World Transport Policy and Practice
Volume 23.3&4
December 2017

The Box

The late delivery of what is less
Than promised, at a higher cost, for what
The arguments and evidence have shown would not
Save time, cut costs, boost growth, but leave the mess

From fossil fuels unchanged, or maybe add to it.
Is infrastructure maybe just a game perverse
In rules, and played between the planners and investors,
For stakes of prized investment and protected profit?

There is a box we cannot think outside,
A mould, a paradigm, which - if we aim
To rectify polluted streets and seas and to reclaim
The climate and the air – needs to be pushed aside.

Norman Fairclough 24 October 2017

ISSN 1352-7614

PROFESSOR JOHN WHITELEGG
SCHOOL OF THE BUILT ENVIRONMENT
LIVERPOOL JOHN MOORES UNIVERSITY

PUBLISHER

WORLD TRANSPORT POLICY AND PRACTICE,
41 CHURCH ST,
CHURCH STRETTON,
SHROPSHIRE
SY6 6DQ
TELEPHONE +44 (0)1694 722365
E-MAIL:
johnwhitelegg@phonecoop.coop
WEB:
http://worldtransportjournal.com

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"More than $26 trillion will be needed between 2016 and 2030, or $1.7 trillion a year in Asia, to deliver infrastructure that supports robust growth and is #climateresilient. http://bit.ly/2hBNLbS #LetsBuildAsia"
Tweet, 13 November 2017

The transport debate in all countries, cities and regions of the world is dominated by the very poorly defined term "infrastructure". We are repeatedly told by national governments, lobbyists and the very large corporations that supply "infrastructure" that we do not have enough or we are not renewing it at a fast enough rate or we are lagging behind another country that has more infrastructure or our ability to deliver economic growth in a highly competitive globalised economy is hampered by the lack of infrastructure. Infrastructure has taken over from the more mundane discussion about new roads, airports and high speed rail. Infrastructure embraces all these components but elevates the discussion of any individual component to a new level. We must have more infrastructure and the use of the word is enough to crush any opposition, promise any number of benefits and dismiss any alternative scenarios or options that don't have the magic wand labelled "infrastructure".

A recent press release, 24th October 2017, captured the essence of this focus on infrastructure and the urgency of providing far more "infrastructure" in the future:

Embargoed: 00:01 Hours, Wednesday 25th October, 2017

It's Crunch Time for Infrastructure Delivery - CBI/AECOM

Three quarters of firms and public doubt any improvement this Parliament

Despite the Government's strong commitment to improving the UK's infrastructure, both business and the public are concerned about the pace of delivery and a record number of firms are dissatisfied with the state of infrastructure in their region, according to the 2017 CBI/AECOM Infrastructure Survey.

With the UK currently ranking 27th in the world for the quality of its infrastructure, nearly all (96%) of the 727 businesses surveyed see infrastructure as important (of which 55% view it as critical) to the Government's agenda. >From the Clean Growth Strategy and the £500 billion infrastructure pipeline to its decision to build a new runway at Heathrow and press ahead with the A303 tunnel, the Government has made clear its commitment to British infrastructure.

However, only one in five firms is satisfied with the pace of delivery (20%) and almost three quarters (74%) doubt infrastructure will improve over this Parliament. This lack of confidence is attributed primarily to policy inconsistency (+94% of firms) & political risk (+86%). The digital sector is the exception, however, where 59% of firms are confident of improvements.

Carolyn Fairbairn, CBI Director-General, said:

> *"We've seen a real commitment from the Government on infrastructure over the last year, from decisions on Heathrow and the A303 to pledges to scale up the supply of housing and clean energy. But our survey shows this is not translating into optimism about future improvements among both firms and the public, who are united in their concern about the pace of delivery for new projects. We've now reached crunch time for the UK's infrastructure.*
> *"As the foundation for wider growth, world-class infrastructure is fundamental in driving productivity, and helps create jobs and raise living standards. Our message is as clear as it is simple – this is no time for discussion and delays, it's time for delivery. This needs to be heard not just by Westminster, but by local and devolved governments, as making progress on smaller, local projects is just as important as the bigger projects. Firms will not be forgiving if this focus slips."*

Richard Robinson, Chief Executive – Civil Infrastructure, Europe, Middle East, India and Africa, at AECOM, said:

"Given the strong correlation between infrastructure investment and economic growth, it is hardly surprising that when infrastructure decisions are delayed, it is UK business that feels the pain. Indeed, the overriding message from business and the public in this year's survey is clear: more needs to be done to raise confidence and up the pace in which infrastructure is delivered. Now is the time to provide clarity around infrastructure investment and accelerate action.

"Transformational infrastructure necessitates bold decisions and strong vision. The next five years present a huge opportunity for the Government to set in train a lasting legacy for future generations. The link between transport and long-term plans for other vital infrastructure such as energy, water, waste and housing must also be considered. A clear vision for integration will be essential to accommodate the UK's projected population growth and maintain economic prosperity."

About AECOM:

AECOM is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM had revenue of approximately $17.4 billion during fiscal year 2016. See how we deliver what others can only imagine at aecom.com or @AECOM.

About the CBI

The Confederation of British Industry (CBI)

The CBI speaks on behalf of 190,000 businesses of all sizes and sectors. Together they employ nearly 7 million people, about one third of the private sector-employed workforce.

http://www.cbi.org.uk/about/about-us/

A key question not addressed by the promoters of "infrastructure" is how this emphasis links with sustainable development, Sustainable Development Goals (SDGs) and sustainable mobility and with the climate change agenda recently under discussion at COP23 in Bonn. It cannot be the case that a strident call for more infrastructure which means more roads, airports and high speed rail is consistent with sustainability principles. Just adding more and more to an already very large burden of pollution, land take, carbon emissions and materials use is not in any way consistent with concepts like "one planet living", living within our means and protecting nature, biodiversity and planetary ecosystems that support human life and the diversity of all fauna and flora. Nor can an infrastructure fetish be consistent with the game-changing work of Rostrom and his colleagues[1] on planetary boundaries. We simply cannot keep up and increase the consumption of land, air, water and nature in the search for the illusory benefits of economic growth. It is clear that planetary boundaries exist and a strident call for more infrastructure can only mean breaching those boundaries with catastrophic implications for biodiversity, ecosystems and climate change.

The infrastructure fetish is illogical, immature and innumerate. It is not possible to keep exploiting the planet in a way that threatens ecosystems and takes us on the wrong side of planetary boundaries. The conclusion, therefore, is that the emphasis on infrastructure is a fundamentally flawed attempt to maintain and develop "Business As Usual" (BAU) thinking and delete any tangible recognition or commitment to sustainability of any kind. It is fraudulent, deviant, destructive and consumes trillions of dollars, a large propor-

tion of which will be public funds siphoned away from health care, social care, education and housing.

The World Health Organisation in its global strategy for increasing levels of physical activity has drawn attention to the importance of Sustainable Development Goals (SDG) and the global agreement that has signed up to these SDGs:

> 9. The 2003 agenda for Sustainable Development, and the commitment for its 17 goals made in 2016 by world leaders, provide a golden opportunity to refocus, renew and combine colective efforts to promote physical activity. It provides opportunities forurgent prioritisation and scaling of efforts in implemetation of effective actions so that increased levels of physical activity can contribute to achieving an improvement inhealth and wellbeing and support specific Sustainable Development Goals (SDGs). These SDGs include: food and nutrition security, through ending all forms of malnutrition including obesity SDG2.2); improved health and wellbeing through reduction of NCDs; reduced road traffic accidnets and improved air quality (SDG3.4, 3.6 and 3.9); quality education through enhanced readiness for primary education and improved educational outcomes (SDG4.2, 4.1); gender equality contributing to ending discrimination (SDG5.1); reduced inequalities through empowerment and promoting equal opportunity (SDG10.2, 10.3); safe, sustainable cities and communities through sustainable transport and urbanisation and universal access to green spaces (SDG11.2, 11,3, 11.6, 11.7); mitigation of climate change through reduction of fossilfuel use and other mitigation measures (SDG13.1, 13.2); protection of life on land through sutainable land use (SDG15.1, 15.5); and peaceful and inclusive societiesthrough reduction of violence adn promotion of non-discriminatory policies (SDG16.1, 16.5, 16.6). These policy connections can provide important reciprocal opportunities for health and other sectors to engage, to link policies and to prioritise investments in more considered an potentially more synergistic ways.

Source: WHO (2017) Draft Global Action Plan on Physical Activity, 2018-2030

http://www.who.int/ncds/governance/gappa_version_4August2017.pdf?ua=1

The summary of SDGs in the WHO Global Action Plan is directly relevant to a discussion about the location of infrastructure in any wider discussion about society, economy, environment, social justice and public health and there are glaring contradictions. An emphasis on infrastructure that does not give full recognition to and support of SDGs is unacceptable. The majority of infrastructure projects currently underway in the EU and other countries e.g. road schemes in the USA and Australia) are inconsistent with and contrary to a number of SDGs:

- SDG 2.2 Food and nutrition security as a consequence of removing high quality agricultural land for road, rail and airport projects
- SDG 2.2 Obesity as a consequence of greater spending and emphasis on motorised mobility and the decline in walking and cycling associated with higher traffic volumes and the reluctance of public authorities to impose lower speed limits
- SDGs 3.4, 3.6 and 3.9 as death and injury in the road traffic environment increases and air quality declines
- SDGs 11.2, 11.3, 11.6 and 11.7 Safe sustainable cities, safe communities and sustainable transport as cities change shape and form to accommodate increased numbers of motor vehicles and green spaces decline
- SDGs 15.1 and 15.5 Climate change and reductions in fossil fuel use as transport and mobility continue to increase carbon emissions and the huge quantities of infrastructure (concrete, cement, steel, asphalt) add a huge burden in embodied energy
- SDGs 15.1 and 15.5 Sustainable land use as land use patterns shift towards urban sprawl, loss of nature and biodiversity and loss of green pace

The majority of infrastructure projects ignore the collective responsibility of humanity to deliver SDGs and do not assess and evaluate the impacts of a particular scheme or overall strategy against the

global agreement to deliver sustainability. Indeed it is frequently argued in a splendid display of illogicality that a road scheme in the UK (for example) which will increase greenhouse gas emissions cannot be subject to challenge because of national or international commitments to reduce greenhouse gases. The two things, we are told, are totally unrelated and if any of readers have not experienced a highly paid barrister acting for the road scheme or airport expansion arguing that national reduction targets cannot be used to block an individual project they should turn up at a Public Inquiry and be prepared to witness the incredible in action.

This special issue focuses on the dramatic failure of one large infrastructure project to have the slightest concern for SDGs or alternatives that would deliver social, economic and environmental objectives and support SDGs. The specific example chosen is the M4 Relief Road in South Wales [2] but all road schemes and tunnels, flyovers, high speed rail and airports are part of the same bigger problem which is an infrastructure fetish that deliberately ignores and obstructs wider sustainability objectives as expressed in the SDGs. The M4 scheme has been the subject of a Public Inquiry that started in February 2017 and the articles in this special issue are a selection from the material presented by objectors at that Public Inquiry. The evidence that was presented was detailed, logical, scientific and persuasive and clearly shows that a new road costing £1.1 billion for 14 miles and causing devastation to protected areas and nature reserves should not proceed. Indeed it should not have got to the stage of a Public Inquiry when so many non-destructive, non-carbon generating, sustainable alternatives were available in the first place.

There are 11 articles in this collection and they cover the full range of issues that point inexorably to the rejection of this road scheme. They deal with impacts on climate change, nature, biodiversity and landscape, conflict with sustainability principles and breaches of statutory principles. The evidence reveals that new road building cannot solve congestion problems and does not deliver local economic benefits. The evidence that is available shows that new roads generate new traffic and it is not possible to detect local economic gains in an area receiving additional road capacity.

This situation is not unusual. There are road schemes in the USA and Australia that are promoted on the argument that they will solve congestion problems and the evidence is that they do not. The situation in Melbourne is yet another example of the infrastructure fetish supplanting a more holistic, rational and sustainable view of mobility, societal and transport futures:

> The State Government is pushing Transurban's Western Distributor tollway, a massive $10 billion road through Melbourne's inner west. The taxpayer contribution to this road is set to be at least $1.6 billion, with the rest paid for by allowing Transurban to levy additional tolls on road users for decades to come.
>
> It's billed as a road to get big trucks out of our residential streets. Yet unlike the original West Gate Distributor proposed before the election, it doesn't directly address this issue. Instead, it's planned to run directly into the city centre, encouraging an extra 5,000 cars an hour into central Melbourne and boosting Transurban's already swollen bank account at the expense of more cost-effective, congestion-busting alternatives.

Source: PTUA, Melbourne, Australia

https://www.ptua.org.au/campaigns/western-distributor/

The M4 Relief Road is very damaging to nature, biodiversity and protected areas and is supported by misleading claims about congestion relief and economic gain. It will also increase greenhouse gas emissions contrary to Welsh Government, UK Government and international agreements about the need to reduce these gases. It is a major failure of public policy because it flies in the face of evidence and is still supported by politicians, highway professionals and planners. It is also not unusual as the Melbourne example demonstrates.

The Public Inquiry into the M4 Relief Road is still in progress so we do not know the outcome. We will report on results when the Inspector reports his findings in 2018.

We are now at a crucial juncture in the discussion around sustainability, climate change and the ways decisions are made and priorities set. Is it acceptable that public policy and funding makes things worse? It is clear that high quality evidence and rational discussion does not have an impact on decision making in those jurisdictions promoting new roads and additional airport capacity. If we are to change things we have to change the way we discuss these projects and the way the decisions are made. This shifts the transport debate into a deeper and more meaningful debate about paradigm shift, transformation and "mindsets"[3].

The material included in this special issue lays down a marker and a challenge that is very important indeed. It challenges governments and politicians at all levels and in all jurisdictions to take evidence seriously, to ask searching questions and to make very sure indeed that the word "infrastructure" does not switch off the rationality and scrutiny process in decision-making and priority setting. If the M4 Relief Road goes ahead we will know that the age of rationality and the age of enlightenment are dead and we have fully embraced the world of unthinking ideology and rejection of evidence with no thought at all about alternatives, better futures and with an acceptance that any amount of damage and destruction to nature, landscape, biodiversity and planetary boundaries is irrelevant and need not be factored into decision-making.

Notes:

1. http://stockholmresilience.org/research/planetary-boundaries.html
https://www.ecologyandsociety.org/vol14/iss2/art32/

2. http://gov.wales/topics/transport/roads/schemes/m4/corridor-around-newport/?lang=en

http://www.bbc.com/news/uk-wales-south-east-wales-41404459

3. Goepel, M (2016) The Great Mindshift

https://wupperinst.org/en/a/wi/a/s/ad/3597/

Plate 1: Funkturm, Berlin

Tackling the M4 Zombie

Ian Rappel

For the last three decades one of Wales' most unique and historic landscapes, the Gwent Levels, has been threatened with destruction because of a proposed motorway relief road for the M4 around Newport. The threats and corresponding campaigns have waxed and waned and although the road proposal has been 'beaten' on several occasions the lure of the tarmac has proved irresistible to successive UK and Welsh Governments. In this respect, the current proposals are a typical example of the 'zombie road scheme' syndrome.

