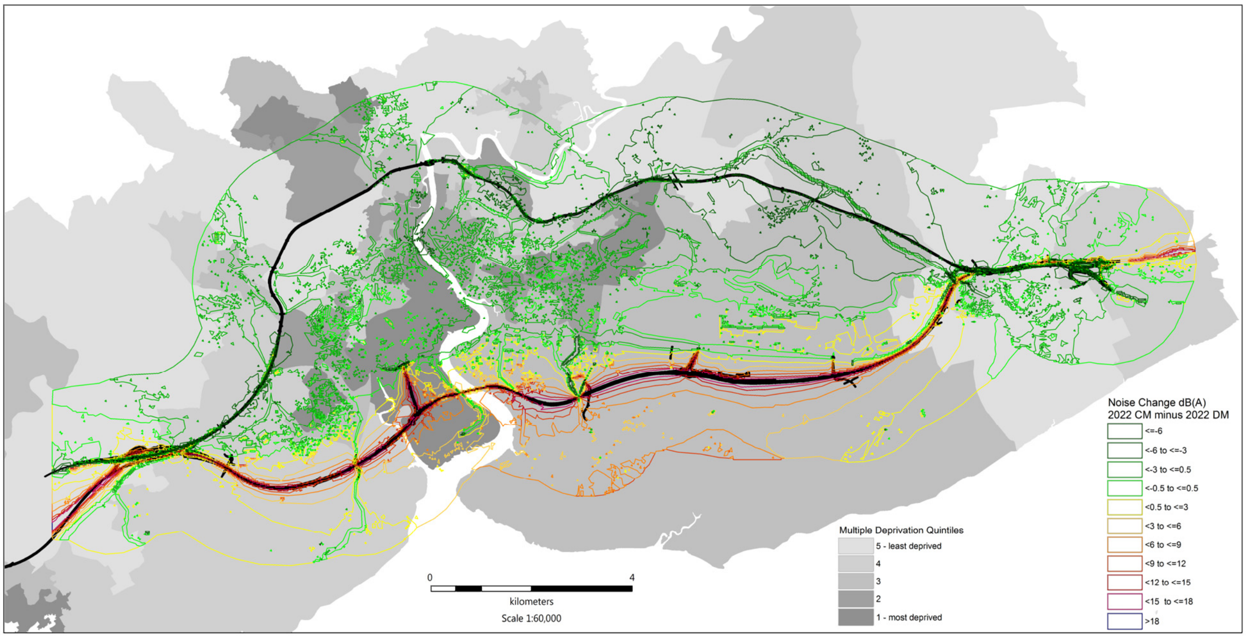
Health outcome	Population attributable fraction					
Scenario	**22DM**	**22B2**	**22 change**	**37DM**	**37B2**	**37 change**
Hypertension incidence	211	151	-60	216	169	-47
IHD hospital admissions	5.71	3.73	-1.98	6.05	4.38	-1.67
AMI hospital admissions	0.59	0.34	-0.26	0.64	0.42	-0.23
Stroke hospital admissions	1.18	0.78	-0.39	1.23	0.91	-0.32

Sums may not equal parts due to rounding.

6.2.20 The spatial distribution of health outcomes is also relevant to potential social inequality in impacts. Figure 6.1 shows the noise change contours in 2022 (B2 minus DM scenario) overlaid on IMD quintiles within the noise study area. Noise reduction and hence associated health benefits around the existing M4 affect areas with a mixture of deprivation characteristics, but do encompass some areas with the highest recorded deprivation levels in Newport. The majority of the area affected by increases in noise lies in the middle of the deprivation scale, although adverse impacts in the area of high deprivation around Newport Docks are apparent.

6.2.21 The IMD score at LSOA scale is a relatively crude means to consider social inequality in the distribution of noise impacts. Associated health impacts would be affected by individuals' age, any existing burden of poor health and lifestyle among other factors, which cannot be considered fully in an assessment of statistical effects on large populations.

Figure 6.1: Noise Change and Multiple Deprivation



6.2.22 The noise impact assessment in the EIA has not assessed sleep disturbance, as traffic flow data specific to the night-time period were not available to inform noise modelling of this period. As a general approximation, the noise assessment has suggested that those receptors identified as experiencing annoyance due to noise in the daytime would already include the group for whom sleep disturbance occurs. However, not all those identified as experiencing annoyance during the day would necessarily be sleep disturbed. Likewise for receptors where noise and potential for annoyance is reduced by impacts of the Scheme, only a subset of the identified group would have a benefit with regard to reduced sleep disturbance.

6.2.23 Exposure-response metrics to relate L_{night} noise levels to the proportion of the population that is highly sleep disturbed are available, but as mentioned this relies on having modelled L_{night} noise data, in turn dependent on night-time traffic flows in the context of this assessment. As a rough approximation, a correction of -12.5 dB could be applied to convert the predicted noise levels in $L_{A10,18hr}$ to L_{night} (Scott, 03 December 2015). Applying this and the non-linear high sleep disturbance factor recommended in the Defra IGCB(N) guidance[4] (Defra and IGCB(N), 2014) for noise levels in the range 45–65 dB (assuming constant risk at >65 dB and no risk at <45

[4] Proportion of population with high sleep disturbance = 20.8 – 1.05 * L_{night} + 0.1486 * L_{night}^2

dB) yields a prediction of approximately 969 people experiencing high sleep disturbance in the 2022 do-minimum (without Scheme) scenario, reduced to 688 in the 2022 with-Scheme scenario including committed mitigation and noise barriers. This overall effect would have a similar spatial distribution in people experiencing benefits and dis-benefits to the other noise change impacts discussed above.

6.3 Air Quality Impacts

6.3.1 The air quality impact assessment in the ES has predicted dust risk during construction and long-term (annual mean) ambient concentrations of NO_2 and PM_{10} during operation of the Scheme, comparing these to the current baseline environment and a future without-development baseline in the opening year (2022) and year of full operation (2037).

6.3.2 The air quality predictions have been made at 52 selected sensitive receptors and at a grid of points (variably spaced) within 200 m of affected road links, allowing contour plots of air pollutant concentrations to be created.

6.3.3 Due to expected improvements in vehicle and fuel technologies over time, reducing vehicle emissions, 2022 is expected to be the worst-case year for air quality around road links affected by the Scheme, and so the full grid assessment (used in this HIA) has only been undertaken for 2022. No uplift to vehicle emissions factors to account for current non-compliance with standards or non-effectiveness of testing has been applied in emission rates assumed in the air quality assessment, as the projected factors for 2022 are considered to be conservative.

6.3.4 Four air quality management areas (AQMAs) have been declared in the vicinity of the existing M4, within which recent monitoring has shown that the annual mean NO_2 concentration objective has been exceeded. The NO_2 objective has also been exceeded within three AQMAs declared elsewhere in Newport, which also have the potential to be affected by changes in traffic flows within the city due to the Scheme.

6.3.5 The existing background pollutant concentrations in the area of the proposed new section of motorway, away from the existing M4, are generally well below the relevant air quality objectives.

6.3.6 The assessment of construction dust risk concludes that there is a high risk of dust soiling (nuisance) and low to medium human health risk, without mitigation. (Level of human health risk, in that assessment, is determined by the magnitude of works – e.g. based on site area, volume of building constructed or demolished, nature of on-site activities, etc – distance to receptors, number of receptors, and existing background PM_{10} concentration.) However, it is considered in the assessment that good practice mitigation measures during the construction period, implemented through the Construction Environmental Management Plan, would reduce these risks to a non-significant level.