In previous incarnations – despite the obvious and catastrophic environmental and ecological consequences – the proposed M4 relief schemes were rejected on largely financial, political and economic grounds. The proposal proffered by Welsh Government in 2015, however, reversed this argument so that the rationale for the scheme became economic gain for South Wales and the Welsh economy as a whole. This argument would have carried greater weight in the past, but the latest proposed route - that has been subject to a 12-month Public Inquiry (the 'Black Route') - has come at a time when Welsh Government has been running around the United Nations circuits boasting of its environmental credentials following the introduction of a Well Being of Future Generations Act and associated Environment Act. These legislative initiatives have sought to place the Post-Rio '92 and 1987 Brundtland Report's definition of sustainability at the core of public policy and decision making. Alas for Welsh Government, a 15-mile 6-lane motorway through a landscape completely covered by European and UK environmental and historic designations falls far short of even the weakest definitions of sustainability. In many ways the recent Public Inquiry for the 'Black Route' has felt like a test case for the new progressive legislation.

In previous campaigns Gwent Wildlife Trust and other environmental NGOs have focused mainly on the ecological impact of the M4 zombie. But – in partial response to the Welsh Government's conversion to sustainability – we decided this time around to strategically broaden our resistance to include economic and other arguments that will be familiar to readers of this journal. The document that follows sums up the evidence provided by our pool of expert witnesses and we were able to recruit excellent pro-bono legal support. This tactic allowed us to counter and expose many of the economic fallacies presented by Welsh Government's legal team and to expose the technical and ecological shortcomings of their proposals. As I write the Public Inquiry is continuing into its 11th month and the weaknesses in the pro-road lobby have been widely circulated within the media.

Exactly why Welsh Government would follow up progressive legislation with regressive operations is a mystery – but as a standard analysis of words vs. deeds they have been found wanting to the point of hypocrisy. Perhaps this case is best understood in its wider context. In our emerging era of resurgent nationalism and neoliberal fundamentalism - as we slide further away from environmental integrity for the sake of short-term profligacy under the much-degraded euphemisms of 'job creation and economic gain' - these zombie schemes in transport and other developments look set to return with a vengeance. Their resurrection is being facilitated by governments across the world as legislative hurdles are erected and 'deregulation' is accelerated to narrow the horizons for effective civil resistance to their lazy economic logic and that of their multilateral corporate allies.

The Rio '92 'Sustainable Development' Consensus has been killed off just as the humane imperative for environmental sustainability has reached fever pitch. The sooner we activists and campaigners face this reality, the more quickly we can return to our foundational principles and mount co-operative resistance to the new wave of zombie schemes.

Author email:
irappel@gwentwildlife.org

The Public Inquiry into the proposed M4 Relief Road

http://m4-newport.persona-pi.com/

http://www.gwentwildlife.org/news/2017/09/26/gwent-wildlife-trust-m4-campaign

The start date of the Public Local Inquiry was 28 February 2017 at the Lysaght Institute, Orb Drive, Newport, NP19 0HE, starting promptly at 10.00am.

The published draft Scheme and draft Orders, which, if made, would authorise the construction of the scheme are:

THE M4 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) TO WEST OF JUNCTION 29 (CASTLETON) AND CONNECTING ROADS) AND THE M48 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) CONNECTING ROAD) SCHEME 201-

THE M4 MOTORWAY (WEST OF MAGOR TO EAST OF CASTLETON) AND THE A48(M) MOTORWAY (WEST OF CASTLETON TO ST MELLONS) (VARIATION OF VARIOUS SCHEMES) SCHEME 201-

THE LONDON TO FISHGUARD TRUNK ROAD (EAST OF MAGOR TO CASTLETON) ORDER 201-

THE M4 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) TO WEST OF JUNCTION 29 (CASTLETON) AND CONNECTING ROADS) AND THE M48 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) CONNECTING ROAD) AND THE LONDON TO FISHGUARD TRUNK ROAD (EAST OF MAGOR TO CASTLETON) (SIDE ROADS) ORDER 201-

THE WELSH MINISTERS (THE M4 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) TO WEST OF JUNCTION 29 (CASTLETON) AND CONNECTING ROADS) AND THE M48 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) CONNECTING ROAD) AND THE LONDON TO FISHGUARD TRUNK ROAD (EAST OF MAGOR TO CASTLETON)) COMPULSORY PURCHASE ORDER 201-

THE M4 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) TO WEST OF JUNCTION 29 (CASTLETON) AND CONNECTING ROADS) AND THE M48 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) CONNECTING ROAD) (SUPPLEMENTARY) SCHEME 201-

THE WELSH MINISTERS (THE M4 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) TO WEST OF JUNCTION 29 (CASTLETON) AND CONNECTING ROADS) AND THE M48 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) CONNECTING ROAD) AND THE LONDON TO FISHGUARD TRUNK ROAD (EAST OF MAGOR TO CASTLETON)) SUPPLEMENTARY COMPULSORY PURCHASE ORDER 201-

THE M4 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) TO WEST OF JUNCTION 29 (CASTLETON) AND CONNECTING ROADS) AND THE M48 MOTORWAY (JUNCTION 23 (EAST OF MAGOR) CONNECTING ROAD) (AMENDMENT) SCHEME 201-

Plate 2: The M20, Kent, England

The M4 Relief Road and damage to one of Europe's most important wildlife sites

John Lawton

Introduction

1. I am Professor Sir John Lawton. I became President of the Institution of Environmental Sciences in April 2015, having been appointed an Honorary Fellow in 2011. I am a recognised authority on ecology, and am currently Vice President of the RSPB, President of the Yorkshire Wildlife Trust and a Life Fellow of WWF-UK. I attach as Appendix 1 to this proof of evidence a short curriculum vitae.

2. By way of summary, in 1989 I was elected a Fellow of the Royal Society, and was knighted in 2005 for my contributions to ecological science. Throughout my career I have held a number of roles, including Chief Executive of the Natural Environment Research Council (NERC) for 6 years and Chairman of the Royal Commission on Environmental Pollution from 2005 until its closure in 2011. My particular interests have revolved around population dynamics and biodiversity of birds and insects. In 1989 I founded the NERC Centre for Population Biology at Imperial College London. I have played a major part in promoting UK-wide wildlife conservation, leading the 'Lawton Review' of the resilience and adequacy of England's wildlife sites. The review's report, Making Space for Nature[1], was published in 2010. Concluding that England's ecological network is too small and isolated, the review called for better protection of England's wildlife and the establishment of new Ecological Restoration Zones. This was widely supported, with the establishment in 2011 of Nature Improvement Areas[2], and the report continues to inform policy today.

3. Over the last decade, I have been particularly interested in the impacts of environmental change on ecosystems worldwide. I have published over 320 scientific papers throughout my career, and in 2011 I was awarded the RSPB medal for my contributions to wild bird protection and countryside conservation.

Evidence

4. Conservation science is underpinned by well-established ecological principles, which strongly support the view that if the proposed M4 extension across the Gwent Levels goes ahead, it will severely damage one of Wales's (indeed the UK's and Europe's) most important wildlife sites, and that the damage is very unlikely to be prevented by proposed mitigation measures.

5. The Gwent Wildlife Trust has provided the Inquiry with a very detailed description of the impacts of the proposed M4 extension (specifically, the M4 Corridor around Newport (M4CaN) Scheme). In summary the impacts include:

- The loss of 125ha of Site of Special Scientific Interest ("SSSI") habitats.
- Permanent damage to 9 Sites of Importance for Nature Conservation ("SINC").
- The permanent loss of a section of their Magor Marsh Nature Reserve.
- The loss of 2,755m of SSSI reens and 9,373m of field ditches.

The consequence of these impacts includes threats to a whole range of species of conservation concern, including European protected species.

6. The evidence put forward by the Gwent Wildlife Trust is underpinned by an extremely robust body of conservation and ecological science.

Summary

7. In summary, my view is that the effect of the proposed M4 extension will be to destroy and fragment large areas of designated SSSI and SNIC habitat and significantly to damage population numbers of a number of vulnerable species, including European protected species. The effect of population reduction is to make those populations more vulnerable to local extinction as a result of inevitable shocks. Fragmentation reduces or eliminates the potential for dispersal and re-colonisation, 'devaluing' remaining habitat and ultimately resulting in a greater risk of the regional extinction of some species. Despite this, the measures proposed to mitigate the effect of the proposed M4 extension are unlikely

to be effective. They are of scientifically unproven, and in some cases appear impossible. The scheme is therefore likely to have a significant and adverse ecological impact.

The Lawton Reprt

8. In 2010 I produced a report for the Department for Environment, Food and Rural Affairs ("DEFRA") (Lawton et al. 2010. Making Space for Nature: a review of England's wildlife sites and ecological network)[3]. In 2009, DEFRA had asked me to chair a working group to advise on whether England's wildlife sites comprise "a coherent and resilient ecological network". Making Space for Nature was the outcome.

9. That report subsequently formed a major part of the Westminster Government's White Paper The Natural Choice: securing the value of nature (CM8082, 2011)[4]. The fact that it referred only to England is not material. The science underpinning the Lawton Report applies to ecosystems anywhere in the world, including Wales.

10. The report concluded that despite individual conservation successes, the overall picture for the conservation of nature in England was gloomy, with continuing loss of many species and habitats, even in protected areas. There has been no overall improvement during the intervening six years, with more than one in ten UK species now threatened with extinction (State of Nature 2016 report[5]).

11. The reasons for this continuing loss of species and habitats are evident. Most pertinent to the present enquiry is the direct loss of wildlife habitats, which can eliminate species from an area altogether, or at the very least reduce the size of surviving populations.

Fragmentation and Reduced Population Size

12. Smaller populations are less able to withstand inevitable 'shocks' (a hard winter, or a fire, for example), and as a result are more likely to die out, even in surviving fragments of suitable habitat. Fragmentation and isolation of habitat patches means that many species are also unable to disperse naturally across hostile environments (arable fields, a motorway, urban areas etc.) to recolonise suitable habitat patches, reducing the long-term viability of so called "meta-populations", which can lead, eventually, to regional extinction, even if suitable habitat still survives.

13. The effects of these two problems (fragmentation and population reduction) are exacerbated by poor habitat management of existing wildlife sites. This further reduces population sizes, and increases the risks of local extinction. (See the Lawton Report 2010; and many ecological and conservation text-books[6].)

Remedies

14. The Lawton Report made a number of recommendations designed to halt and eventually to remedy of these serious problems. In simple, headline terms what is needed are "more, bigger, better and joined up" wildlife sites. We need more protected sites; bigger sites; better managed sites; and sites that are connected either by corridors or 'stepping stones' of suitable habitat.

15. With trends all in the 'wrong' direction across many parts of the UK, we will inevitably continue to lose our wildlife. It is true that the effects are not the same upon all wildlife; some species can and are doing well in a hostile UK environment, but there are far more losers than winners. Amongst the most vulnerable species are some of the Gwent Levels' specialities – Dormouse, Water Vole, Hedgehog, Barn Owl and several species of wintering birds, for instance.

16. One of the key recommendations of the Lawton Report was that Defra should establish a national (England-wide) competition to establish twelve voluntary Nature Improvement Areas (NIAs) (see The Natural Choice). I chaired the panel that awarded NIA status to 12 successful bids (from a total of 76 bids). The modal size of each NIA is about 50km2 made up of 'working' countryside (agriculture, forestry, wetlands and so on), one major urban NIA, and sites important for nature-conservation. The whole point of the NIAs is

to increase the land in sympathetic management for nature conservation, without detracting from major existing patterns of land-use, using seed-corn funding from Westminster and additional money raised by each NIA from a variety of sources. Work started on the NIAs in April 2012, and Government funding ceased in 2015; all 12 NIAs are still doing "more, bigger, better and joined" nature conservation very successfully. The project is working; all the NIAs have delivered significant benefits for wildlife, some remarkably quickly, exactly as the underpinning science predicts should be the case.

The Impact of the M4CaN Scheme

17. The proposed M4CaN Scheme is designed to do the exact opposite of the NIAs, namely "less, smaller, worse and fragmented"; less habitat designated as SSSI or SINC, resulting in smaller areas surviving for nature conservation; potentially deteriorating habitat conditions (through alteration of drainage patters, or pollution for instance) in surviving habitat patches; and increased isolation of sites cut through by the road and associated infrastructure. There is bound to be a negative impact on a wide range of protected species, exactly as Gwent Wildlife Trust has stated (though without very detailed studies, which do not appear to have been done, exactly how many, and which, species, I cannot say with certainty).

18. In particular I whish to express agreement with the professional assessments of colleagues (for example Professor Altringham) that the so-called 'mitigation measures' proposed by those promoting this scheme are unlikely to be effective. Many of the measures proposed are of unproven viability, and in some cases even appear impossible; they will not, in my opinion, significantly reduce the detrimental impacts on wildlife that will inevitably follow if this scheme goes ahead.

19. The Gwent Levels is one of the largest surviving areas of ancient grazing marshes and reen systems in the UK, and the largest in Wales. It is a jewel in the crown of Welsh wildlife conservation. Unsurprisingly, it has a very high level of protection, both statutory and through the planning system. So I am absolutely baffled by the Welsh Government proposals to destroy and heavily modify parts of the area, in direct contravention of;

- section 6 (1) Environment (Wales) Act 2016,
- the Resilient Wales goal of the Well-being of Future Generations (Wales) Act 2015,
- the Wildlife and Countryside Act 1981 (as amended)

20. Without wishing to sound hyperbolic, the gravity of the effects of the proposal should not be underestimated. In matters such as this, it sometimes helps to stand back from the detailed facts of the case and to use an analogy. I ask the Welsh Government whether they would countenance building a highway through 'just' a small part of St David's Cathedral, mitigated by minor aesthetic improvements to the highway? This would be vandalism on a scale beyond contemplation. The Gwent Levels are a cathedral of nature conservation and deserve equal protection.

Author email:
dandj@snotrag.fsnet.co.uk

Notes:

1. Professor Sir John Lawton (2010) - Making Space for Nature - Making Space for Nature: A review of England's Wildlife Sites and Ecological Network - Submitted to the Secretary of State, the Department for Environment, Food and Rural Affairs on 16 September 2010 http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf

2. Nature Improvement Areas: about the programme https://www.gov.uk/government/publications/nature-improvement-areas-improved-ecological-networks/nature-improvement-areas-about-the-programme

3. See footnote 1

4. The Natural Choice: securing the value of nature https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228842/8082.pdf

5. State of Nature Report (2016) http://www.wtwales.org/wildlife/state-nature-2016

6. For example, Lindenmayer, D., and Burgman, M. 2005. Practical Conservation Biology. CSIRO Publishing; 609pp.). https://www.cabdirect.org/cabdirect/abstract/20063045222

Appendix 1
Sir John Lawton - Curriculum Vitae:

Career and Positions Held

- Department of Zoology, University of Durham: 1st Class Honours Degree (1965); PhD (1969).
- Demonstrator in Animal Ecology, Department of Zoology, Oxford University (1968-71).
- Lecturer, University of York (1971-78); Senior Lecturer (1978-82); Reader (1982-85); Professor (personal chair) (1985-89).
- Director, NERC Centre for Population Biology and Professor of Community Ecology, Imperial College of Science, Technology and Medicine, London (1989-99).
- Chief Executive, Natural Environment Research Council (1999- 2005).
- Chairman, Royal Commission on Environmental Pollution (2005-11).

Honorary and Adjunct Positions

- Honorary Visiting Research Fellow, Natural History Museum, London (1990-2005).
- Adjunct Scientist, Institute of Ecosystem Studies, New York (1992-2000).
- Fellow of Institute of Arable Crops Research, Rothamsted (1998-2000).
- Honorary Visiting Professor, University of York (1998-2015).
- Honorary Visiting Professor, Imperial College, Silwood Park (1999-).

Selected Honours and Prizes

- Elected Fellow of the Royal Society of London for my work on ecology and conservation (1989).
- CBE in The Queen's Birthday Honours List for services to ecological science (1997).
- KBE (Knighted) in the New Year Honours list (2005).
- Foreign Associate of US National Academy of Science (2008).
- Foreign Honorary Member of American Academy of Arts and Sciences (2008).
- Japan Prize, Science and Technology for Conservation of Biodiversity (2004).
- President's Gold Medal of the British Ecological Society (1987).
- Kempe Award for Distinguished Ecologists, Sweden (1998).
- Zoological Society of London Frink Medal (1998).
- Honorary Life Member, Royal Entomological Society (2001).
- Society for Conservation Biology La Roe Award (2002).
- Ramon Margalef Prize in Ecology and Environmental Science, Catalonia (2006).
- Honorary Fellow of the Zoological Society of London (2007).
- Fellow of WF-UK (2008).
- Honorary Member of the British Ecological Society (2009).
- The RSPB Medal for outstanding achievements in wild bird protection and countryside conservation (2011).
- Patron, Chartered Institute of Ecology and Environmental Management (2011).

Selected Professional-Related Activities

- Vice President, British Trust for Ornithology (1999-2007).
- President British Ecological Society (2005-07).
- Chairman, RSPB Council (1993-'98); Vice President (1999-).
- Trustee, Yorkshire Wildlife Trust (2007-09); Chairman (2009-14); President (2014-).
- Chairman for Defra of Making Space for Nature (the "Lawton Report") (2010-11); Chairman of the subsequent Nature Improvement Areas competition (2011-12) for Westminster Government.

Plate 3: M62 crossing the Pennine Way, England

The effect of the proposed M4 Relief Road on the Magor Marsh nature reserve and site of special scientific interest

Richard Bakere

Witness introduction

1. I am a Senior Reserves Officer for Gwent Wildlife Trust. I have been responsible for the management and maintenance of many of Gwent Wildlife Trust's nature reserves since 2006, and in addition the Magor Marsh Nature reserve since 2010.

2. In addition to more than a decade's experience in managing nature reserves, I have a master's degree in Mechanical engineering and a passion for working to try to reconnect people with nature.

Evidence

History of the Magor Marsh Nature Reserve

3. The Gwent Levels has slowly evolved in parallel with people over the last 2000 years. Consistency in agriculture and management of the drainage structures produced a stable environment where wildlife and farming flourished. This is not a simple habitat that can be recreated just by digging a new reen, ditch or grip.

4. In response to the threats of development and changing agriculture, the Magor Marsh Nature Reserve[1] was established in 1963 by what later became the Gwent Wildlife Trust. Over the years the reserve has grown in size when funding has allowed additional ground to be purchased, since then both the reserve and surrounding area has received legal protection in the form of multiple Sites of Special Scientific Interest (SSSI) designations established in 1982 and 1989.

5. These designations reflect only the best examples of a habitat type within a given area, and SSSI areas do not and cannot function in isolation. It is only with resilient habitat in the wider context that these areas can support viable long term metapopulations (in essence a group of individual populations made robust by mutual support from adjacent populations). The nature reserve is now covered by the:

- Magor and Undy SSSI[2]
- The Magor Marsh SSSI[3]
- The Redwick and Llandevenny SSSI[4]

6. The part of Magor Marsh Nature Reserve which lies on Barecroft Common was purchased by Gwent Wildlife Trust in 2012. The particular interest of this ground is its peatland composition and unlike so much of the Gwent Levels, this fragment has avoided both development and intensive agriculture. This is clearly expressed in the lowland peatland survey of 2009 conducted by the Countryside Council for Wales (subsequently refered to as CCW) "The Barecroft Common area has, along with Magor Marsh, escaped the large scale habitat loss that has affected the Gwent Levels". In addition the definitive work the Flora of Monmouthshire by Vice county recorder Trevor Evans also singles out the species rich nature of the Barecroft Common fields which support plant communities of SINC quality (site of importance for nature conservation).

7. The purchase of Barecroft Common, a unique piece of ground, was funded by an appeal to the members of Gwent Wildlife Trust, and other likeminded individuals and organisations including the Gwent Ornithological Society, who appreciated the value of this ground. In recognition of the wildlife value of the ground the money raised for the land purchase was matched by the CCW[5] (now Natural Resources Wales). Since then the ground has been managed for the benefit of wildlife by the collaborative work of a local grazier and volunteers from Gwent Wildlife Trust.

8. It must be reiterated that Barecroft Common is of particular note due to the combination of its low lying geography and deep peat makeup.

Impact of M4 Propsoal on Magor Marsh Nature Reserve

Direct Loss to the habitat of the Nature Reserve

9. The two fields that are part of the Magor Marsh Nature Reserve which would be lost or partially lost to the motorway togeth-

er are home to a rare habitat (both rare on the Gwent Levels and rare in the UK) which includes the terrestrial habitats of Fen meadow, Marshy grassland and Rush pasture (section 7 habitats of principal importance for the purpose of maintaining and enhancing biodiversity in relation to Wales). This area is special because of the peat rich ground, high water table and history of sympathetic management without agricultural improvement. These fields are home to, meadow thistle (Cirsium dissectum) and meadow rue (Thalictrum flavum) both these plants are listed on the Vascular Plant Red Data List for Great Britain - 2006. These two plant species are particularly rare on the Gwent Levels being found in fewer than a handful of sites.

10. The reen, and field ditches bounding these fields form part of the Redwick and Llandevenny SSSI.

As well as the European protected species otter (Lutra lutra) and nationally protected water vole (Arvicola amphibious) (protected on Schedule 5 of the Wildlife and Countryside Act 1981 (as amended)), the reens also provides habitat for the SSSI citation species including.

- the aquatic plant whorled water milfoil (Myriophyllum verticillatum as listed on Vascular Plant Red Data List for Great Britain - 2006
- the great silver water beetle (Hydrophilus piceus Red listing based on 2001 IUCN guidelines)

11. A section of Stutwall reen runs through this section of the reserve and would be lost beneath the motorway embankment. Stutwall reen flows from East to West in this section, and is a particularly good example of a sensitively managed water course. Water vole activity is present along this section. A diverse range of marginal vegetation exists alongside a more open central channel. Records which have both been noted on the Gwent Rare Plants Register as well as the as listed on Vascular Plant Red Data List for Great Britain – 2006 are;

- Rootless duckweed (Wolffia arrhiza)
- Hairlike pondweed (Potamogeton trichoides)

12. Many harvest mice (Micromys minutus) nests have been found in these fields. The harvest mouse is protected by the Section 7 of the Environment (Wales) Act 2016 which states:

> *"Welsh Ministers must— (a) take all reasonable steps to maintain and enhance the living organisms and types of habitat included in any list published under this section".*

INDIRECT LOSS TO THE ADJACENT HABITAT ON THE NATURE RESERVE.

Indirect Loss To The Adjacent Habitat On The Nature Reserve

13. The undisturbed habitat in this part of the reserve contains one of the greatest known abundances of meadow thistle and meadow rue of any site on the Gwent levels as well as an unusually high density of harvest mouse nests. As one of the last fragments of unimproved peatland on the Gwent Levels any loss of this ground is irreplaceable.

14. Disturbance to wildlife in the reens, ditches and fields would be both severe and long lasting. It has taken centuries of consistent management for the current wildlife balance to become established.

15. We have significant concerns that the following negative impacts would affect the reserve;

- This proposal risks the very essence of the Nature Reserve at Magor Marsh by threatening the water that creates the wetland habitat in the reserve.
- Disruption of ground water flow to the spring in the nature reserve which is vital to maintaining the high water levels on the whole nature reserve. The spring is at risk of being permanently lost.
- Reduced water levels and reduced water quality would lead to a loss of biodiversity and localised extinctions of sensitive species across the whole reserve. With over 800 invertebrate species (as recorded by Peter Kirbys invertebrate survey of part of Magor Marsh in 2010 see appendix 3) including the red listed water beetles, Agabus uliginosus and Dytiscus dimidiatus, there is a grave risk to the truly unique wildlife assemblage

on the reserve.
- The quality and stability of this water not only protects the wildlife of the levels, but preserves the archaeology both that we know of and that which we have yet to find (the Romano- Celtic boat found 1km west of the reserve and adjacent to the line of the proposed route being one such example.)
- Polluted water from the carriageway would be likely to pass into the reen and ditch system.
- Silt flow into the historic SSSI ditch network during the build process caused both by the creation of new water courses and from direct run off from the construction site.
- Run off from the carriageway, carrying additional pollutants including increased oil levels, and catalytic converter particulates.
- The wildlife isolated on the northern side of the road would no longer be able to effectively link with that to the south, decreasing the robustness of populations on both sides of the divide.
- Noise, which would be carried from the elevated level on the prevailing wind over the nature reserve, adversely affecting both people and any wildlife that relies on calls, whether for establishing territories (such as cuckoos)or for warning of the approach of predators (water voles).
- Contamination of watercourses from motorway embankment construction (including leaching from the use of contaminated material in embankment construction).
- Increased flood risk from disturbance to the drainage system.
- Increased drought risk caused by disturbance to the drainage system.
- It is likely that bats would suffer under the increased risk of collision with vehicles.
- Otter casualties are likely to increase.

16. I have great concerns regarding the inadequacy of the proposed reen and ditch mitigation. In particular with reference to:
- the timescales for equivalent habitat to become established on new watercourses.
- the mitigation ratio of 1:1.
- the sites of proposed mitigation within existing SSSIs.

17. I am also aware that other witness's share my grave concerns over the impacts of the proposed scheme and the limitations of the proposed mitigation/ compensation and I ask you to refer to their submissions.

Impact On The People That Use The Nature Reserve

18. As the oldest and most visited of all of Gwent Wildlife Trusts Nature Reserves, Magor Marsh is a cherished place. Each year:
- 3000 visits by school children are made to the education centre on the reserve. Some of these children are from disadvantaged areas and will have had little or no exposure to wildlife and the natural world.
- 10,000 people visit the nature reserve.
- The infrastructure and wildlife is supported by an outstanding army of volunteers who contribute in the order of 1000 man days per annum.
- Regular Recording Walks for both Bumblebees and Butterflies pass through the fields earmarked for loss. These both contribute to national recording schemes.
- Guided walks which encourage people to learn and appreciate more about wildlife visit these fields.
- Visitors to the nature reserve would be affected by the noise from the motorway on its raised embankment, which would readily carry across all of the nature reserve.

19. It is not just Gwent Wildlife Trust and a large proportion of their ten thousand members that share our concerns. Natural Resources Wales and their predecessor CCW have completed a character assessment for all of Wales using "LANDMAP[6]". This approach identifies and evaluates landscapes from a cultural, geological, historic, habitat and visual & sensory perspective.

> *"It's a tool to help sustainable decision-making and natural resource planning at a range of levels from local to national whilst ensuring transparency in decision-making.[7]"*

20. The landscape within which Magor Marsh lies has been assessed within the

LANDMAP characterisation as follows;

- "Outstanding habitat significance"
- "Outstanding as an evolved reclaimed landscape dating back 2 millennia"
- "A cultural resource of exceptional importance"
- "Outstanding rarity from a visual and sensory point of view"

21. The relevant LANDMAP assessments can be found in Appendix 2.

22. Gwent Wildlife Trust has been the custodian of the Magor Marsh nature reserve for more than 50 years, but the wildlife we are fortunate to still have in this area is the legacy of the work that has taken place over the proceeding millennia. The evidence for this lies in both the archaeology of the landscape and the wildlife it supports. We believe this proposal would be hugely detrimental to both features of this fantastic landscape.

23. The people, wildlife and geography of the Gwent Levels have evolved together over millennia. Woven together by these three cords this precious inheritance is now threatened like never before. Clearly a home to a host of wildlife and appreciated by a huge number of people and organisations, it is my hope that the area will be protected in the manner that its designations warrant and so clearly deserves.

Author email:
rbakere@gwentwildlife.org

Appendix 1

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

Site of Special Scientific Interest Citation:
Monmouthshire Gwent Levels - Magor and Undy

Date of Notification:
1989
National Grid Reference:
ST 440860
O.S. Maps:
1:50,000 Sheet number: 171
1:25,000 Sheet number: ST 48/58
Site Area:
586.6 ha

Description:
The Gwent Levels constitute the lowlands between Cardiff and Chepstow and are drained by an ordered network of drainage ditches. They are an example of one of the most extensive areas of reclaimed wet pasture in Great Britain which includes the Somerset Levels, Romney Marsh and the Pevensey Levels, and is the largest area of its kind in Wales. Together these Levels systems constitute a national series of sites each with its own special features. The Gwent Levels reens are rich in plant species and communities, many of which are rare or absent in other Levels systems. This is due to the variety of reen types and their management regimes and the timing of the management which results in a staggered programme across the Levels. The regular maintenance of some reens provides conditions for submerged plant species such as hairlike pondweed *Potamogeton trichoides* and openwater emergents such as arrowhead *Sagittaria sagittifolia* an opportunity to flourish. Others are less intensively managed and some have become completely overgrown by weeds and hedges.

The aquatic invertebrate fauna is very diverse and the Gwent Levels compares well with similar areas in Britain. Many nationally rare or notable species are present such as *Haliplus mucronatus* and *Hydrophilus piceus*. The area is important in the Welsh context for its snails and dragonflies and includes the species *Physa heterostropha* and *Brachytron pratense* respectively. The

large number of hedgerows add to the diversity of the area and, together with the main reen banks, provide a habitat for nationally important assemblages of terrestrial invertebrates such as *Pipunculus fonsecai* and *Tomosvaryella minima*.

The Magor and Undy area is the most easterly of the Gwent Levels sites supporting a total of 43 nationally rare and notable invertebrate species such as the soldier fly *Stratiomys furcata*, the snail killing fly *Pherbellia brunnipes* and the water beetle *Haliplus mucronatus*. This area also supports a number of rare and notable aquatic plant species including the pondweed *Potamogeton trichoides* and *P. berchtoldii* and the narrow-leaved water plantain Alisma lanceolatum.