6.3.7 The assessment of road traffic air pollution impacts during the operational phase of the Scheme concludes that no new exceedances of PM_{10} or NO_2 objectives are predicted within the study area, including at locations around the new section of motorway and road links affected by it. Although NO_2 and PM_{10} concentrations are predicted to increase at some of the 52 selected sensitive human health receptors (with the greatest increase being 1.4 $\mu g.m^{-3}$ NO_2 and 0.3 $\mu g.m^{-3}$ PM_{10} at Fair Orchard Farm off Lighthouse Road), significant decreases at receptors around the existing M4 corridor and its adjacent AQMAs are also predicted. The maximum predicted decrease for a single receptor is -6.5 $\mu g.m^{-3}$ NO_2 and -0.9 $\mu g.m^{-3}$ PM_{10} at Buckland Cottage within the Royal Oak Hill AQMA. Decreases of around -1 to -2 $\mu g.m^{-3}$ NO_2 at receptors within the three Newport AQMAs and -2 to -7 $\mu g.m^{-3}$ NO_2 in the AQMAs around the existing M4 are predicted.

6.3.8 Overall, the Scheme is predicted to improve air quality in urban areas alongside the existing M4 corridor (that currently closely approach or breach the NO_2 air quality objective and remain at risk of exceedance without the Scheme in 2022), and while it would have a negative effect on air quality around the new section of motorway and connecting roads, this is not predicted to cause any exceedances of air quality objectives.

6.3.9 Although no exceedances of air quality objectives with the Scheme in place in 2022 are predicted, health impacts from air pollutant exposure are experienced at pollutant concentrations below the objectives, and on the basis of the available evidence, there may not be a threshold below which no adverse health effect occurs. The prediction of air quality changes at individually selected receptors, while useful for showing changes in sensitive areas such as AQMAs, does not indicate the number of people exposed to the air pollution changes. For these reasons, health outcomes due to the Scheme have been quantified as follows.

6.3.10 The baseline health and population data sources are as specified in the community profile and noise health assessment for study area receptors within Wales, with average household size and baseline age-standardised disease and mortality rates for the local authorities of Cardiff, Monmouthshire, Newport and Torfaen used. A small number of air quality receptors are located in England, in South Gloucestershire and Forest of Dean. Unlike Wales, data on average household size and hospital admission rates in English local authorities has proven difficult to obtain, and in view of the small number of receptors affected, and limited variability in admission rates seen across the Welsh local authorities, the average household size for England and average cardiovascular and respiratory disease hospital admission rates for Wales have been used for receptors in these two local authorities.

6.3.11 The available disease-specific hospital admissions rates for Wales are for emergency admissions, which may underestimate total admissions associated with air pollutant exposure. The effect of this on the analysis would be to under-estimate net health benefits associated with the Scheme.

6.3.12 The assessment scenario presented (an instantaneous effect on present-day population and disease/mortality rates) is the same as in the noise health assessment, as are the uncertainties in the chain of modelling assumptions underlying it (predicted traffic flow, predicted air pollutant dispersion, average household size and baseline health indicator rates); and again, for this reason, only the results from central estimate risk ratios are presented here. Again, as discussed above, caution should be exercised in summing noise and air pollutant health impacts, as there may be some degree of double-counting.

6.3.13 The air quality assessment has predicted PM_{10} concentrations, whereas the strongest health evidence is for $PM_{2.5}$ exposure. PM_{10} concentrations have been adjusted to $PM_{2.5}$ concentrations by multiplying by 0.6 (Stone, 16/10/15; Stone, 2015).

6.3.14 The air quality assessment has predicted pollutant concentrations at a grid of points with variable spacing within 200 m of affected road links. These points do not necessarily coincide with the locations of residential receptors. A triangulated irregular network (TIN) algorithm was used to interpolate between the dispersion model result points, from which the air pollutant concentration contour plots in Chapter 7 the ES were created. For this HIA, the TIN values have then been sampled on a 1 m regular grid to create a raster from which the pollutant concentrations at the co-ordinates of each residential receptor have been derived[5].

6.3.15 As discussed in section 5.3, extensive guidance and recommended metrics (concentration-response functions, CRFs) for quantifying health outcomes due to change in air pollution exposure are available. The principal CRFs used in this analysis (shown in Table 6.5) are a subset of those recommended in the WHO HRAPIE guidance (WHO, 2013), that are applicable using the available evidence (annual average pollutant concentrations and mortality/hospital admissions data).

6.3.16 The HRAPIE central estimate $PM_{2.5}$ CRF is the same as that applied in UK guidance from COMEAP (COMEAP, 2009), both being based on many of the same underlying epidemiological studies (principally Pope *et al*, 2002 (Pope III, et al., 2002)). The HRAPIE NO_2 mortality CRF is based on a meta-analysis by Hoek *et al* in 2013 (Hoek, et al., 2013), which recommends a -33% adjustment to account for potential double-counting with $PM_{2.5}$ exposure mortality; this has been applied in the CRF shown. As an alternative, CRFs for NO_2 exposure and $PM_{2.5}$ exposure mortality from a meta-analysis by Faustini *et al*, 2014 (Faustini, et al., 2014) have also been used, which assume no overlap in mortality effects from each pollutant. Finally, the latest interim COMEAP and Defra guidance provides a somewhat lower recommended NO_2 CRF and again a suggested -33% adjustment to account for overlap with $PM_{2.5}$ exposure; however, it discusses significant uncertainty about the overlap adjustment and the risk of double-counting. Given that the COMEAP NO_2 CRF is lower and is an interim recommendation pending further work, it has been used unadjusted as a sensitivity test for single pollutant exposure and not included in the sum of total health impacts.

6.3.17 The HRAPIE guidance provides CRFs for both short- and long-term changes in air pollutant concentrations. The air quality modelling data are provided as annual average concentrations, and short-term mortality impacts have not been assessed separately to avoid double-counting with long-term effects. The CRFs for long-term effects, being based mainly on cohort studies, are likely to capture short-term effects. Hospital admission CRFs are for daily-mean rather than annual-mean concentrations; however, as there are no upper or lower concentration thresholds recommended for the CRFs, they can be treated as applicable to the annual mean. The guidance separates CRFs into categories (A*, A, B*, B) based on strength of evidence and potential overlap in impacts that would lead to double-counting. A* CRFs have been used with the exception of long-term mortality due to NO_2 exposure (B*), which has been adjusted to avoid double-counting with $PM_{2.5}$ exposure mortality as described above.

[5] As a test, the interpolated results from the raster were compared to the original pollutant concentration at each grid point from the dispersion modelling results. This yielded a mean absolute error (MAE) of <0.01 $\mu g.m^{-3}$ and root mean squared error (RMSE) of 0.02 $\mu g.m^{-3}$ in the PM_{10} results, with >99% of grid points being over- or under-predicted by ≤0.1 $\mu g.m^{-3}$ and none by ≥1 $\mu g.m^{-3}$. For NO_2, the MAE was 0.07 $\mu g.m^{-3}$ and the RMSE was 0.15 $\mu g.m^{-3}$, with 98% of grid points being over- or under-predicted by ≤0.1 $\mu g.m^{-3}$ and 0.2% by ≥1 $\mu g.m^{-3}$. The interpolated results are therefore considered acceptable for use in this assessment, well within the other uncertainties present.

Table 6.5: Air Pollutant CRFs

Health outcome	Pollutant	Relative risk (95% CI)*	Ages	Sources
All natural cause mortality	NO_2	1.025 (1.010 – 1.040)	30+	(COMEAP, 2015)
		1.055 (1.021 – 1.054)		(Hoek, et al., 2013) via (WHO, 2013)
		1.040 (1.020 – 1.060)		(Faustini, et al., 2014)
	$PM_{2.5}$	1.062 (1.040 – 1.083)		(Hoek, et al., 2013) via (WHO, 2013)
		1.050 (1.010 – 1.090)		(Faustini, et al., 2014)
Respiratory disease hospital admissions	NO_2	1.018 (1.012 – 1.025)	All	(Atkinson, 2012) via (WHO, 2013)
	$PM_{2.5}$	1.019 (0.998 – 1.053)**		(Atkinson, 2012) via (WHO, 2013)
Cardiovascular disease hospital admissions	$PM_{2.5}$	1.009 (1.002 – 1.017)		(Atkinson, 2012) via (WHO, 2013)

* Per 10 $\mu g.m^{-3}$ concentration increase
** The 95% CI encompassing values <1 should not be read as an indication of potential health benefit due to air pollutant exposure, but rather potential that there is no associated effect.