The boundary of this site has been drawn to include the sea wall back ditch which contains brackish water fauna and flora such as the water beetle *Agabus conspersus* and the nationally rare brackish water crowfoot *Ranunculus baudotii.*

Plate 4: M9 at Newbridge, Scotland

Visual and Sensory	
Aspect Area Name	Western coastal grasslands
Aspect Area Classification	Lowland/Flat Lowland/Levels/Flat Open Lowland Farmland (Level 3)
Aspect Area Code	MNMTHVS053
Date Of Survey : 30/01/2007	

Evaluation

Value:	High (The area has long views framed by attractive pollarded willows lining the reens with a coastal edge character. The reens, hedgerows and tree lines including pollarded willows are mostly intact although the area is spoilt to an extent by the powerlines. A unique landscape defined by its flat levels, historical character and fragile grasslands/reen system. The area is part of the Gwent levels which is the largest levels systems in the UK and a rare landscape.)
Condition:	Fair (n/a)
Trend:	Declining (n/a)

Recommendations

Define the key qualities that should be conserved:	Openness
Define the key qualities that should be enhanced:	Tranquility
Define the key qualities that should be changed:	
Define the key elements that should be conserved:	Reens, hedgerows and tree-lines.
Define the key elements that should be enhanced:	Hedgerows, wetlands, permanent pasture
Define the key elements that should be changed:	Pylons and inappropriate modern development
Principal management recommendation:	maintain open and natural character of the levels landscape

Tolerance To Change

Are there any significant threats to the current integrity and condition of the visual & sensory features of the area?	Not known

Aspect Area Boundary

To what level was this information site-surveyed?	Level 3
At 1:10,000, how much of the Aspect Area boundary is precise?	All
What baseline information source was used for Aspect Area boundary mapping?	OS Raster
If OS Data was used, what was the scale?	1:10,000 and 1:25,000
What is the justification for the Aspect Area boundaries?	County boundary to the west, coast to the south, settlement and M4 to the north.

Bibliography

List the key sources used for this assessment	

Assessment

Additional Assessments	
Additional Comments	

Description	
Physical Form And Elements: Topographic Form?	Levels
Physical Form And Elements: Landcover Pattern?	Open Land
Aesthetic Qualities: Scale?	Large
Aesthetic Qualities: Sense of Enclosure?	Open
Aesthetic Qualities: Diversity?	Simple
Aesthetic Qualities: Texture?	Medium
Aesthetic Qualities: Lines?	Straight
Aesthetic Qualities: Colour?	Muted
Aesthetic Qualities: Balance?	Balanced
Aesthetic Qualities: Unity?	Unity
Aesthetic Qualities: Pattern?	Regular
Aesthetic Qualities: Seasonal Interest?	Autumn (n/a)
Other Factors: Level of Human Access?	Infrequent
Other Factors: Night Time Light Pollution?	Slight (Rural settlement)
Other Factors: Use of Construction Materials?	Generally Appropriate
What materials? Give Details:	stone and slate, render - though some new houses jar eg brightly coloured brick
There are attractive views...	...both in and out (to backcloth of hills and into area from M4 and edge of Severn estuary)
There are detractive views...	....out (Undy and to pylons)
Perceptual and Other Sensory Qualities	Attractive (-)
What is the sense of place/local distinctiveness	Strong (The flatness of the area with a lack of field boundaries and distinctive open ditch / rean system and long views)

Evaluation Matrix

Evaluation Criteria: Overall Evaluation	High (The area has long views framed by attractive pollarded willows lining the reens with a coastal edge character. The reens, hedgerows and tree lines including pollarded willows are mostly intact although the area is spoilt to an extent by the powerlines. A unique landscape defined by its flat levels, historical character and fragile grasslands/reen system. The area is part of the Gwent levels which is the largest levels systems in the UK and a rare landscape.)
Justification of overall evaluation	One outstanding, one high and two moderates equals high because of the area is strong sense of place, reens and historic character.
Evaluation Criteria: Scenic quality	Moderate (The area has long views framed by attractive pollarded willows lining the reens with a coastal edge character.)
Evaluation Criteria: Integrity	Moderate (The reens, hedgerows and tree lines including pollarded willows are mostly intact although the area is spoilt to an extent by the powerlines.)
Evaluation Criteria: Character	High (A unique landscape defined by its flat levels, historical character and fragile grasslands/reen system.)
Evaluation Criteria: Rarity	Outstanding (The area is part of the Gwent levels which is the largest levels systems in the UK and a rare landscape.)

Description

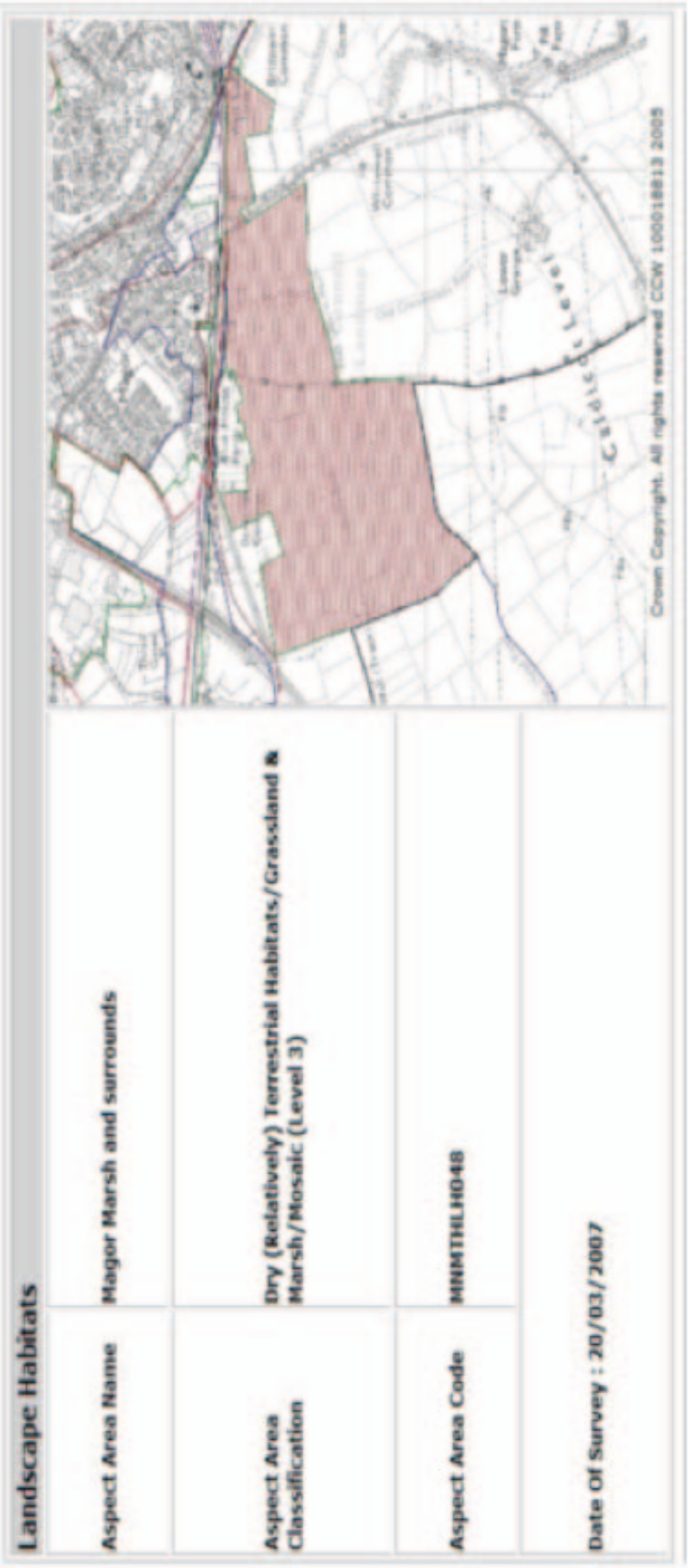
Summary Description	Bounded to the west by Cold Harbour Pill and Sudbrook to the east, this landscape is open and exposed with long views across the Severn Estuary, whilst overlooked by the Second Severn Crossing and the settlements of Magor and Caldicot to the north. Forming part of the Caldicot Levels it is a historic landscape of reclaimed pasture, with a variety of regular and irregular field patterns, and drainage channels. Caldicot Moor, Banecroft, Whitewall, and Undy Common are reflective of the enclosure of this common land, a unique landscape of neat and clean appearance, these fields of mainly improved grassland have retained their integrity, although Caldicot Moor has been degraded somewhat by the Second Severn Crossing and the intrusive lines of pylons. In contrast the irregular piecemeal enclosures of the land immediately south of Undy through to Magor Pill have a mixture of mature overgrown treelines and low intensively trimmed hedges, creating a wilder more unkempt appearance. However in
Physical form and elements: Settlement pattern	Scattered Rural/Farm
Physical form and elements: Boundary type	Mixture

Recommendations

Guideline	Immediate (discourage development which will intrude upon the open character) Medium Term (encourage species diversity of wetland habitats) Medium Term (discourage improvement of permanent pastures)
Existing management	Generally Inappropriate
Existing management remarks:	over- intensive improvement permanent pasture

Monitoring	
Has the information ever been verified in the field?	Yes (1:10.000)
Does this area have a special or functional link with an adjacent area?	Yes (Part of the Ghent levels)
Date of monitoring?	2015-02-06
Monitoring undertaken by	Stages 1. 2 and 3 change detection. Field verification and amendment completed by Bronnen Thomas. in conjunction with the planning authority.Quality Assurance completed by White Consultants.
Has this record has been updated following monitoring work?	

Supporting Landmap documents. -2b
Landscape Habitats



Monitoring

Does this area have a special or functional link with an adjacent area?	Yes (It is linked hydrologically to the adjacent 'levels'...)
What is the total land area within the boundary (in hectares)?	94 hectares

Description

What are the dominant soil types? (specify up to 3 types)	Ground-water gley soils Peat soils
What Phase 1 habitat types are present? Only select the five most dominant types and, for each of these, specify below what percentage of the Aspect Area is made up of these.	Semi-natural Broadleaved Woodland (11%) Dense Scrub (3%) Semi-improved Neutral Grassland (48%) Improved Grassland (11%) Marshy Grassland (26%)
Does the area contain habitats of international importance?	Yes
Does the area contain BAP habitats?	Yes
Does the area contain protected sites?	Yes
If yes, which ones?	SSSI (Gwent Levels - Redwick & Llandevenny, Gwent Levels - Magor & Undy and Magor Marsh...)
Approximately what proportion of the Aspect Area is within the protected site?	91-100%
Does the area support important species?	Yes
Are there any significant threat species present in abundance? (Field visit required)	Not known
What other features significantly influence the biodiversity in this area?	Ponds Wet Ditches
Are any of these features in a very good condition? (Field visit required)	Some (The main pond at Magor Marsh is a valuable ecological resource...)
Are any of these features in a poor condition? (Field visit required)	None
What are the main land management activities taking place in the area? (Field visit required)	Stock grazing Mowing
Do any of the above appear to have an appreciable positive impact on biodiversity? (Field visit required)	Some (The mowing and grazing regime at Magor Marsh is designed to be by traditional methods to create valuable hay meadows...)
Do any of the above appear to have an appreciable negative impact on biodiversity? (Field visit required)	None
Is the biodiversity in the area in any way threatened?	Yes (In the long term global warming could impact on these wetland habitats... The proposed M4 relief road is likely to pass very close to this area if it goes ahead ....)
Are there clear opportunities to improve the biodiversity aspect of this area?	No
Summarise the key features that define this area's biodiversity character	The area is a mosaic of wood/scrub, grassland and tall herb vegetation with an underlying wet nature to the area....

Evaluation

Value	High
Condition	Good (The area is managed for the benefit of wildlife...)
Trend	Unassessed

Description

If yes, which habitats of international importance?	Lowland hay meadows
If yes, which BAP habitats?	Wet Woodland Lowland Meadows Fens Reedbeds Coastal & Floodplain Grazing Marsh

Recommendations

Existing management	Generally Appropriate
Principal management recommendations	Maintain a good balance between preserving biodiversity and allowing public access and educating the public...
Guideline	Long Term (Continue management of the area as it is at present...) Long Term (Ensure that areas of open water are maintained by preventing too much reed encroachment...) Long Term (Ensure that this wet habitat is not polluted or eutrophied...)

Monitoring

Has the information ever been verified in the field?	Yes (The site has been visited and walked around via the boardwalks that pass through the site...)

Aspect Area Boundary

To what level was this information site-surveyed?	Level 3
At 1:10,000, how much of the Aspect Area boundary is precise?	All
What baseline information source was used for Aspect Area boundary mapping?	Other (Phase 1 habitat, OS Raster, Aerial photographs...)
If OS Data was used, what was the scale?	1:10,000
What is the justification for the Aspect Area boundaries?	The Aspect Area boundaries encompass Magor Marsh but also include the surrounding more semi-natural habitats as these are distinct from the arable and improved grassland farmland in the wider area....

Bibliography

List the key sources used for this assessment	CCW Phase 1 data (digitised), Aerial photographs (digitised), OS Raster (1:10,000), Protected species information from SEWBReC, Protected sites information from CCW (digitised), SINC sites provided by SEWBReC (digitised), Invasive plant mapping provided by SEWBReC (digitised), Monmouthshire LBAP, Monmouthshire Unitary Development Plan, Protected Sites citations from CCW website (www...ccw...gov...uk), Protected Sites citations from the JNCC website (www..jncc...gov...uk), Soils of England and Wales 1:250,000 (Sheet 2 Wales)...

Assessment

Additional Assessments	N/A
Additional Comments	N/A

Evaluation Matrix

Evaluation Criteria: Priority Habitats	High (Much Priority habitat is present of a number of different types...)
Evaluation Criteria: Significance	Outstanding (The 'levels' habitat type is a unique habitat type and within the context of the 'levels' this area is unique as it is the last remaining area of fen over peat soils remaining...)
Evaluation Criteria: Opportunity	Low (The area is already well managed for wildlife...)
Evaluation Criteria: Expansion rates	Unassessed
Evaluation Criteria: Sensitivity	High (The area could be very vulnerable to a pollution incident or in the longer term the effects of global warming...)
Evaluation Criteria: Connectivity/Cohesion	Moderate (The area of Magor Marsh is an isolated fragment of a once much larger habitat area, it does however have good connectivity with the 'levels' area to the south through the network of reens...)
Evaluation Criteria: Habitat Evaluation	High (A number of valuable, quite scarce Priority BAP habitats are present...)
Evaluation Criteria: Importance for key species	High (A good number and variety of key species are present...)
Evaluation Criteria: Overall Evaluation Habitat and Species	High (Evaluated as outstanding for habitats and high for species, considered to be outstanding overall...)

Description

If yes, which species? (for each of the species, also note the source of information)	Eel, Hairlike Pondweed, Blunt Flowered Rush, Black Poplar, Marestail, Round-leaved Cranesbill, Common Shrew, Hairy Dragonfly (all LBAP)... Rootless Duckweed , 6 banded Nomad Bee, Gracilia minuta (beetle) (all Red Data Book 1)... Lapwing (Section 74 of the CROW Act 2000)... Brown Hare (BAP... All records SEWBReC..... Reed Bunting (BAP) Kingfisher and Bittern (WCA1) (these three records from Gwent Wildlife website)...

Evaluation Matrix

Justification of overall evaluation	The area contains a mixture of valuable habitats that support a good number of key species and the area is worthy of SSSI designation... Most significantly this area is part of the 'Levels' area which is a unique and highly valuable example of this type of habitat with the mosaic of reens...

Recommendations

Existing management remarks:	The area is managed for the benefit of wildlife...

Monitoring

Date of monitoring?	2016-01-15
Monitoring undertaken by	Stages 1, 2 and 3 change detection, field verification and amendment completed by Environment Systems in conjunction with the local planning authority. Quality Assurance completed by TACP.
Has this record has been updated following monitoring work?	

Supporting Landmap documents. -2c
Historic Landscape

Historic Landscape

Aspect Area Name	Caldicot Level
Aspect Area Classification	Rural environment/Non agricultural/Reclaimed land (Level 3)
Aspect Area Code	HNMTHHL001
Date Of Survey : 28/09/2007	

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Description

If working at level 3, the classification describes the dominant historic pattern, but which other patterns are important to the historical pattern of this area? (Tick all that apply)	Irregular Fieldscapes Regular Fieldscapes Reclaimed land Water & Wetland

Monitoring

Has the information ever been verified in the field?	No
Does this area have a special or functional link with an adjacent area?	Yes (Reclaimed landscape similar to H7 Nathern Level... Exploited for farmland from adjoining Aspect Areas H2 (Magor), H4 (Roget Fen Edge) and H5 (Caldicot))

Description

Which traditional boundary types prevail in the area? (Tick all that apply)	Cut Drainage
What is the nature of any significant archaeological interest in the area? (Tick all that apply)	Buried-Waterlogged Relict-Earthworks Documentary
Which chronological period is dominant in the area?	Medieval (to 1536) Post Medieval (1536+)
Has a Historic Landscape Characterisation been undertaken here?	Yes (Rippon, S... 1995. The Gwent Levels Historic Landscape Study: Characterisation and Assessment of the Landscape... Cardiff: CADW/CCW)
Are there SMR sites here?	Yes
Are there SAMs here?	No
Are there Listed Buildings here?	Yes
Are there Registered Historic Parks and Gardens here?	No
Are there Conservation Areas here?	No
Are there World Heritage Sites here?	No
Is the area within a Registered Landscape of Historic Interest?	Yes

Aspect Area Boundary

To what level was this information site-surveyed?	Level 3
At 1:10,000, how much of the Aspect Area boundary is precise?	All
What baseline information source was used for Aspect Area boundary mapping?	OS Raster
If OS Data was used, what was the scale?	1:10,000
What is the justification for the Aspect Area boundaries?	This is one of two major landscape components of the Gwent Levels and as such forms part of the most significant example in Wales of a "hand-crafted" landscape resulting from gradual enclosure and reclamation since the Roman period... The Area Boundary reflects the physical extent of the Level except where it is bisected by the political boundary with Newport County Borough Council to the W...

Bibliography

List the key sources used for this assessment	Aldhouse-Green et al, 1992, "Prehistoric human footprints from the Severn Estuary at Uskmouth and Magor Pill, Gwent, Wales", Arch Camb..., 141, 14-55 Allen & Rippon, 1994, "Magor Pill, Gwent: The Geoarchaeology of a Late Flandrian Tidal Palaeochannel", Archaeology in the Severn Estuary 1994 41-50 Bell et al...., 2000, Prehistoric Intertidal Archaeology in the Welsh Severn Estuary, York, CBA Research Report 120 Carew, T...., 2003, Assessment of archaeological excavation, evaluation test pits, field survey and watching briefs along South East Coastal Strategy Pipeline between Chepstow and Magor, PCA Report Evans, E...., 2001, Romano-British South East Wales Settlement Survey: Final Report, GGAT Report No 2001/023 Hamilton, M.... A...., 2004, "The Bronze Age" in M.... Aldhouse-Green & R.... Howell (Eds....) The Gwent County History, Vol 1, Gwent in Prehistory and Early History, Cardiff Lawler, M.... & Nayling, N...., 1993, "Investigations at Barland"s Farm, Magor, 1993", Archaeology in the Severn Estuary 4, 109-112 Locock et al...., 1997 Nayling, N.... Maynard, D.... and McGrail, S...., 1994, "Barland"s Farm, Magor, Gwent: a Romano-Celtic boat", Antiquity 68 596-603 Nayling, N.... & Caseldine, A...., 1997, Excavations at Caldicot, Gwent: Bronze Age Palaeochannels in the Lower Nedern Valley York, CBA Research Report 108 Nayling, N.... & McGrail, S...., 2004, The Barland"s Farm Romano-Celtic Boat York, CBA Research Report 139 Peterson, R.... & Pollard, J...., 2004 "The Neolithic" in M.... Aldhouse-Green & R.... Howell (Eds....) The Gwent County History, Vol 1, Gwent in Prehistory and Early History, Cardiff Rippon, S...., 1995a The Gwent Levels Historic Landscape Study: Characterisation and Assessment of the Landscape, Cardiff Rippon, S...., 1996 The Gwent Levels: The evolution of a wetland landscape York: CBA Research Report 105

Assessment

Additional Assessments	
Additional Comments	

Evaluation Matrix

Evaluation Criteria: Overall Evaluation	Outstanding
Justification of overall evaluation	Caldicot Level is a major component of the Gwent Levels coastal plain located on the N side of the Severn Estuary. This area of reclaimed estuarine alluvium is regarded as a cultural resource of exceptional importance.

Evaluation

Condition:	
Value:	Outstanding (Caldicot Level is a major component of the Gwent Levels coastal plain located on the N side of the Severn Estuary. This area of reclaimed estuarine alluvium is regarded as a cultural resource of exceptional importance.)
Trend:	

Recommendations

Existing management	
Existing management remarks:	
Principal management recommendations	
Guideline	

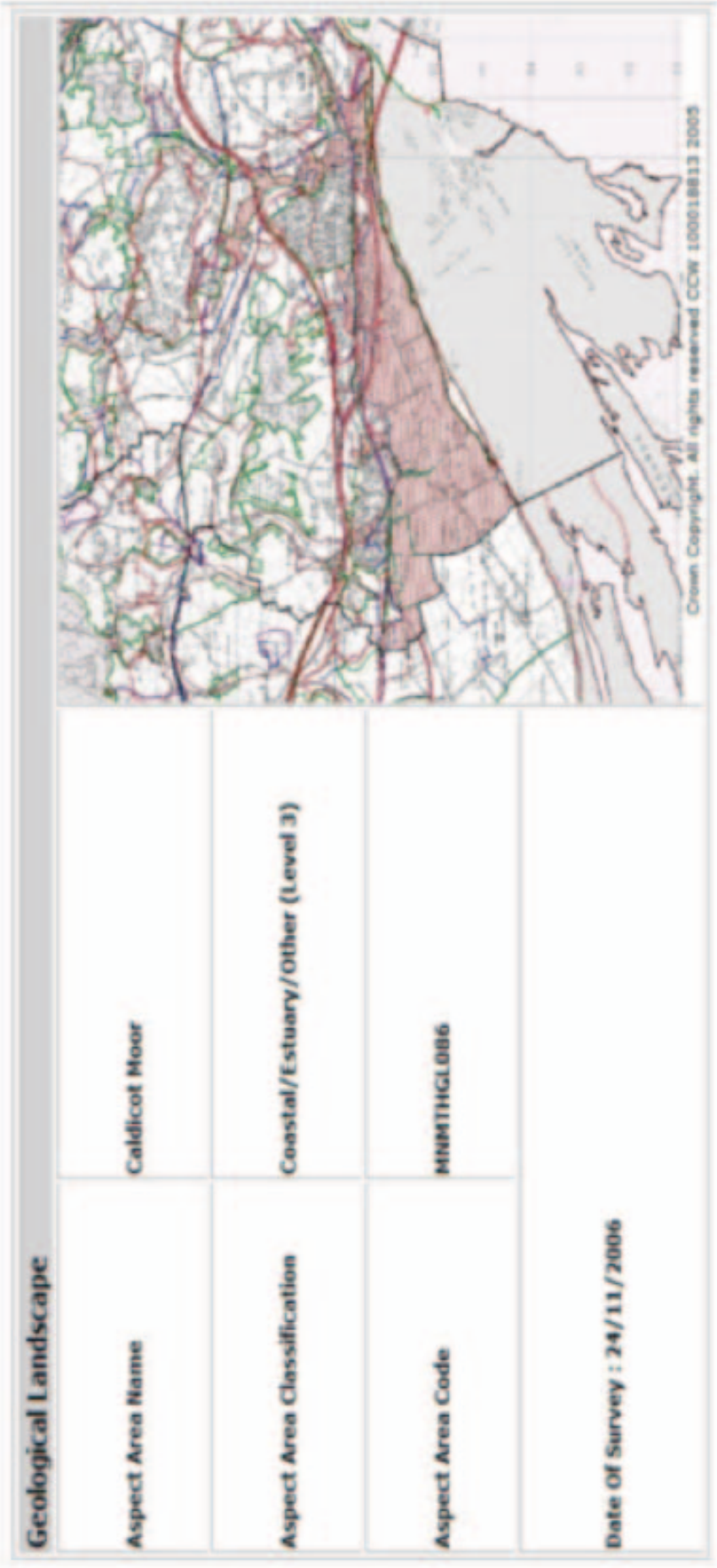
Description

Summary Description / Key Patterns and Elements	Site Location This Aspect Area forms part of the extensive alluvial wetlands and inter-tidal mudflats known as the Gwent Levels, extending along the N side of the Severn Estuary between Chepstow in the E and Cardiff in the W. Caldicot Level is one of two major components of this important estuarine landscape, the other being Wentlooge Level lying to the W of Newport. The study area comprises that part of the Caldicot Level extending E from the political boundary with Newport County Borough Council to the promontory of Sudbrook. The Character Area continues into the area of Newport County Borough Council. Its northern extent follows the 10m-contour line representing the interface between alluvium and solid geology and to the S the area is demarcated by the sea wall dividing the land from the Severn Estuary. Evidence of human activity found outside the sea wall and thus technically not within the Aspect Area includes a group of three Palaeolithic hand-axes and a blade representing the earliest evidence for human activity in the current county, which was found during construction of the Second Severn Crossing, and a considerable amount of Roman, medieval and post-medieval pottery found off Magor Pill. The wreck of a 13th century clinker-built cargo ship was also recovered in this area. Historical Overview The Gwent Levels have formed over the last 10000 years as rising post-glacial sea levels laid down sediment on the banks of the Severn. Humans have exploited this estuarine environment more or less intensively throughout the post-glacial period in response to fluctuations in the heights and range of tides: however, significant attempts to modify the landscape were not undertaken until the Roman period, when the construction of sea walls and drainage ditches began to transform the character of the Levels, a process that continued, following a period of extensive post-Roman flooding, into the medieval and post-medieval periods. Sea level rose rapidly
If Classification is "Other", specify here	

Evaluation Matrix

Evaluation Criteria: Integrity	High (Caldicot Level is regarded as a well-preserved example of a 'hand crafted landscape' and the distinctive pattern of irregular, intermediate and planned landscape has generally survived: however, some loss of integrity has occurred as a result of agricultural improvement and development (Rippon 1996).) High (Caldicot Level is regarded as a well-preserved example of a 'hand crafted landscape' and the distinctive pattern of irregular, intermediate and planned landscape has generally survived: however, some loss of integrity has occurred as a result of agricultural improvement and development (Rippon 1996).)
Evaluation Criteria: Potential	Outstanding (The results of archaeological investigation to date indicate that people have utilised the Levels since the Mesolithic period and suggest that the area contains a wealth of buried archaeological and environmental deposits.)
Evaluation Criteria: Rarity	Outstanding (Caldicot Level forms a major component of the Gwent Levels, which are regarded as an exceptional example of a hand-crafted landscape. In addition to the observable historic aspects of this landscape, the Levels are also rich in buried archaeology)
Evaluation Criteria: Survival	N/A (Caldicot Moor has witnessed the loss of a significant number of field boundaries, up to 40 per cent, to agricultural improvement and the creation of the second Severn crossing. Further E, the pattern of small irregular fields and droveways has also suffered with, for example, areas of ridge and furrow having been destroyed, although a well documented area of reclaimed meadow, Temple Mead, does survive. To the W of Caldicot Moor, a well-preserved irregular pattern of small fields and drainage features survives, which includes the 13th century landscape around Lower Grange Magor.)
Evaluation Criteria: Condition	

Supporting Landmap documents. -2d
Geological Landscape



Description

What is the geographical and topographical character of this area?	Broad coastal flat representing reclaimed former saltmarsh adjacent to Severn estuary from which it is separated by a flood defence bank. Includes lowest part of the Nedern Brook valley at Caldicot and the St Bride''s Brook valley at Magor. Stream course canalised with banks and network of drainage ditches present. Typically less than 5 m above current sea level. (Quaternary: Holocene).
What is the characteristic Level 3 component of the area?	Other (Reclaimed saltmarsh/mudflat)
Which of the following is a significant contributor to the geological character of the area?	Superficial deposits (Estuarine alluvium/saltmarsh deposits (Quaternary: Holocene).) Active processes (Stream.) Past processes (Estuarine/saltmarsh.)
What additional subsidiary Level 3 components are notable?	Coastal flat
What Level 4 components are notable in this area?	River channel / canal (artificial) Urban / industrial development
What active geological and geomorphological processes are significant in this area?	Stream.
Are there components of significant hydrological importance?	Yes (Stream, drainage ditches.)
Are there any pedological processes that are significant in the area or have had a landscape forming effect?	Yes (Saltmarsh.)
Is there current mineral extraction?	No
Has there been mineral extraction in the past?	Not known
Are there SSSI/GCR sites here?	No
Are there geological SINC, 2nd tier, or RIGS sites in the area?	No

Evaluation

Value	Moderate (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Condition	Fair (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Trend	Constant (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)

Recommendations

Existing management	Generally Inappropriate
Principal management recommendations	Ensure that no significant geological or geomorphological features are lost or sterilised (e.g. due to development).
Guideline	Long Term (Ensure that no significant geological or geomorphological features are lost or sterilised (e.g. due to development).)

Tolerance To Change

Are there any significant threats to the current integrity and condition of the Earth Heritage features of the area?	Not known

Aspect Area Boundary

To what level was this information site-surveyed?	Level 3
At 1:10,000, how much of the Aspect Area boundary is precise?	Most (Aspect Area boundaries surveyed at 1:10,000, mapped at 1:25,000.)
What baseline information source was used for Aspect Area boundary mapping?	Other (1:50,000 British Geological Survey maps, aerial photographs, OS 1:25,000 Landranger topographical map.)
If OS Data was used, what was the scale?	1:25,000
What is the justification for the Aspect Area boundaries?	Margins of coastal flat area including outer side of seawall.