6.3.18 Air pollutant exposure is also associated with health outcomes such as increased respiratory disease symptoms (e.g. asthma) and reduced activity days due to short-term changes in concentrations, that cannot be quantified at the level of detail available in this analysis. When interpreting the mortality and hospital admission rate changes in Table 6.5, it should therefore be borne in mind that the Scheme would also have these unquantified wider health outcomes.

6.3.19 No upper or lower concentration thresholds have been applied as cut-offs for health impacts in this assessment (i.e. relative risk = 1 at zero concentration is implicitly assumed). Due to the nature of this study of annual-average ambient concentrations, no very high concentrations above air quality objectives are involved in the analysis; equally, as the assessment area is within 200 m of road links, no very low concentrations (close to zero) are involved either. The maximum concentrations at residential receptors in the future baseline or with-Scheme scenario are 38.3 $\mu g.m^{-3}$ for NO_2 and 11.4 $\mu g.m^{-3}$ for $PM_{2.5}$. The minimum concentrations are 7.6 $\mu g.m^{-3}$ for NO_2 and 7.5 $\mu g.m^{-3}$ for $PM_{2.5}$. Although the HRAPIE guidance recommends a lower threshold of 20 $\mu g.m^{-3}$ for the NO_2 CRF, this discontinuity would either lead to unreasonably large changes in health outcomes being predicted where a small change in concentration causes receptors to cross the threshold, or an adjustment of the CRF so that RR = 1 at 20 $\mu g.m^{-3}$ which may significantly underestimate health impacts, and so it has not been applied. (See further discussion of this issue in Annex 7.1 in (Walton, et al., 2015).)

6.3.20 The CRFs are for natural-cause mortality rates, i.e. excluding 'external' causes of mortality such as suicide, accidents and homicide. In the Welsh data, external cause mortality rates for the local authorities were only available for 2007-2011. The average ratio of external to all-cause mortality in that period has therefore been used to adjust the 2010-2014 all-cause mortality to natural-cause mortality. In the English mortality data, both all-cause and external cause mortality rates were available for 2012-2014 and the latter was subtracted from the former. As with the noise impact assessment, although some metrics are for adult (30+) population, the available age standardised all-age mortality rates have been used as mortality under 30 is low in any case, which is an acceptable simplification (Gowers, et al., 2014).

6.3.21 Air quality health impacts have been calculated at each residential receptor using the following equation, and then summed for each health outcome and each scenario. The results are shown as total effects in the study area population.

$$PAF = \frac{RR - 1}{RR} \times P \times B$$

where:
PAF is the population attributable fraction (health outcome within the exposed population due to air pollution)
RR is the relative risk, from which an attributable fraction is calculated as shown. RR (given per 10 μg.m^{-3} concentration) is scaled multiplicatively using:

$$RR_A = RR^{(A/10)}$$

A is the interpolated air pollutant exposure at the receptor
P is the population exposed, assumed to be 2.30 to 2.34 per residential receptor in this case
B is the baseline annual rate of health outcome per person

Table 6.6: Air Pollutant Exposure Health Outcomes

Health outcome*	Population attributable fraction		
Scenario**	**2022 DM**	**2022 DS**	**2022 change**
All natural cause mortality***	92.88	91.62	-1.27
Respiratory disease hospital admissions	57.69	56.76	-0.94
Cardiovascular disease hospital admissions	11.97	11.94	-0.04

* Only results using the central estimate RR are shown. Use of the 95% confidence interval RR would give a misleading impression of precision, given the many other uncertainties in the assessment that cannot be quantified.
** DM = do minimum, the future baseline scenario. DS = do something, i.e. the Scheme. There is no committed mitigation (CM) relevant to the air quality modelling scenario.
*** The outcomes using the HRAPIE (Hoek *et al*) CRFs and Faustini *at al* CRFs are extremely similar, and only the HRAPIE CRF outcomes are shown here. Net change in all-cause mortality attributable to NO_2 exposure using the COMEAP factor, unadjusted for any $PM_{2.5}$ overlap, is -0.80.

6.3.22 Although a significant burden of premature mortality and disease is attributable to air pollutant exposure within the study area, the effect of changes in road traffic on the modelled links to pollutant concentrations is limited, and the net change predicted due to the Scheme is therefore relatively minor: a reduction in annual mortality equivalent to around 1.3 deaths at typical ages and an annual reduction of <1 hospital admissions for cardiovascular and respiratory diseases.

6.3.23 While NO_2 and $PM_{2.5}$ make fairly similar total contributions to mortality and hospital admissions with and without the Scheme, the change attributable to the Scheme is due mainly to decreased NO_2 concentrations. As the evidence for health impacts due to NO_2 exposure is at present less clear than that for $PM_{2.5}$, these results may overestimate the total benefit attributable to the Scheme. In addition, the assumed cumulative effect of NO_2 and $PM_{2.5}$ exposure reduction health benefits – adjusting for only a 33% double-counting overlap – may also overestimate health benefits. The net mortality effect if considering $PM_{2.5}$ alone would be a reduction equivalent to 0.13 deaths per annum at typical ages; the net effect on hospital admissions would be a reduction of 0.10 per annum.

6.3.24 The net changes shown in Table 6.6 are composed of increases and decreases in health impacts, due to an improvement in air quality around the existing M4 and a worsening of air quality in some areas around the new section of motorway and certain other links/junctions. However, as shown in Table 6.7 and Table 6.8, the net change is dominated by improved health outcomes. This is due to the combined effect of (a) a much greater number of residential receptors being predicted to experience a decrease in air pollutant concentrations and (b) the decrease in pollutant concentrations at those receptors being typically greater than the increase at those receptors predicted to experience degraded air quality.

6.3.25 For NO_2, a decrease in annual mean concentration is predicted at 91% of receptors in the study area (70,601 people), with the average decrease being 0.47 $\mu g.m^{-3}$ (95th percentile range 0.02 – 1.50), whereas for the 7,078 people for whom an exposure increase is predicted[6], the average increase is 0.09 (0.00 – 0.32) $\mu g.m^{-3}$. For $PM_{2.5}$, 92% of receptors (70,324 people) are predicted to benefit from an average decrease in annual mean exposure of 0.03 $\mu g.m^{-3}$ (0.00 – 0.11), whereas the increase for 5,882 people would be on average 0.01 (0.00 – 0.04) $\mu g.m^{-3}$.

6.3.26 As the predicted increased mortality and disease due to road traffic pollution attributable to the new section of motorway is very minor (see Table 6.7), it has not been considered useful to further discuss the spatial distribution and no significant inequality impacts are predicted.

Table 6.7: Health Outcomes from Increased Air Pollutant Exposure

Health outcome	Population attributable fraction		
Scenario	**2022 DM**	**2022 DS**	**2022 change**
All natural cause mortality	6.01	6.03	0.02
Respiratory disease hospital admissions	3.52	3.53	0.01
Cardiovascular disease hospital admissions	0.83	0.83	0.00

Sums may not equal parts due to rounding.

[6] No change in air quality attributable to the scheme is predicted at for the remaining 14 people for NO_2 and 44 for $PM_{2.5}$.

Table 6.8: Health Outcomes from Decreased Air Pollutant Exposure

Health outcome	Population attributable fraction		
Scenario	**2022 DM**	**2022 DS**	**2022 change**
All natural cause mortality	86.85	85.56	-1.29
Respiratory disease hospital admissions	54.16	53.21	-0.95
Cardiovascular disease hospital admissions	11.14	11.10	-0.04

Sums may not equal parts due to rounding.

6.4 Contaminated Land

6.4.1 Chapter 11 in the ES summarises the findings of ground investigations into 27 areas along the route of the new section of motorway potentially affected by land contamination. Risk to construction workers or general public health has been identified at some of these sites, and a remediation strategy has therefore been developed to specify the handling, treatment, movement and reuse of contaminated soils, together with management measures for ground water and ground gases to mitigate these risks.

6.4.2 The assessment concludes that risks during construction would be mitigated by these measures, and that overall there would be a slight benefit due to the Scheme once into the operational phase, as the Scheme construction including remediation measures employed would break any potential contaminant linkages between contaminated soils and human receptors.

6.4.3 No significant adverse health impact due to contaminated land affected by the Scheme is therefore predicted.

6.5 Flood Risk

6.5.1 A Flood Consequences Assessment has been undertaken based on extensive flood modelling of the Gwent Levels and wider corridor of the new section of motorway. From the flood model results, it is concluded that no significant adverse effect on flood risk is anticipated as a consequence of construction. Construction drainage has been designed to accommodate the predicted increase in rainfall reasonably expected due to storms during the construction period.

6.5.2 Operational road drainage has been designed to accommodate 1 in 100 year plus climate change rainfall. The drainage infrastructure would therefore be capable of capturing, conveying and releasing highways drainage within acceptable limits.

6.5.3 The effect on flood risk has been assessed for the proposed new section of motorway following the culverting of reens and provision of replacement reens and ditches to maintain conveyance of surface water through the alignment. Localised areas of flooding affecting land, but not property, are predicted.

6.5.4 The Severn Estuary Flood Risk Management Strategy recommends improved defences for the Gwent Levels, keeping pace with climate change. The proposed defences along the foreshore and along the lower reaches of the Rivers Usk and

Ebbw would offer protection to the proposed new section of motorway against a 1 in 1,000 year tidal surge event within the Severn Estuary.

6.5.5 In conjunction with improvements to the Gwent Levels sea defences by Natural Resources Wales (NRW), the proposed new section of motorway would be compliant with current Welsh Government planning policy with respect to tidal flood risk up to the year 2030. Continued improvements to sea defences beyond 2030, in line with NRW policy, would ensure that the proposed new section of motorway would remain compliant into the future.

6.5.6 No significant adverse health or socio-economic impact due to the flood risk is therefore predicted.

6.6 Socio-Economic Impacts

6.6.1 Employment and income are among the most significant determinants of long-term health, influencing a range of factors including the quality of housing, education, diet, lifestyle, coping skills, access to services and social networks. Consequently, poor economic circumstances can influence health throughout life, where communities subject to socio-economic deprivation are more likely to suffer from morbidity, injury, mental anxiety, depression and tend to suffer from higher rates of premature death than those less deprived (Beland, et al., 2002; Stafford, et al., 2004).

6.6.2 Research indicates that socio-economic circumstance and relative deprivation are key markers of poor health, associated with increased all-cause mortality in the US and five European countries (van Lenthe, et al., 2005). This association was seen independently of individual country-specific socio-economic characteristics, with no evidence from any of the countries in the study that substantially modified the association. For men, living in the quartile of neighbourhoods with the highest unemployment compared to the lowest unemployment was associated with an increased risk of mortality (14%–46%), after adjustment for age, education, and occupation. A similar but statistically weaker association between unemployment and mortality was found for women.

6.6.3 Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstance, would contribute to improving the health and wellbeing of socio-economically deprived communities.

6.6.4 It is important to note, however, that increasing employment and income opportunities alone would not maximise health benefits. Increased support, training and community involvement is required in order to link and develop skills to employment and reduce the risk of inequality.

6.6.5 The Economic Appraisal Report (Pritchard, 2016) provides an assessment of the direct and wider economic costs and benefits accrued over a 60-year period for the Scheme. Benefits and costs are derived from journey time savings, vehicle operating cost savings, user charges (tolls) and additional costs to travellers due to construction/maintenance works, as well as public accounts costs from investment and operating costs. The Economic Appraisal concludes that the Scheme would overall provide value for money with a benefit to cost ratio of 2.67 under the central growth scenario. The cost to benefit ratio highlights that there are predicted to be significant economic user benefits to be gained from implementation of the scheme, including benefits from labour market impacts and lower transportation times, all of which could result in economic benefits for the local area and direct benefits to individuals through journey cost reductions.

6.6.6 The Wider Economic Impact Assessment (Bussell, 2016) provides a further assessment of the predicted wider economic effects of the Scheme. Direct construction phase employment is expected to average at 700 workers per month over the construction period. In addition to this the Scheme requires procurement of approximately £543m worth of materials and equipment. Local procurement and employment would be favoured wherever practicable, which would result in a temporary positive economic impact in the local area.

6.6.7 In addition to local employment, the contractor has committed to 20% of the total labour requirement consisting of new entrant trainees, with an apprenticeship, trainee or employment contract with the contractor/subcontractor, engaged in a construction training programme. This investment in training has the potential for long term positive impacts on employment and skills for the region and local communities, through development of local skills.

6.6.8 Disruption during the construction phase may have the potential to disrupt local transport networks, with indirect effects on economic activity in some areas. However careful traffic management, including route choices and diversions, combined with the fact that much of the construction work would be carried out offline, should ensure that disruption and subsequent impacts to local economies during the construction phase has only a temporary effect on local communities and economics.

6.6.9 Potential land take required for the Scheme would result in the loss of twelve residential dwellings along the route of the proposed new section of the M4. Due to the low number of properties to be demolished, the impact on housing stock is very low, with the properties demolished representing 0.025% or below of the housing stock in Newport and Monmouthshire. Furthermore the houses to be removed tend to be individual houses located outside of the main settlements. The exception is the cluster of four houses to be demolished to the north west of Castleton, which are located adjacent to the existing M4 route along with a small number of other houses, outside of the main settlement. Owner and occupiers of properties to be demolished as part of the land take would be financially compensated for their loss. The impacts on individuals from housing loss would be addressed at the project level, and the small number of houses to be demolished is not anticipated to result in significant impacts to health associated from changes to housing stock and quality.

6.6.10 There is potential for adverse economic impact at Newport Docks due to loss of operational land. The degree of effect on the docks has been a matter of ongoing discussion between the Welsh Government and the landowner since the late 1990s and responses are still awaited from the landowner regarding the economic impact of the proposed new section of motorway on the docks. This effect has therefore not been assessed in detail. (Bussell, 2016). There is potential for a minor adverse health impact if this affects employment at the Port of Newport, which is in a strongly socio-economically deprived area.

6.6.11 The community profile identified areas of multiple socio-economic deprivation influenced by unemployment or lower incomes and limited educational qualifications. Overall, construction-phase investment and employment combined with the training offered therefore has significant potential for socio-economic benefits to health and wellbeing.

6.6.12 Operational effects of the Scheme, namely reduced congestion, faster journey times and improved network resilience, are predicted to result in lower transport costs for local business worth £39m per year by 2037. Other mechanisms that are predicted to impact on the economy of the study area include improvements to the local labour markets, through increased access to employment opportunities and widening of recruitment area for firms due to improved commuting (albeit by unsustainable, non-healthy transport mode). There may also be increased productivity through proximity changes between South Wales and South West England, estimated at a value of £40m per annum by 2027. Finally, there is potential for new investment for areas with improved access to key employment sites within the region.

6.6.13 The mechanisms highlighted within the Economic Appraisal Report and Wider Economic Impact Assessment create potential for new investment, job creation and improved access to employment, which would overall present socio-economic benefits for local communities and the consequent health benefits associated with this once the Scheme is operational.

6.7 Transport Safety

6.7.1 One of the overall goals for the Scheme is to improve transport safety. The Traffic Forecasting Report (Pritchard, et al., 2016) suggests that under the do-minimum scenario, without the proposed new motorway, traffic would be expected to increase on the existing M4 with conditions likely to become more unstable leading to a higher frequency of incidents and accidents. The Traffic and Collisions Report (Huws, 2015) provides information on historic traffic collisions and trends for the existing section of the M4. It shows that despite improvements in traffic safety achieved through the introduction of a variable speed limit in 2011, three sections of the M4 corridor around Newport still have a collision rate that is higher than the default rate for motorways, contained in the WebTAG Data Book.