Evaluation Matrix

Evaluation Criteria: Research Value	Moderate (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Evaluation Criteria: Educational Value	Moderate (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Evaluation Criteria: Historical Value	Low (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Evaluation Criteria: Rarity / Uniqueness	Low (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Evaluation Criteria: Classic Example	Low (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Evaluation Criteria: Overall Evaluation	Moderate (Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.)
Justification of overall evaluation	Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.

Bibliography

List the key sources used for this assessment	INSTITUTE OF GEOLOGICAL SCIENCES 1972. Chepstow. Sheet 250 (1:50,000). NERC: ORDNANCE SURVEY 2005d. OS Explorer Map 154 (1:25, 000): WELCH, F.B.A. and TROTTER, F.M. 1961. Memoir of the Geological Survey, England and Wales. Sheets 233 and 250.

Assessment

Additional Assessments	Gwent Geodiversity Audit (Davies 2006): no sites recorded (to 12/06).
Additional Comments	Additional Level 4 features include: Stream; Flood defence bank/works.

Monitoring

Has the information ever been verified in the field?	No
Does this area have a special or functional link with an adjacent area?	Yes (Part of former saltmarsh system bordering the Severn estuary (including MNMTHGL 71, 74, 87, 92, 99).)

Description

If Classification is "Other", specify here	Reclaimed saltmarsh/mudflat

Recommendations	
Existing management remarks:	Reclaimed saltmarsh but not sterilised by industrial development so deposits may retain some scientific value.
Description	
Where drift dominated, what is the dominant drift deposit?	Coastal
Where drift dominated, what is the major sediment that characterises the area?	

Cultural Landscape

Aspect Area Name	Gwent Levels
Aspect Area Classification	Influences/Material expressions/Rural/Agricultural (Level 4)
Aspect Area Code	MNMTHCL001
Date Of Survey : 29/01/2007	

Monitoring

Has the information ever been verified in the field?	Yes (Site visits and 1:10000)
Does this area have a special or functional link with an adjacent area?	Yes (M4/M48 Motorways (002)); Cardiff-London Railway (003)); Caldicot, Raglet etc (004)); Magor with Undy (006)); Mathern Palace (011)); Moynes Court (012)); Celtic Trail (052))

Description	
The classification at level 3 describes the dominant cultural context, but which other contexts are important to the cultural landscape of this area?	Rural Urban Infrastructure Places Customs Artistic Oral
Which level 4 classes are particularly significant to the cultural landscape character of this area - Influences?	Agricultural Rural Crafts Fishing/ hunting Rural Settlement Communications & Transport Tourism
To what extent do the context and level 4 details selected contribute to the cultural identity, local distinctiveness or sense of place of the area?	Very Strong (Level 4 details underline the richness of the cultural associations on and adjacent to the Levels)
To what extent is the cultural information widely recognised or appreciated?	Regionally (This landscape, unique in Wales, is not widely known of or appreciated except by specialists, residents and the increasing numbers of birdwatchers, cyclists and walkers)
Are there any artistic expressions that are particularly famous or associated with the Aspect Area?	Not known
Are there any people / movements / institutions that are particularly famous or associated with the Aspect Area?	Yes (The Romans and Cistercian monks who both influenced the draining of the Levels before more methodical and concentrated efforts in the 18th and 19th centuries)
Is there any folklore or are there legends that are particularly famous or associated with the Aspect Area?	Not known
Are there any events/traditions that are particularly famous or associated with the Aspect Area?	Yes (The flood in 1606 when the seawalls were breached, causing many deaths. Could this have been an example of a tsunami?)
Are there any technical / scientific discoveries that are particularly famous or associated with the Aspect Area?	No
What are the attributes of the cultural elements in the Aspect Area?	Evolved
What chronological periods are culturally dominant in the area?	Post 1950 Inter War Victorian & Edwardian Georgian Late Medieval Medieval Early Christian Roman
Are there certain place-names in the area that are particularly significant?	Yes

Summary Description: (no more than 150 words)	The Gwent Levels (in this instance, the Caldicot Level portion) represent an evolved landscape of exceptional integrity dating back at least to Roman period, and containing vestigial evidence of Cistercian monastic land holdings. They are principally a reclaimed, man-made landscape protected for most of its area by sea walls and criss-crossed with a subtle but practical system of drainage - reens, grips, putchers and stanks. Field patterns vary widely, at times the product of cultural evolution, at others to meet prevailing systems of agriculture or to respond to topographical features. Beneath the accumulated silt is buried a large number of archaeological features in the form of Mesolithic footprints, Bronze Age huts, trackways, paleo-channels, Roman wharves. The Middle Ages are represented by a large numbers of Norman sites, including castles, moated sites, churches, mills, manor houses and court houses. There remain some ancient farmhouses. Part of the Levels adjacent to Newport are to be severly compromised by the building of the Newport Relief Road off the M4. An even more damaging threat is the long-mooted (but so far discounted) Severnside Airport. The landtake for both projects would almost certainly mean the wholesale destruction of an unique cultural landscape. The Levels contain a number of SSSI and adjacent to the RAMSAR site of the Severn Estuary.
Tolerance To Change	
Are there any significant threats to the current integrity and condition of the Cultural Landscape features of the area?	Yes (Newport Relief Road; the mooted Severnside Airport; "creep" of residential housing)
Description	
If yes, give examples of the place-names and their significance	Monks Ditch and Lower Grange - both signifying former monastic holdings Reens, grips, ditches, stanks - nomenclature for elements in the system of drainage
Aspect Area Boundary	
To what level was this information site-surveyed?	Level 4
At 1:10,000, how much of the Aspect Area boundary is precise?	Most (Boundaries are drawn from illustrations in expert research papers)
What baseline information source was used for Aspect Area boundary mapping?	OS Raster
If OS Data was used, what was the scale?	1:10,000
What is the justification for the Aspect Area boundaries?	Boundaries are drawn from illustrations in expert research papers
Bibliography	
List the key sources used for this assessment	Rippon, Stephen: The Gwent Levels Historic Landscape Study; Whittle, Elisabeth: A Guide to Ancient and Historic Wales: Glamorgan and Gwent (series ed. Rees, Sian); Monmouthshire County Council: Unitary Development Plan, June 2006; Locock, Martin: Monmouthshire Historic Settlements: Part 3: The Hundreds of Caldicot and Raglan (GGAT); Locock, Martin: Coastal Archaeology Survey (Glamorgan-Gwent Archaeological Trust); Evans, E.M: Welsh Historic Churches Project: Gwent Historic Churches Survey (Glamorgan-Gwent Archaeological Trust); Rees, William: South Wales and The Border in the 14th Century; Ordnance Survey: Map of Monmouthshire (1:50,000); Register of Landscapes, Parks and Gardens, Part 2.1: Landscapes of Outstanding Historic Interest in Wales
Assessment	
Additional Assessments	none
Additional Comments	none

Evaluation Matrix

Evaluation Criteria: Overall Evaluation	Outstanding (Outstanding as an evolved reclaimed landscape dating back for two millenia)
Justification of overall evaluation	see Q40
Evaluation Criteria: Recognition/transparency	Local recognition (Unfortunately the historic and cultural importance of the Levels is not widely recognised)
Evaluation Criteria: Period	Strongly apparent (Outstanding example of the evolution of a reclaimed landscape over two millennia)
Evaluation Criteria: Rarity (Culture)	Very rare (A landscape unique in Wales)
Evaluation Criteria: Documentation	Substantial (There are many academic research papers)
Evaluation Criteria: Group Value	Exceptional (As a group of evolved landscapes showing different period influences)
Evaluation Criteria: Survival	N/A (The Levels are under further threat. They have been gradually eroded - particularly in the second half of the 20th century - and are still declining)
Evaluation Criteria: Vulnerability	Highly tolerant (Exceptionally vulnerable to large-scale engineering works - e.g. the Newport Relief Road)
Evaluation Criteria: Diversity	Complex (There is a fasinating and subtle variation in the types of landscape on the various parts of the Levels)
Evaluation Criteria: Potential (Culture)	Considerable (There is high potential for the Levels to be safeguarded and (what is left) returned to their traditional form. There is also potential for the re-introduction of traditional crafts - such as pollarding, basket weaving)

Description

Which level 4 classes are particularly significant to the cultural landscape character of this area - Associations?	Places & Place Names Sense of Place Land Holdings Land Divisions Leisure/Recreation

Evaluation

Condition:	Poor (The landscape has been severely compromised by inappropriate development, ravaged by modern communications systems and suffering from land-husbandry neglect - e.g. cessation of the practice of pollarding reen-side willows)
Value:	Outstanding (Outstanding as a reclaimed landscape unique in Wales dating back at least two millennia)
Trend:	Declining (Declining as more large tracts are threatened by modern development - e.g. the Newport Relief Road)

Recommendations

Existing management:	Generally Inappropriate
Existing management remarks:	Land holders are neglecting basic landscape and ecological management
Principal management recommendations	Return to the practice of pollarding reen-side willows: through the use of planning restrictions, deny inappropriate road and housing development
Guideline	Long Term (Strictly enforce planning controls on inappropriate development)

Description

If Classification is "Other", specify here	

Appendix 3

List of invertebrate records taken from the 2010 Invertebrate survey conducted on part of the Magor Marsh reserve by Peter Kirby.

Taxon	*Status*	*04/05*	*active*	*traps*	*pond-net*
Tricladida					
Planariidae					
Polycelis sp.					+
Mollusca					
Agriolimacidae					
Deroceras laeve	*c*	+			
Arionidae					
Arion ater	*c*		+		
Bithyniidae					
Bithynia tentaculata	*c*	+			+
Carychiidae					
Carychium minimum	*c*			*9*	
Cochlicopidae					
Cochlicopa lubrica	*c*			*11*	
Discidae					
Discus rotundatus	*c*		+	*5*	
Euconulidae					
Euconulus sp.				*6,10*	
Gastrodontidae					
Zonitoides nitidus	*c*			*6,10*	
Helicidae					
Arianta arbustorum	*c*			*6*	
Cepaea hortensis	*c*		+		
Cepaea nemoralis	*c*	+	+		
Hygromiidae					
Trochulus striolatus	*c*			*6*	
Limacidae					
Limax maximus	*c*		+		
Lymnaeidae					
Lymnaea palustris agg.	*c*	+			+
Lymnaea stagnalis	*c*	+			+
Radix balthica	*c*	+			+
Oxychilidae					
Oxychilus alliarius	*c*			*10,11*	
Physidae					
Aplexa hypnorum	*l*	+			
Physa fontinalis	*c*	+			
Planorbidae					
Anisus leucostoma	*c*	+			
Anisus vortex	*c*	+			+
Bathyomphalus contortus	*c*	+			+
Hippeutis complanatus	*c*	+			

Planorbarius corneus	*c*				+
Planorbis carinatus	*c*	+			
Planorbis planorbis	*c*	+			+
Sphaeriidae					
Musculium lacustre	*c*	+			
Pisidium sp.					+
Sphaerium corneum	*c*	+			+
Succineidae					
Succinea putris	*c*		+		
Valvatidae					
Valvata cristata	*l*	+			
Vertiginidae					
Vertigo antivertigo	*l*	+			
Hirudinea					
Erpobdellidae					
Erpobdella octoculata	*c*	+			+
Glossiphoniidae					
Glossiphonia complanata	*c*	+			+
Helobdella stagnalis	*c*	+			+
Theromyzon tessulatum	*c*	+			+
Hirudidae					
Haemopis sanguisuga	*c*	+			
Crustacea					
Asellidae					
Asellus aquaticus	*c*	+			+
Crangonyctidae					
Crangonyx pseudogracilis	*c*	+			+
Oniscidae					
Oniscus asellus	*c*			*5,11*	
Araneae					
Araneidae					
Araneus diadematus	*c*		+		
Araneus marmoreus	*c*		+		
Araneus sturmi	*l*		+		
Larinioides cornutus	*c*	+	+		
Nuctenea umbratica	*c*	+	+		
Clubionidae					
Clubiona phragmitis	*c*	+	+	*3*	
Clubiona stagnatilis	*l*	+	+		
Cybaeidae					
Argyroneta aquatica	*l*	+			
Hahniidae					
Antistea elegans	*l*				
Linyphiidae					
Allomengea vidua	*l*	+		*7,10*	
Bathyphantes approximatus	*l*	+			
Bathyphantes gracilis	*c*	+		*1,6*	

Bathyphantes parvulus	*c*	+			
Diplocephalus permixtus	*c*	+			
Erigone atra	*c*	+		*7*	
Erigone dentipalpis	*c*	+		*7*	
Erigone vagans	*l*			*7*	
Gnathonarium dentatum	*c*	+			+
Gongylidiellum vivum	*c*	+			
Lepthyphantes flavipes	*c*	+			
Lepthyphantes tenuis	*c*	+			
Leptorhoptrum robustum	*l*	+		*6,10*	
Lophomma punctatum	*l*			*6*	
Microlinyphia impigra	*l*	+			
Microneta viaria	*c*			*11*	
Oedothorax fuscus	*c*	+		*1,7*	
Oedothorax retusus	*c*	+		*7*	
Porhomma pygmaeum	*c*			*11*	
Tmeticus affinis	*c*			*7*	
Lycosidae					
Arctosa leopardus	*l*	+			
Pardosa amentata	*c*			*3*	
Pardosa prativaga	*c*	+			
Pirata hygrophilus	*c*	+			
Pirata latitans	*l*	+			
Pirata piraticus	*c*	+			+
Trochosa rusricola	*c*			*5*	
Trochosa terricola	*c*	+			
Pisauridae					
Pisaura mirabilis	*c*		+		
Tetragnathidae					
Metellina segmentata	*c*		+		
Pachygnatha clercki	*c*	+	+	*3,5,6,8,11*	+
Pachygnatha degeeri	*c*	+	+		
Theridiidae					
Enoplognatha ovata	*c*	+			
Theridiosomatidae					
Theridiosoma gemmosum	*Nb*	+			
Thomisidae					
Ozyptila brevipes	*l*	+			
Xysticus ulmi	*c*		+		
Hydracarina					+
Coleoptera					
Anthicidae					
Anticus antherinus	*c*			*2*	
Apionidae					
Apion frumentarium	*c*		+		
Ceratapion gibbirostre	*c*	+			
Oxystoma cerdo	*Nb*	+			