6.7.2 The new section of motorway, improved junctions and Complementary Measures would be designed to a modern motorway safety standard, which suggests that an improvement in safety per vehicle-km is likely to be achieved compared to the older design of the existing M4 (which includes tunnels and sections with no hard shoulder).

6.7.3 An accident appraisal has been undertaken based on default accident rates for different road classifications and the forecast traffic flows on the road network using Department for Transport COBALT software and parameters (Pritchard, 16 February 2016). Comparison of the results with and without the Scheme indicates a reduction of around nine accidents causing personal injury per year in 2022 or 2037 with the Scheme in place. This reduction in accidents is predicted to lead to around 14 slight injuries being avoided per year in 2022, or around 13 per year by 2037. The number of serious and fatal injuries avoided per year would be fewer than one in both cases.

6.7.4 The accident appraisal indicates that the improvement in road traffic safety with the Scheme would offer a minor health benefit.

6.7.1 The Non-Motorised User (NMU) Context Report (Westwood, 2016) provides accident and injury data collected for NMU accidents between 2009 and 2013 for the junctions and key routes within the study area. The report states that during this period there were 40 accidents involving NMUs, representing 17% of all accidents. The analysis noted that 34 accidents involving NMUs were recorded within the vicinity of roundabouts on existing M4 junctions, and that those junctions with provision for pedestrians and cyclists had fewer accidents than those without specific NMU infrastructure.

6.7.2 The NMU Context Report indicates that since the new section of motorway intersects with a number of roads and rights of way used by NMUs, management of these conflict points would be required, such as through diverting routes to suitable crossing points or providing separated crossing points.

6.7.3 As discussed further in the permeability section below, the Scheme would provide crossings and other infrastructure for NMUs on the new section of motorway and junctions with the existing M4, and would generally maintain the existing provisions on the existing section of the M4. Crossings of the new section of motorway itself for NMUs would be grade-separated and no NMUs would be permitted on the motorway.

6.7.4 If the NMU Objectives set out in the NMU Context Report are met, which should be secured through the further stages of NMU audit that would be undertaken during detailed design, it is anticipated that there would be no significant net adverse health impacts due to road safety risk for NMUs.

6.8 Personal Security

6.8.1 Personal security is the relative freedom from risk or fear of attack or robbery, considering people’s perception of security in addition to any evidence of actual risk. The degree of security which individuals feel when using the transport network can influence the choice of mode, destination and time of travel, all of which have potential secondary impacts in terms of social inclusion, environmental quality and economic prosperity.

6.8.2 In terms of security for users of public transport, despite the existing M4 being used by bus services, boarding or alighting from public transport services is not permitted on the motorway, which would continue to be the case should bus services make use of the new section of motorway. For this reason, personal security when using public transport within the new section of motorway is not an issue. Likewise non-motorised road users are prohibited from accessing the motorway carriageway, and so for this reason personal security for non-motorised users within the new section of motorway is not an issue.

6.8.3 As part of the Complementary Measures there would be provisions in place for non-motorised users, including provision of facilities for pedestrians, cyclists and equestrians, to replace or divert those stopped up temporarily or permanently during scheme construction, as well as provide supplementary routes in certain areas. These resources would maintain personal security through providing safe methods of travel across highway routes and around areas potentially affected by the Scheme.

6.8.4 Due to much of the new route running through areas with a low number of dwellings, businesses and services, there is potential for some areas of the new section of motorway (particularly to the east of Castleton and south west of Newport) to feel isolated for users, which may influence perception of risk and their personal security, particularly for vulnerable users.

6.8.5 However, suitable lighting would be installed where required, including approaches to and throughout the Castleton and Magor Interchanges, approaches to the Docks

Way Junction and over the River Usk crossing and finally approaches to and throughout the Glan Llyn Junction and linking road connecting the new motorway with the A4810 junction and approaches. This lighting design may help to improve personal security through improving the perception of security by users, which is important since according to WelTAG a proposal which impacts a user perception of security is significant even if the actual risk remains unchanged.

6.8.6 Due to the nature of the Scheme, it is unlikely that the new section of motorway, reclassification of the existing M4 and other Complementary Measures would result in any significant changes to personal security, or the perception of risk. At most a slight adverse effect might be experienced due to potential isolation of the new section of motorway in certain areas. The measures for non-motorised users would avoid a negative effect through providing safe routes and crossings.

6.9 Permeability

6.9.1 Permeability is the ease with which people in the affected area can travel by non-motorised modes. WelTAG specifies that permeability should consider any changes in the number or type of barriers to travel and any changes in the ability to reach key services by non-motorised modes.

6.9.2 In terms of the Scheme's potential for effects on permeability through changes to the number and types of barriers, for the area of new motorway created there would be an additional barrier bisecting the areas to the south and west of Newport, that would impact on the ability of non-motorised users to cross the area affected. This is especially the case during the construction phase where temporary or permanent closure of existing public rights of way, cycleways and other important routes would occur, such as temporary stopping up of the section of public footpath along which the Wales Coast Path and Newport Coast Path run. A list of important routes affected is provided in Chapter 14 (All Travellers) of the ES. For this reason the construction phase could have the potential to increase journey lengths and hinder non-motorised journeys. However, mitigation in the form of temporary diversions for affected rights of way would be in place during construction to ensure that impacts to these resources are minimised as far as possible.

6.9.3 The underpass and overbridge crossings along the existing M4 provide vital non-motorway user links between the more sparsely populated areas to the north and the main settlements at Newport and Magor. During the operational phase, these links would remain (with the exception of the Pound Hill crossing, discussed further below), allowing continued linkage between areas over the reclassified existing M4.

6.9.4 New crossing structures would be provided for the new carriageway, to ensure that the new section of motorway does not preclude movements to settlements and resources within the Scheme area and further afield.

6.9.5 In terms of community severance and access to services, during the construction phase, it has been assessed within Chapter 14 in the ES that the impacts of land take and construction activities would be limited through measures to ensure that the network of non-motorised user resources are maintained. Temporary closures of public rights of way and cycle routes could have the potential to hinder journeys, and therefore preclude access to services. It is anticipated that the potential health impacts from changes to accessibility of services due to community severance may be minor for some areas, for example through residents being dissuaded from making trips, and therefore consequent reduction in the ability to access key services.

6.9.6 Similarly for accessibility of key services during the operational phase, existing highways and non-motorised user resources would be maintained with new structures and measures in place to allow safe crossing for the new section of motorway. New PRoW in the form of new public footpaths and bridleways would also be provided to allow additional resources for non-motorised users, which should enable users to access services in these areas. This would ensure that for the most part local journeys would be unaffected by the operation of the new section of the motorway and community severance from local facilities would be prevented. The main exception is with the proposed new section of motorway and the existing M4 at Pound Hill, which would result in the need for an alternative route for traffic and non-motorway vehicles wishing to cross the existing and new motorway, involving diversion to crossings further along the motorway route. However, it is anticipated that the number of people to be affected by this change would be small, principally the residents of the properties located on the retained section of Pound Hill and the residents of Pen-y-Lan.

6.9.7 For the majority of non-motorised user journeys there would be minor changes to routes and crossing points, which should not result in a substantial increase in journey time. It is therefore considered that health impacts from community severance in the operational phase should be neutral, with the majority of journey patterns maintained, with only minor hindrance to movement and provision of additional resources for some areas. Furthermore, with existing routes to be maintained and new routes and crossings made available, to enable local users to travel to key facilities and health services, the Scheme should not result in a significant impact to health from changes to the accessibility of key services. During the construction phase, temporary closure of non-motorised routes may cause some disruption to journeys, potentially hindering access to services. However, measures in place to ensure that the majority of routes are maintained or diverted would help to minimise the impacts from construction.

6.10 Physical Fitness

Introduction

6.10.1 Physical fitness, as defined by WelTAG, includes several lifestyle factors encompassed by 'good health and wellbeing':

- smoking, alcohol consumption and risk-taking behaviour (e.g. drug misuse);
- nutrition and healthy eating;
- physical activity;
- sexual health;
- health care; and
- education and training.

6.10.2 In relation to the development, the main influence on physical fitness would be through:

- potential changes in physical activity during the construction and operational phases;

- potential changes in access/accessibility and capacity of health care during construction and operational phases; and
- potential changes in the level and access to education and training during construction and operation.

6.10.3 The Scheme would not affect nutrition and healthy eating, which has therefore not been considered further. The only potential impact on sexual health could be with regard to the mobile construction workforce. The size the population in the Newport area relative to the construction workforce is such that a significant impact on existing sexual health due to temporary presence of mobile construction workforce would not be anticipated.

Physical Activity

6.10.4 Evidence suggests that increasing levels of walking and cycling as a key mode of local transport not only promotes good health and wellbeing, but also aids significantly in reducing the prevalence and treatment costs for a wide range of key physical health issues (Christl, et al., 2009; Bourn, 2001; Buroni & Jones, 2011). These include obesity, type two diabetes, cardiovascular disease, cancer and osteoporosis, improvements in which would ultimately aid in reducing all-cause mortality. In addition, walking promotes social inclusion, can reduce crime and perceptions of crime (more people walking and watching over neighbourhoods can discourage opportunistic crime and anti-social behaviour), and is typically open to all demographic and socio-economic groups, with the exception of those with mobility impairments.

6.10.5 A chronic underlying factor in existing burdens of poor health within the study area, particularly within Newport, where the majority of the Scheme is based is a poor level of adult physical activity and a high rate of obesity.

6.10.6 The Scheme therefore presents an opportunity to support physical activity and social connectivity improvements at both a local and regional level, while further addressing existing environmental and behavioural barriers limiting levels of physical activity, including:

- improving the quality of green transport networks (influencing the desire to walk/cycle over alternative options);
- improving pedestrian safety and addressing perceptions of poor safety (enabling people of all ages and levels of mobility to safely utilise routes); and
- raising awareness regarding the convenience, economic and social, mental and physical health benefits of active lifestyles.

6.10.7 As detailed in Chapter 14 of the ES (All Travellers), several existing public rights of way (PRoW), cycleways and informal routes used by non-motorised users lie within the footprint of the new carriageway or area required for earthworks, implementation of Complementary Measures etc., and so would be subject to land take during construction. As a result, several routes would need to be stopped or diverted. However, there would also be several new routes would be created as part of the Scheme to replace or divert those effected by the schemes construction (details of which are provided in Chapter 14). Once operational, a number of additional new routes would be provided, including new public footpaths and bridleways around the new section of the motorway and to the south of the existing road, which would provide additional opportunities for physical activity within these areas and would likely to result in a minor positive effect on physical fitness.

6.10.8 During construction, temporary stoppage of sections of important routes such as the Wales Coastal Path and the Newport Coastal Path may have the potential to impact on the integrity of the route as a whole. Therefore, temporary effects may result in impacts on accessibility of well-used routes, hence there is potential for health impacts from reduction in use of these routes for physical activity. However, upon completion of the construction phase, public rights of way temporarily stopped would be reinstated along their original or diverted alignments, in addition to the new PRoW to be implemented as part of the Scheme.

6.10.9 Changes in amenity on some PRoWs as a result of the Scheme are likely. However, it is anticipated that changes to amenity for the PRoW in close proximity to the existing M4, M48 and A48 would not be as great as those within the rural areas to the south and west of Newport which would experience changes resulting from visual and noise impacts from the new section of motorway. Mitigation would be put into place to address these issues wherever possible with use of landscape planting to lessen the impact and as a result of this, positive visual impacts are anticipated for many of the access ways used. There may also be changes to amenity as a result of changes in the noise environment, with some areas experiencing improved amenity due to reduction in noise around the existing M4.

6.10.10 An increase in noise is anticipated in some sections of PRoWs around the new section of motorway, with consequent potential for reduction in amenity. However, the committed noise mitigation and woodland planting would help to minimise deterrence to use of the area for physical activity.

6.10.11 The impacts for important routes may be greater during the construction phase, and therefore there is the potential for a decrease in use, physical activity and connectivity from these routes and hence health implications resulting from this. For the most part, the Scheme has ensured that where sections of important routes are to be interrupted throughout the construction or operational phase, suitable diversions or alternatives would be put into place. For example diversions used for the Wales Coast Path and Newport Coast Path would result in a slight decrease on the length of pedestrian journeys. For this reason, disruption may only be temporary and would be compensated with use of alternative routes and diversions, and in the long term in the operational phase measures would be in place to maintain and increase user resources.

6.10.12 Taken as a whole, permanent impacts on PRoWs and other resources for non-road travellers are likely to be neutral. Health and wellbeing impacts due to reduced opportunities for physical activity and recreation are therefore likely to be correspondingly neutral.

Health Care

6.10.13 No doctor’s surgeries, hospitals or aged persons’ homes would be directly affected by the Scheme during construction.

6.10.14 Once operational, the Scheme may improve road safety, reducing health care demand through a reduction in the number and severity of road traffic accidents.

6.10.15 The Scheme would further improve access to health care through enhanced public and private transport connectivity, and may facilitate faster and safer emergency response through improved road capacity and resilience.

6.10.16 During construction, however, there is the potential for a temporary reduction in access and accessibility along the Scheme as a consequence of road and pedestrian diversions (see discussion of permeability, above). Any disruption would be managed primarily through diversion design and scheduling, and engagement with the emergency services and local health care providers.

Education and Training

6.10.17 Education is a key determinant of health that influences a wide range of other socio-economic factors (income, employment, housing and health care) and lifestyle (risk-taking behaviour, physical activity and social support), and ultimately the quality and length of life. This correlation between education, employment and health can be clearly seen when comparing the community and health profiles for Newport and Monmouthshire. Communities within Newport tend to demonstrate a correlation between the higher rates of morbidity and mortality, and the higher rates of socio-economic deprivation and low academic achievement, in comparison to the levels attained in Monmouthshire, generally a more affluent area.

6.10.18 A key principle of the construction phase is to optimise the uptake of direct, indirect and induced socio-economic benefits through local recruitment initiatives. 'Targeted Training and Recruitment' requirements have been identified for the works, set by the Welsh Government. The Joint Venture Contractor has committed to 20% of the total labour costs to be covered by employment of new entrant trainees with an apprenticeship, trainee or employment contract with the contractor or subcontractor and who are engaged in an appropriate training programme. The objective of such an initiative is in part to address local socio-economic circumstance and inequality, by addressing existing barriers to local update of employment benefits, and optimising long term socio-economic health benefits through the creation and promotion of local skills and experience.

6.10.19 Furthermore, once operational, the Scheme is designed to improve connectivity to services in south Wales, including a range of training and educational establishments.

6.10.20 Overall, the Scheme's direct and indirect influences on education and training during the construction and operational phases are expected to lead to a subsequent health benefit.

6.11 Access to Services

6.11.1 Accessibility can be defined as the ways in which an individual can access services and facilities that they need or desire. It encompasses the entire journey chain from the origin to the destination and reflects the ability of individuals to reach and use transport services and infrastructure as well as other necessary services relevant to health and wellbeing (e.g. education and healthcare services, sports and other recreational or social facilities, etc.).

Scheme impacts on access and accessibility to services and facilities

6.11.2 The potential for the Scheme to change the ability of non-motorised transport users to reach key services and the impacts of community severance has previously been discussed in section 6.9: Permeability, which should be considered along with the following impacts to accessibility of services.

6.11.3 During the construction phase, there would be no direct land take or construction impacts on community facilities, such as hospitals, care homes and schools, as a result of the Scheme, hence there are no predicted health impacts resulting from loss of community services. However, a number of land areas used by the community would be subject to land take under the Scheme, including a portion of common land near the River Ebbw and the Green Moor Lane allotments, used by local residents. The common land near to the river and the Castleton 'grow you own' plots are also expected to experience effects from construction, through the construction of the River Ebbw crossing and proximity to construction works. These land use areas are assessed in Chapter 15 (Community and Private Assets) in the ES as being of high importance due to a limited potential for substitution. Access to facilities within Castleton, Newport, Magor and outlying settlements would remain via the existing road network during construction, with traffic management being implemented along certain routes as required, thus ensuring that access to facilities is not completely prevented throughout construction.