Perapion curtirostre	*c*	+			
Perapion violaceum	*c*	+	+		
Protapion fulvipes	*c*		+		
Cantharidae					
Cantharis lateralis	*c*	+			
Cantharis nigra	*c*	+			
Cantharis thoracica	*l*	+			
Rhagonycha fulva	*c*	+			
Silis ruficollis	*Nb*	+			
Carabidae					
Acupalpus dubius	*c*	+		*8*	
Agonum afrum	*c*	+			
Agonum fuliginosum	*c*	+	+	*1,3,7,8,11*	
Agonum thoreyi	*c*	+			+
Agonum viduum	*c*	+			
Amara plebeja	*c*			*11*	
Badister dilatatus	*Nb*	+			
Bembidion aeneum	*c*			*3*	
Bembidion articulatum	*c*	+			
Bembidion assimile	*c*	+			
Bembidion biguttatum	*c*	+			
Bembidion guttula	*c*	+	+	*3*	
Bembidion lunulatum	*c*			*5*	
Bembidion mannerheimii	*c*	+			
Bembidion quadrimaculatum	*c*			*8*	
Calodromius spilotus	*c*		+		
Carabus granulatus	*l*	+		*2,5,7*	
Chlaenius nigricornis	*Nb*	+		*9*	
Clivina fossor	*c*	+			
Demetrias atricapillus	*c*	+	+		
Demetrias imperialis	*Nb*	+	+		
Dromius linearis	*c*	+	+		
Dromius quadrimaculatus	*c*			*6*	
Dyschirius globosus	*c*	+		*2,3*	
Elaphrus cupreus	*c*	+			
Leistus ferrugineus	*c*			*9*	
Leistus rufescens	*c*			*5*	
Leistus terminatus	*c*	+			
Loricera pilicornis	*c*	+	+	*7*	
Nebria brevicollis	*c*			*3,5*	
Ocys harpaloides	*c*	+	+		
Odacantha melanura	*Nb*	+			
Oodes helopoides	*Nb*	+		*3,10*	
Oxypselaphus obscurus	*c*	+		*8,11*	
Poecilus cupreus	*c*			*2,3*	
Pterostichus anthracinus	*Nb*	+		*2,3,5,8*	
Pterostichus diligens	*c*	+	+	*5,7,10,11*	

Pterostichus madidus	*c*		+		
Pterostichus melanarius	*c*	+		*3*	
Pterostichus minor	*l*	+		*5,11*	
Pterostichus niger	*c*			*3*	
Pterostichus nigrita	*c*	+	+	*2,3,4,5*	
Pterostichus strenuus	*c*	+	+	*1,5,7,11*	
Pterostichus vernalis	*c*	+		*1,2,3,10*	
Stenolophus mixtus	*c*	+			
Stomis pumicatus	*c*	+			
Cerambycidae					
Aromia moschata	*Nb*	+			
Clytus arietis	*c*	+			
Grammoptera ruficornis	*c*	+			
Pseudovadonia livida	*l*	+			
Rutpela maculata	*c*	+			
Chrysomelidae					
Aphthona lutescens	*c*	+	+		
Aphthona nonstriata	*c*	+	+		
Bruchus rufimanus	*c*		+		
Cassida flaveola	*l*	+			
Cassida rubiginosa	*c*	+	+		
Cassida viridis	*l*		+		
Cassida vibex	*l*	+			
Chaetocnema arida	*l*		+		
Chaetocnema concinna	*c*	+	+		
Chaetocnema confusa	*c*	+			
Chaetocnema hortensis	*c*		+		
Chrysolina polita	*c*	+		*6*	
Crepidodera aurata	*c*	+	+		
Crepidodera fulvicornis	*c*	+	+		
Crepidodera plutus	*l*	+	+		
Cryptocephalus pusillus	*c*	+			
Donacia clavipes	*Nb*	+			
Donacia marginata	*l*	+	+		
Donacia semicuprea	*l*	+			
Epitrix pubescens	*l*	+			
Galerucella lineola	*c*	+			
Galerucella pusilla	*c*		+		
Galerucella sagittariae	*c*	+	+		
Gastrophysa viridula	*c*	+	+		
Longitarsus luridus	*c*		+		
Longitarsus melanocephalus	*c*		+		
Neocrepidodera transversa	*c*	+	+		
Oulema melanopa agg.	*c*	+	+		
Phaedon armoraciae	*c*		+		
Phratora vulgatissima	*c*	+	+		
Phyllobrotica quadrimaculata	*l*	+			

Phyllotreta exclamationis	*l*		+	*10*	
Phyllotreta flexuosa	*c*			*10*	
Phyllotreta nigripes	*c*	+			
Phyllotreta undulata	*c*	+	+	*7*	
Plagiodera versicolorea	*l*	+	+		
Prasocuris junci	*l*	+			
Prasocuris phellandrii	*l*	+			
Psylliodes affinis	*c*		+		
Psylliodes chrysocephala	*c*	+			
Psylliodes dulcamarae	*c*	+			
Sphaeroderma testacea	*c*			*5*	
Ciidae					
Cis bilamellatus	*c*	+			
Coccinellidae					
Adalia bipunctata	*c*	+	+		
Adalia 10-punctata	*c*	+	+		
Anisosticta 19-punctata	*l*	+	+		
Calvia 14-guttata	*c*	+			
Chilocorus renipustulatus	*c*		+		
Coccidula rufa	*c*	+	+		
Coccinella 7-punctata	*c*	+	+		
Exochomus quadripustulatus	*c*	+			
Harmonia axyridis	*c*		+		
Propylea 14-punctata	*c*	+	+		
Psyllobora 22-punctata	*c*		+		
Rhyzobius litura	*c*	+			
Cryptophagidae					
Ephistemus globulus	*c*	+			
Curculionidae					
Archarias salicivorus	*c*	+			
Bagous alismatis	*Nb*	+			
Bagous lutulentus	*Nb*	+			
Ceutorhynchus assimilis	*c*	+			
Ceutorhynchus erysimi	*c*	+			
Ceutorhynchus pallidactylus	*c*		+		
Ceutorhynchus typhae	*c*		+		
Datonychus melanostictus	*l*	+	+		
Dorytomus taeniatus	*c*		+		
Hypera pollux	*c*	+	+		
Hypera punctata	*c*		+		
Hypera rumicis	*c*		+		
Limnobaris pilistriata	*l*	+			
Nedyus quadrimaculatus	*c*	+	+		
Parethelcus pollinarius	*c*	+	+		
Rhamphus pulicarius	*c*		+		
Rhinoncus bruchoides	*l*		+		
Rhinoncus inconspectus	*c*	+	+		

Rhinoncus pericarpius	*c*	+	+		
Rhinoncus perpendicularis	*c*		+	*3*	
Sitona cambricus	*l*		+		
Sitona hispidulus	*c*		+	*3*	
Sitona lepidus	*c*		+		
Sitona lineatus	*c*		+		
Tachyerges salicis	*l*	+			
Tanysphyrus lemnae	*c*	+			+
Dryopidae					
Dryops luridus	*c*	+			+
Dytiscidae					
Acilius sulcatus	*l*	+			
Agabus bipustulatus	*c*	+		*1,3*	+
Agabus nebulosus	*c*	+			
Agabus sturmii	*c*	+			+
Colymbetes fuscus	*c*	+			+
Dytiscus dimidiatus	*NT*				+
Dytiscus marginalis	*c*	+			+
Graptodytes pictus	*l*	+			+
Hydaticus transversalis	*NS*	+			+
Hydroglyphus geminus	*l*				+
Hydroporus angustatus	*c*	+			+
Hydroporus erythrocephalus	*c*	+			
Hydroporus incognitus	*l*	+			+
Hydroporus memnonius	*c*				+
Hydroporus palustris	*c*	+			+
Hydroporus planus	*c*	+			+
Hydroporus pubescens	*c*	+			+
Hydroporus striola	*l*	+			+
Hydroporus tessellatus	*c*	+			+
Hygrotus impressopunctatus	*c*				+
Hygrotus inaequalis	*c*	+			+
Hyphydrus ovatus	*c*	+			+
Ilybius ater	*l*	+		*7*	+
Ilybius guttiger	*l*	+			
Ilybius montanus	*l*	+		*2*	+
Ilybius quadriguttatus	*c*	+			+
Laccophilus minutus	*c*				+
Liopterus haemorrhoidalis	*c*	+			+
Porhydrus lineatus	*l*	+			+
Rhantus grapii	*l*	+		*2*	+
Rhantus suturalis	*c*				+
Suphrodytes dorsalis	*l*				+
Elateridae					
Athous bicolor	*c*	+			
Hemicrepidius hirtus	*c*	+			
Erirrhinidae					

Notaris acridulus	*c*	+		*3*	
Notaris scirpi	*Nb*	+			
Stenopelmus rufinasus	*c*	+			
Thryogenes nereis	*l*	+			+
Gyrinidae					
Gyrinus substriatus	*c*	+			+
Haliplidae					
Haliplus confinis	*c*	+			
Haliplus flavicollis	*c*				+
Haliplus heydeni	*l*	+			+
Haliplus immaculatus	*c*	+			+
Haliplus lineatocollis	*c*	+			+
Haliplus ruficollis	*c*	+			+
Haliplus sibiricus	*c*	+			+
Peltodytes caesus	*NS*				+
Helophoridae					
Helophorus aequalis	*c*	+			+
Helophorus brevipalpis	*c*	+			+
Helophorus grandis	*c*	+			
Helophorus granularis	*l*	+			
Helophorus minutus	*c*	+	+		+
Hydraenidae					
Hydraena riparia	*l*	+			
Hydraena testacea	*l*	+			
Ochthebius minimus	*c*	+			+
Hydrophilidae					
Anacaena globulus	*c*	+		*5,6,8,11*	
Anacaena limbata	*c*	+	+		+
Anacaena lutescens	*c*	+			+
Berosus affinis	*l*	+			
Cercyon convexiusculus	*l*	+		*8*	+
Cercyon melanocephalus	*c*	+			
Cercyon pygmaeus	*c*	+			
Cercyon sternalis	*l*	+			+
Cercyon tristis	*l*	+			
Cercyon ustulatus	*l*	+		*3,9*	
Coelostoma orbiculare	*l*	+		*3,9*	+
Cryptopleurum minutum	*c*	+			
Cymbiodyta marginella	*l*	+			+
Enochrus coarctatus	*l*	+			+
Enochrus ochropterus	*l*	+			+
Enochrus testaceus	*c*	+			+
Helochares lividus	*l*	+			+
Helophorus obscurus	*c*	+			+
Hydrobius fuscipes	*c*	+			+
Hydrophilus piceus	*NT*	+			+
Laccobius bipunctatus	*c*	+			+

Laccobius minutus	*c*	+			+
Megasternum concinnum	*c*			*1,4,5,7,10*	
Sphaeridium scarabaeoides	*c*	+			
Kateretidae					
Brachypterus urticae	*c*	+			
Kateretes pusillus	*l*	+			
Kateretes rufilabris	*c*	+			
Latridiidae					
Aridius bifasciatus	*c*		+		
Leiodidae					
Catops morio	*l*	+		*5,7*	
Sciodrepoides watsoni	*c*	+		*5*	
Melyridae					
Anthocomus rufus	*l*	+	+		
Mycetophagidae					
Mycetophagus multipunctatus	*l*	+			
Nanophyidae					
Nanophyes marmoratus	*c*	+	+		
Nitidulidae					
Meligethes aeneus	*c*	+			
Pria dulcamarae	*l*		+		
Noteridae					
Noterus clavicornis	*l*	+			+
Oedemeridae					
Oedemera lurida	*c*	+			
Oedemera nobilis	*c*	+			
Phalacridae					
Olibrus aeneus	*c*		+		
Stilbus oblongus	*l*	+			
Scarabaeidae					
Aphodius ater	*c*	+			
Aphodius erraticus	*c*	+			
Aphodius fimetarius	*c*	+			
Aphodius haemorrhoidalis	*c*	+			
Aphodius rufipes	*c*	+			
Scirtidae					
Cyphon coarctatum	*c*	+			
Cyphon hilaris	*c*	+			
Cyphon padi	*l*	+	+		
Cyphon laevipennis	*c*		+		
Cyphon palustris	*c*	+			
Cyphon sp. larvae					+
Microcara testacea	*c*	+			
Scirtes hemisphaericus	*l*	+			
Scirtes orbicularis	*Na*	+			
Scraptiidae					
Anaspis maculata	*c*	+			

Scydmaenidae					
Euconnus hirticollis	*l*	+			
Silphidae					
Nicrophorus vespillo	*c*			*1,7*	
Silpha atrata	*c*	+	+		
Thanatophiilus sinuatus	*c*			*7*	
Silvanidae					
Psammoecus bipunctatus	*l*	+	+	*8*	+
Staphylinidae					
Anotylus rugosus	*c*	+			
Anotylus sculpturatus	*c*	+			
Astenus lyonessius	*c*				+
Bryaxis bulbifer	*c*	+	+		
Erichsonius cinerascens	*c*	+			
Gabrius breviventer	*l*	+	+	*8,11*	
Gabrius keysianus	*Nb*		+		
Gabrius trossulus	*l*	+			
Lathrobium brunnipes	*c*	+			
Lathrobium geminum	*c*			*2,7,9*	
Ocypus olens	*c*			*7*	
Oxytelus fulvipes	*Nb*	+		*5,6*	
Oxytelus laqueatus	*c*		+		
Paederus fuscipes	*Nb*	+	+	*1*	
Paederus riparius	*l*	+	+		
Philonthus micans	*c*	+			
Philonthus quisquiliarius	*l*	+			
Platystethus alutaceus	*l*	+			
Platystethus cornutus	*c*		+		
Platystethus nitens	*l*	+			
Quedius fuliginosus	*c*	+			
Quedius maurorufus	*l*		+	*2,3,7,11*	
Quedius mesomelinus	*c*			*8*	
Quedius molochinus	*c*			*2*	
Quedius tristis	*c*			*8*	
Rugilus rufipes	*c*	+			
Rybaxis longicornis	*c*		+		
Stenus bifoveolatus	*c*	+	+		
Stenus bimaculatus	*c*	+	+	*10*	+
Stenus boops	*c*	+			
Stenus brunnipes	*c*		+	*7*	
Stenus cicindeloides	*c*	+	+		
Stenus flavipes	*c*	+			
Stenus fulvipes	*c*		+		
Stenus juno	*c*	+	+	*7*	+
Stenus picipes	*l*		+		
Stenus providus	*c*	+			
Stenus solutus	*l*	+			

Stenus tarsalis	*c*		+		
Tachinus signatus	*c*	+		*3*	
Tachyporus chrysomelinus	*c*		+		
Tachyporus hypnorum	*c*		+		
Tachyporus nitidulus	*c*	+	+		
Tachyporus obtusus	*c*		+		
Xantholinus linearis	*c*	+		*10*	
Xantholinus longiventris	*c*		+		
Tenebrionidae					
Lagria hirta	*c*	+			
Dermaptera					
Forficulidae					
Forficula auricularia	*c*	+	+		
Diptera					
Asilidae					
Leptogaster cylindrica	*c*	+			
Bibionidae					
Dilophus febrilis	*c*		+		
Campichoetidae					
Campichoeta punctum	*c*		+		
Chironomidae					+
Clusiidae					
Clusiodes albimana	*c*	+			
Culicidae					
Anopheles sp.					+
Dixidae					
Dixella autumnalis	*c*		+		+
Dolichopodidae					
Achalcus cinereus	*c*	+			
Achalcus flavicollis	*c*	+			
Anepsiomyia flaviventris	*c*	+			
Argyra leucocephala	*c*		+		
Bathycranium bicolorellum	*l*		+		
Campsicnemus curvipes	*c*		+		
Campsicnemus scambus	*c*	+			
Chrysotus cilipes	*c*	+	+		
Chrysotus gramineus	*c*		+		
Dolichopus campestris	*l*	+			
Dolichopus griseipennis	*c*	+	+		
Dolichopus linearis	*l*		+		
Dolichopus pennatus	*c*	+			
Dolichopus plumipes	*c*	+	+		
Dolichopus popularis	*c*	+			
Dolichopus simplex	*c*	+	+		
Dolichopus ungulatus	*c*	+			
Hercostomus aerosus	*c*	+			
Hercostomus chalybaeus	*l*	+			