6.11.4 Complementary measures including the reclassification of the existing M4 and construction of route connections may also potentially result in changes to amenity of community and private assets local to the works, through construction related works and traffic and the visual and noise impacts this would have on resources in proximity to construction works.

6.11.5 During the operational phase of the Scheme there is potential for changes to amenity of community facilities within and outside of the settlements of Castleton, Newport and Magor, resulting from changes to the visual and noise environment of the area, as well as changes to traffic flows resulting from the Scheme. There is potential therefore for an impact to human health should the amenity or accessibility be reduced to a level significantly discouraging access to services and facilities, such as hospitals, recreational greenspace and care homes. However, it is anticipated that changes to amenity with be minor for the majority of users of public rights of way. A full description of changes in amenity predicted from the construction and operation of the scheme can be found in Chapter 14: All Travellers in the ES.

6.11.6 As a result of the above, there may be potential for some minor adverse health and wellbeing impacts due to loss or disruption to access to community facilities, but this is anticipated to be limited. Overall the Scheme is designed to improve transport options for all travellers and hence would provide a benefit from increased road accessibility to services.

Building demolition

6.11.7 As mentioned previously, land take required for the Scheme would result in the demolition of twelve residential dwellings along the route of the proposed new section of the M4. In addition, five further properties would experience some effects from land take from part of their land for the scheme. However, no buildings providing services to the community, such as schools, churches, hospitals etc. would be demolished as part of the Scheme. For this reason, no impacts upon access to services would result from demolition of properties as part of the Scheme.

6.12 Equality, Diversity and Human Rights

6.12.1 In accordance with the Welsh Government guidance on Equalities Impact Assessment (EqIA), a Stage 1 assessment comprising a high level appraisal was performed to establish the likely aspects of the Scheme with the potential to disproportionately impact upon sensitive community groups, to investigate the need for and if so the scope of any further assessment.

6.12.2 Equality, diversity and human rights has been assessed as one integrated topic, as set out in WelTAG, as inequality in health or social impacts on individuals or groups due to factors such as disability, age or religion may affect their human rights.

Construction Phase

6.12.3 As detailed in Section 3.4 of this HIA, construction health pathways are associated with potential temporary diversion and disruption of existing road networks, footpaths and cycle paths, which may affect accessibility of services, amenities facilities, employment and recreation. Construction-phase employment also has potential for inequalities or discrimination if not appropriately managed, although this is controlled by existing legislation.

6.12.4 Sensitive community groups largely include those with fewer options and coping mechanisms to address temporary disruption that may limit access and accessibility to services amenities and social networks, including the elderly, infirm and socio-economically deprived. Children are also subject to higher risk from road traffic accident and injury than adults, and evidence suggests that this risk is further heightened in areas with socio-economic deprivation.

6.12.5 The Scheme would result in some land take and demolition of twelve residential properties in total. The majority of properties to be demolished are individual properties outside of the main settlements, with the exception of four properties within a cluster of residential dwellings to the southern side of Junction 29 at Castleton. Demolition of these four properties could result in impacts to wellbeing for vulnerable groups, such as the elderly or infirm, living in the remaining properties through loss of community support and security associated with this, for those vulnerable groups which rely on this support.

6.12.6 The construction of the Scheme represents a significant capital investment and associated direct, indirect and induced income and employment opportunities. Sensitive community groups largely include the socio-economically deprived, who could most benefit. A commitment has been made for 20% of labour costs to consist of employment of new entrant trainees, undertaking an appropriate training programme. If this is effectively targeted, it can be a positive measure for reducing economic and educational inequality in the Newport area.

6.12.7 Construction-phase noise and dust are considered to have potential for significant impacts, which are proposed to be managed through additional mitigation measures under the CEMP. Additional mitigation must be provided equally in affected areas to avoid discriminatory impacts through these environmental pathways.

6.12.8 Overall, construction-phase health pathways are not anticipated to have any disproportionate impact upon gender, race, ethnicity, religion, sexual orientation or sexual preference. On this basis, no further Equalities Impact Assessment is required for the construction phase of the Scheme.

Operational Phase

6.12.9 Once operational, the principal potential health pathways would be in the domains of transport (safety, access to services, options for non-motorised road transport) and changes in noise and air quality.

6.12.10 Severance or reductions in accessibility of public transport, footpaths or cycleways could have the potential for inequality in impacts for those with mobility impairment or who are not car owners. A reduction in opportunities for physical activity and recreation could also disproportionately affect those with lower socio-economic status, which is correlated with obesity. However, as detailed in section 6.9 above, the Scheme is being designed to maintain and improve facilities for non-car travel through retaining, providing alternative/diverted and in some areas additional footpaths and cycleways, and there are no predicted effects on public transport routes. No significant inequality impacts due to these environmental and social pathways are therefore anticipated.

6.12.11 At the level of analysis in this HIA, assessing changes in average environmental and social effects across a large study area population, it is not possible to directly investigate differential impacts on groups that would be especially sensitive to changes in exposure, such as those with existing disease or disability. With regard to the principal environmental health pathways, the net effect of the Scheme is predicted to be an improvement in air quality and noise exposure, and on balance there is likely to be a greater benefit than disbenefit to sensitive groups as the areas with improvements cover a much larger population. However, at an individual level there is likely to be some inequality (positive or negative) in reality.

6.12.12 Noise and air pollutant reduction around the existing M4 affect areas with a mixture of deprivation characteristics, encompassing some areas with the highest recorded deprivation levels in Newport. The majority of the area affected by increases in noise lies in the middle of the deprivation scale, although adverse impacts in the area of high deprivation around Newport Docks are apparent. Increases in air pollutant concentrations are generally less significant and affect a smaller spatial area.

6.12.13 The index of multiple deprivation is a relatively crude means to consider social inequality in the distribution of impacts, but does provide some evidence that adverse impacts from the Scheme are not disproportionately affecting areas with high existing socio-economic deprivation.

6.12.14 On the above basis, overall the operational health pathways are again not anticipated to have any disproportionate adverse impact upon gender, race, ethnicity, religion, sexual orientation or sexual preference.

6.13 Assessment Conclusions

6.13.1 Overall, the Scheme is predicted to cause quantifiable but minor beneficial health outcomes due to a net reduction in residential noise and air pollutant exposure. Construction-stage employment, investment and training, and operational-phase improvements to the accessibility of services and reduced journey costs are predicted to have socio-economic health and wellbeing benefits. The impacts on physical fitness and permeability are on balance likely to be neutral.

6.13.2 The Scheme's health and wellbeing impacts would not be evenly spatially distributed, with much of the benefit from physical and environmental health pathways accruing to areas in north Newport around the existing M4, and disbenefits being experienced around the new section of motorway to the south and junctions to the east and west.

6.13.3 However, there is no clear pattern of adverse or beneficial health and wellbeing outcomes disproportionately affecting areas of high or low multiple deprivation, and thus little evidence at this scale of analysis for significant inequalities in impacts. The nature of the Scheme itself is not such that any specific disproportionate impact on individuals or groups based on their gender, race, ethnicity, religion, sexual orientation or sexual preference is anticipated.

7 WelTAG Appraisal Summary

7.1 Introduction

7.1.1 This section provides a summary of the assessment outputs to meet WelTAG health, social and inequality appraisal requirements.

7.1.2 As per WelTAG requirements, the Appraisal Summary Table applies a five-point scale (moderate negative, slight negative, nil impact/neutral, slight positive and moderate positive) and is not intended to be a detailed assessment, but to aid decision makers by drawing the combined assessment findings together and highlighting key elements to be explored in more detail.

Appraisal Criteria	Assessment Rationale	Distribution	Significance
Social Impact Criteria			
Transport safety	The Scheme is intended to improve road traffic safety by providing a new road link and associated Complementary Measures built to modern safety standards. The existing M4 section is predicted to become highly congested in the absence of the Scheme and does not meet modern motorway standards in several respects. A small positive impact on traffic safety is therefore likely, with around 14 slight injuries avoided per year based on an appraisal of traffic flows with the Scheme in place using default accident rates for different road classifications.	Existing M4 and proposed new section of motorway and associated junctions.	Slight positive
Personal security	Construction is not anticipated to significantly impact on personal security.	n/a	Nil impact/neutral
	Complementary Measures would include provision for non-motorised users increasing personal security through safer crossing of busy routes. Potential for isolation along new sections of motorway due to location. Other measures such as suitable lighting along sections of the motorway can help to improve perception of security.	Sections of the proposed route to the east of Castleton and southwest of Newport may seem isolated, which may particularly affect vulnerable users.	Slight negative
Permeability	Construction has the potential to reduce permeability through some temporary closures to routes, which may hinder journeys and prevent to services. Impacts from construction would be minimised however by ensuring that the network of non-motorised user resources (footpaths, bridleways, cycle ways) are maintained, as far as possible.	Non-motorised routes passing through the area of the new section of motorway are likely to be disrupted due to temporary closure during construction.	Slight negative
	Non-motorised user resources would continue to be maintained during the operational phase, and additional PRoW resources will be provided for some areas. New structures and measures would be in place to allow safe crossing of the new section of the motorway and new routes. These measures would ensure that the majority of local journeys would not be prevented by the Scheme and community severance is prevented; however, certain areas (Pound Hill) would experience permanent diversion and some existing PRoWs would have reduced amenity.	Non-motorised users would mostly experience disruption around the Pound Hill area, where alternative routes would need to be found to allow users to cross the motorway.	Neutral

Appraisal Criteria	Assessment Rationale	Distribution	Significance
Physical fitness	During construction, public rights of way and cycle paths may be temporarily closed or diverted, which may affect use of these areas for recreation and the subsequent impact on physical fitness.	Users of the Wales Coastal Path and Newport coastal path may be particularly affected by changes to the integrity of the cycle ways as a whole, which may reduce use of these routes for recreation.	Slight negative
	There may be changes in amenity for users of routes in proximity to the new section of motorway during the operational phase, due to increased visual and noise impacts. Mitigation would be put into place to lessen impact where possible. Loss of routes throughout the study area would be compensated with creation of new routes and crossings for non-motorised users, maintaining the opportunities for physical activity.	Scheme would particularly affect users in proximity to the new section of motorway, due to changes in amenity, which may reduce use of area for physical activity.	Slight benefit
Social inclusion	Social inclusion in WelTAG relates specifically to access to services. During construction, there would be some disruption and diversions for both road users and for non-road transport. Although measures would be put in place to minimise the disruption, some residual impact is likely.	Road and non-road transport around existing M4 junctions and the proposed new section of motorway may be affected. Disruption may disproportionately impact certain groups (e.g. those with mobility impairment).	Slight negative
	The Scheme is intended to improve road transport access to services in and around Newport, and should have no overall net adverse effect on accessibility by non-road/motorised transport.	Accessibility and inclusion benefits would mainly accrue to road users, especially private car owners.	Slight positive
Equality, diversity and human rights	During construction, temporary disruption and has potential for impact to vulnerable groups such as the elderly, infirm and socio-economically deprived, through reduced access to community services and support and noise/dust effects, although mitigation measures are expected to be provided. Scheme construction would also involve employment and training which may be of benefit to the socio-economically deprived, with appropriate recruitment and training targeting.	Those sensitive to changes in health pathways, who may have limited coping methods or alternatives, including the elderly, infirm and socio-economically deprived.	Slight positive

Appraisal Criteria	Assessment Rationale	Distribution	Significance
	The construction phase is not anticipated to have a disproportionate impact on gender, race, ethnicity, religion, sexual orientation or sexual preference.		
	Severance or reductions in accessibility of public transport, footpaths or cycleways has the potential for inequality in impacts for those with mobility impairment or who are not car owners. However, the Scheme is being designed to maintain or improve on facilities for non-car travel and no significant inequality impacts are anticipated. The net effect of the Scheme is predicted to be an improvement in air quality and noise exposure, and on balance there is likely to be a greater benefit than disbenefit to sensitive groups as the areas with improvements cover a much larger population. However, at an individual level there is likely to be some inequality (positive or negative) in reality. Spatial analysis using the index of multiple deprivation provides some evidence that adverse impacts from the Scheme would not disproportionately affect areas with high existing socio-economic deprivation.	Those sensitive to changes in health pathways, who may have limited coping methods or alternatives, including the elderly, infirm and socio-economically deprived.	Slight positive
Health Impact Criteria			
Lifestyle / capacities affecting health	Construction activities may have potential to disrupt resources currently used for recreation and physical activity or access to services in certain locations. However alternative routes and diversions would be provided to maintain access to resources where possible.	Particularly vulnerable groups include the elderly, infirm and socio-economically deprived with varying levels of mobility and alternatives, in areas where temporary or permanent disruption occurs.	Slight negative
	During the operational phase non-motorised user routes would be maintained, and alternative resources would be provided for those permanently disrupted, which would help maintain use of these areas for physical activity. Increased connectivity and reduced transport times with the use of the new route can help to increase accessibility to health services. However there may be some loss of amenity at recreation resources experiencing impacts due to proximity to the Scheme.	Particularly vulnerable groups as above, with varying levels of mobility and limited access to alternatives, may benefit from the additional resources	Slight negative

Appraisal Criteria	Assessment Rationale	Distribution	Significance
Social and community influences affecting health	Construction would result in demolition of twelve properties, and several non-motorised route ways. Mitigation and alternative routes would be provided to help reduce disruption and continued connectivity, to prevent community severance.		Nil impact/neutral
	During the operational phase, improved connectivity from new transportation routes from the new road would improve for the majority of road users around the Scheme. Connectivity would be maintained for non-motorised users through maintenance, replacement and additional provision of PRoW, cycle ways etc.	Particularly vulnerable groups as above, principally those in proximity to the Scheme that would be affected by changes to transportation networks	Slight positive
Living conditions	There is potential for significant adverse impacts due to construction noise and dust, although additional mitigation through measures in the CEMP to reduce these impacts can be employed.	Particularly vulnerable groups, including the elderly, infirm and socio-economically deprived, who are more susceptible to health impacts related to living conditions.	Slight negative
	During the operational phase, local air quality would remain within air quality objective levels. The net effect of the Scheme is predicted to be a reduction in noise and air pollutant exposure, mainly for the population around the existing M4. An increase in exposure is predicted around the new section of motorway and certain junctions and other road links, although affecting a smaller population and this is not anticipated to result in new exceedances of air quality objective levels. Although there is a moderate net benefit, within this there is spatial inequality in the impacts.	All residents, but particularly vulnerable groups are the elderly, infirm and socio-economically deprived, who are more susceptible to health impacts related to living conditions.	Slight positive
Working conditions	Construction activities would be carried out in accordance with occupational health requirements to ensure safety and wellbeing of staff.		Nil impact/neutral
	Operational activities should not adversely impact on working conditions and should result in improvements to road safety for vehicle operators.		Nil impact/neutral

Appraisal Criteria	Assessment Rationale	Distribution	Significance
Services (access and quality)	No direct impacts on services would result from construction activities. There may be changes to amenity and accessibility of services; however, mitigation would be put into place to maintain connectivity within areas affected by construction works.	Particularly vulnerable groups include the elderly, infirm and socio-economically deprived with varying levels of mobility and alternatives, which would be particularly affected by changes to transportation networks.	Slight negative
	No direct impacts on services which could influence health would result from operation of the Scheme. Alternative and additional non-motorised user resources would be implemented to replace those lost and to maintain connectivity to services to ensure that health impacts from changes to accessibility are minimised.	Particularly vulnerable groups include the elderly, infirm and socio-economically deprived with varying levels of mobility and alternatives, which would be particularly affected by changes to transportation networks.	Nil impact/neutral

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