Hercostomus metallicus	*c*	+			
Lamprochromus bifasciatus	*l*	+			
Micromorphus albipes	*l*	+			
Poecilobothrus nobilitatus	*c*	+			
Rhaphium caliginosum	*c*	+			
Rhaphium fasciatum	*l*	+			
Scellus notatus	*c*	+			
Sciapus platypterus	*c*	+		*6*	
Sybistroma obscurellum	*c*	+	+		
Sympycnus desoutteri	*c*	+	+		
Syntormon pallipes	*c*	+	+		
Teucophorus spinigerellus	*l*	+			
Empididae					
Empis livida	*c*	+			
Heleomyzidae					
Suillia atricornis	*c*		+		
Suillia variegata	*c*		+		
Hybotidae					
Bicellaria vana	*c*		+		
Drapetis ephippiata	*l*	+			
Drapetis parilis	*l*	+			
Hybos femoratus	*c*	+			
Ocydromia glabricula	*c*		+		
Oropezella sphenoptera	*1*	+			
Platypalpus minutus	*c*	+			
Platypalpus pallidiventris	*c*	+			
Platypalpus stabilis	*l*	+			
Stilpon graminum	*l*	+			
Trichina clavipes	*c*	+			
Keroplatidae					
Macrocera lutea	*c*	+			
Macrocera maculata	*c*	+			
Macrocera vittata	*c*		+		
Lauxaniidae					
Homoneura subnotata	*c*	+	+		
Tricholauxania praeusta	*c*	+			
Trigonometopus frontalis	*l*	+	+		
Limoniidae					
Antocha vitripennis	*c*		+		
Austrolimnophila ochracea	*c*	+			
Dicranomyia modesta	*c*	+	+		
Dicranomyia morio	*l*	+	+		
Erioptera fuscipennis	*c*	+			
Erioptera fusculenta	*l*	+			
Erioptera lutea	*c*	+			
Euphylidorea lineoila	*c*		+		
Helius flavus	*l*	+			

Helius longirostris	*l*	+			
Limonia macrostigma	*c*		+		
Limonia nubeculosa	*c*		+		
Limonia trivittata	*N*	+			
Molophilus medius	*c*	+			
Molophilus obscurus	*c*		+		
Neolimnophila batava	*l*	+			
Neolimnophila nemoralis	*c*		+		
Phylidorea fulvonervosa	*c*	+			
Pilaria discicollis	*c*	+			
Rhipidia maculata	*c*	+			
Indet. larvae					+
Lonchopteridae					
Lonchoptera lutea	*c*	+	+		
Megamerinidae					
Megamerina dolium	*N*	+			
Micropezidae					
Neria commutata	*c*	+			
Muscidae					
Mesembrina meridiana	*c*	+			
Mycetophilidae					
Mycomya flava	*c*		+		
Opomyzidae					
Geomyza apicalis	*N*		+		
Geomyza tripunctata	*c*	+	+		
Opomyza florum	*c*	+	+		
Opomyza germinationis	*c*	+	+		
Pallopteridae					
Palloptera trimacula	*c*	+	+		
Pipunculidae					
Dorylomorpha haemorrhoidalis	*c*	+			
Platystomatidae					
Rivellia syngenesiae	*l*	+			
Psilidae					
Loxocera albiseta	*c*	+			
Ptychopteridae					
Ptychoptera contaminata	*c*	+			
Ptychoptera albimana	*c*			*10*	
Ptychoptera sp. larva					+
Rhagionidae					
Chrysopilus asiliformis	*c*	+			
Chrysopilus cristatus	*c*	+			
Rhagio lineola	*c*	+			
Rhagio scolopacea	*c*	+			
Rhagio tringarius	*c*	+			
Scathophagidae					
Cleigastra apicalis	*c*	+	+		

Cordilura ciliata	*c*	+	+		
Cordilura impudica	*c*	+	+		
Norellisoma spinimanum	*c*	+	+		
Scathophaga stercoraria	*c*	+	+		
Scatopsidae					
Rhegmoclema verralli	*c*		+		
Sciomyzidae					
Antichaeta brevipennis	*RDB2*	+	+		
Dichetophora obliterata	*I*	+			
Elgiva solicita	*I*		+		
Hydromya dorsalis	*c*	+			
Ilione albiseta	*c*	+	+	*2,7*	
Limnia paludicola	*c*	+			
Pherbellia schoenherri	*I*	+			
Pherbina coryleti	*c*	+	+	*1,3,6,7*	
Psacadina verbeckei	*N*	+	+		
Pteromicra angustipennis	*I*	+	+		
Pteromicra leucopeza	*RDB2*			*1*	
Renocera pallida	*c*	+			
Sepedon sphegea	*I*	+	+		
Sepedon spinipes	*I*	+	+		
Tetanocera arrogans	*I*	+	+		
Tetanocera elata	*c*		+	*7*	
Tetanocera ferruginea	*c*	+	+	*1,3,7,11*	
Tetanocera hyalipennis	*c*	+	+	*6,11*	
Tetanocera robusta	*I*	+			
Tetanura pallidiventris	*I*	+			
Trypetoptera punctulata	*c*	+			
Sepsidae					
Sepsis cynipsea	*c*	+			
Sepsis punctum	*c*		+		
Themira annulipes	*c*	+			
Sphaeroceridae					
Gonioneura spinipennis	*c*	+			
Stratiomyidae					
Beris morrisii	*c*		+		
Beris vallata	*c*	+		*6,8*	
Chloromyia formosa	*c*	+			
Chorisops nagatomii	*N*	+			
Chorisops tibialis	*c*	+			
Microchrysa flavicornis	*c*	+			
Microchrysa polita	*c*	+	+		
Nemotelus nigrinus	*I*	+			
Nemotelus pantherinus	*I*	+			
Odontomyia ornata	*RDB2*				+
Odontomyia tigrina	*N*	+			
Oplodontha viridula	*I*	+			

Oxycera nigricornis	*l*	+			
Pachygaster atra	*c*	+		*4*	
Pachygaster leachii	*c*	+			
Stratiomys potamida	*N*	+			+
Syrphidae					
Anasimyia lineata	*l*		+		
Cheilosia impressa	*l*	+			
Cheilosia pagana	*c*		+		
Episyrphus balteatus	*c*	+	+		
Eristalis arbustorum	*c*		+		
Eristalis interruptus	*c*	+	+		
Eristalis intricarius	*c*	+			
Eristalis tenax	*c*	+	+		
Eupeodes corollae	*c*	+			
Euepodes latifasciatus	*l*		+		
Eupeodes luniger	*c*	+	+		
Helophilus pendulus	*c*	+	+		
Helophilus trivittatus	*l*		+		
Heringia senilis	*?*	+			
Lejogaster metallina	*c*	+	+		
Melangyna compositarum	*c*		+		
Melanostoma mellinum	*c*	+	+		
Neoascia podagrica	*c*	+			
Neoascia tenur	*c*	+	+		
Parhelophilus frutetorum	*l*	+			
Platycheirus albimanus	*c*		+	*6*	
Platycheirus clypeatus	*c*		+		
Platycheirus granditarsis	*c*		+		
Platycheirus occultus	*c*	+			
Platycheirus peltatus	*c*	+			
Platycheirus rosarum	*l*	+	+		
Rhingia campestris	*c*		+	*5*	
Scaeva pyrastri	*c*	+	+		
Sericomyia silentis	*l*			*7,8,10*	
Sphaerophoria interrupta	*c*		+		
Sphaerophoria scripta	*c*	+	+		
Sphaerophoris taeniata	*l*		+		
Syritta pipiens	*c*	+	+		
Tropidia scita	*l*	+			
Volucella pellucens	*c*	+			
Xylota segnis	*c*	+	+		
Tabanidae					
Chrysops relictus	*c*	+			
Chrysops viduatus	*l*	+			
Chrysops sp. larva					+
Haematopota crassicornis	*c*	+			
Haematopota pluvialis	*c*	+			

Tabanus autumnalis	*l*	+			
Tachinidae					
Eriothrix rufomaculatus	*c*	+			
Tachina fera	*c*		+		
Tephritidae					
Chaetostomella cylindrica	*c*	+			
Dioxyna bidentis	*N*		+		
Sphenella marginata	*l*		+		
Tephritis formosa	*c*		+		
Urophora cardui	*c*	+			
Tipulidae					
Nephrotoma appendiculata	*c*	+			
Nigrotipula nigra	*l*	+			
Tipula lateralis	*c*	+			
Tipula paludosa	*c*		+		
Ulidiidae					
Melieria crassipennis	*l*	+			
Ephemeroptera					
Baetidae					
Cloeon dipterum	*c*	+			+
Caenidae					
Caenis luctuosa	*c*				+
Hemiptera-Auchenorhyncha					
Cercopidae					
Aphrophora alni	*c*	+	+		
Aphrophora pectoralis	*l*		+		
Aphrophora salicina	*c*	+	+		
Neophilaenus lineatus	*c*	+	+		
Philaenus spumarius	*c*	+	+		
Cicadellidae					
Alnetoidea alneti	*c*		+		
Aphrodes albifrons	*c*	+			
Aphrodes albiger	*Nb*	+		*2,3,7*	
Aphrodes flavostriatus	*c*	+	+		
Aphrodes makarovi	*c*	+	+		
Arthaldeus pascuellus	*c*	+	+		
Balclutha punctata	*c*		+		
Cicadella viridis	*c*	+	+	*1*	
Cicadula aurantipes	*l*	+	+		
Cicadula frontalis	*c*	+	+	*9*	
Cicadula quadrinotata	*c*	+	+		
Conosanus obsoletus	*c*	+	+	*1,2,3,7,8*	
Empoasca decipiens	*c*		+		
Empoasca vitis	*c*		+		
Eupteryx aurata	*c*		+		
Eupteryx cyclops	*c*	+			
Eupteryx florida	*c*		+		

Eupteryx melissae	*c*		+		
Eupteryx urticae	*c*	+	+		
Eupteryx vittata	*c*	+			
Euscelis incisus	*c*	+	+		
Evacanthus acuminatus	*c*		+		
Evacanthus interruptus	*c*	+			
Iassus lanio	*c*	+			
Idiocerus confusus	*c*	+	+		
Idiocerus herrichii	*l*	+	+		
Idiocerus rutilans	*l*	+	+		
Linnavuoriana sexmaculata	*c*		+		
Macropsis albae	*l*	+			
Macropsis prasina	*c*	+	+		
Macrosteles larvis	*c*		+		
Macrosteles sexnotatus	*c*	+	+		
Macrosteles viridigriseus	*c*	+	+		
Mocydia crocea	*c*		+		
Notus flavipennis	*c*	+	+		
Psammotettix confinis	*c*		+		
Streptanus sordidus	*c*		+		
Stroggylocephalus agrestis	*l*	+			
Zyginidia scutellaris	*c*	+	+		
Cixiidae					
Cixius nervosus	*c*	+	+		
Cixius simplex	*l*		+		
Delphacidae					
Anakelisia fasciata	*l*	+	+		
Chloriona smaragdula	*c*	+			
Chloriona unicolor	*c*	+			
Chloriona vasconica	*Nb*	+			
Conomelus anceps	*c*	+	+	*1,2,10*	
Criomorphus albomarginatus	*c*	+			
Delphax pulchellus	*l*	+	+		
Dicranotropis hamata	*c*		+		
Euides speciosa	*l*	+	+		
Florodelphax leptosoma	*c*	+	+		
Kelisia punctulum	*l*	+	+		
Javesella obscurella	*c*		+		
Javesella pellucida	*c*		+		
Megamelodes quadrimaculatus	*l*	+	+	*8*	
Megamelus notula	*l*	+	+	*5,7,8*	
Muellerianella brevipennis	*c*		+		
Stenocranus major	*c*		+		
Stenocranus minutus	*c*		+		
Struebingianella lugubrina	*l*			*10*	
Hemiptera-Heteroptera					
Acanthosomatidae					

Acanthosoma haemorrhoidale	*c*		+		
Anthocoridae					
Anthocoris nemoralis	*c*	+	+		
Anthocoris nemorum	*c*	+	+		
Orius majusculus	*c*	+			
Orius niger	*c*	+	+		
Orius vicinus	*c*	+	+		
Aradidae					
Aneurus avenius	*l*	+			
Coreidae					
Coreus marginatus	*c*		+		
Corixidae					
Callicorixa praeusta	*c*				+
Corixa punctata	*c*	+			+
Hesperocorixa linnei	*c*	+			+
Hesperocorixa sahlbergi	*c*	+			+
Sigara dorsalis	*c*	+			+
Gerridae					
Gerris lacustris	*c*	+			+
Gerris odontogaster	*c*	+			+
Gerris thoracicus	*c*	+			
Hydrometridae					
Hydrometra stagnorum	*c*	+			+
Lygaeidae					
Cymus glandicolor	*c*	+			
Cymus melanocephalus	*c*	+	+		
Drymus brunneus	*c*	+			
Drymus sylvaticus	*c*	+	+		
Heterogaster urticae	*c*	+			
Ischnodemus sabuleti	*c*	+	+		
Kleidocerys resedae	*c*	+			
Scolopostethus puberulus	*l*	+	+		
Scolopostethus thomsoni	*c*	+	+		
Mesoveliidae					
Mesovelia furcata	*l*				+
Microphysidae					
Loricula elegantula	*c*	+			
Myrmedobia distinguenda	*l*	+			
Miridae					
Bryocoris pteridis	*c*	+	+		
Capsus ater	*c*	+			
Closterotomus norwegicus	*c*	+			
Coniortodes salicellus	*c*		+		
Cyrtorhinus caricis	*c*	+			
Dicyphus epilobii	*c*	+	+		
Fieberocapsus flaveolus	*l*	+			
Grypocoris stysi	*c*	+			

Leptopterna dolabrata	*c*	+			
Liocoris tripustulatus	*c*	+	+		
Lygocoris lucorum	*c*	+			
Lygocoris pabulinus	*c*	+	+		
Lygus pratensis	*RDB3*		+		
Lygus rugulipennis	*c*	+	+		
Megaloceroea recticornis	*c*	+			
Miridius quadrivirgatus	*l*	+			
Notostira elongata	*c*	+	+		
Orthops campestris	*c*		+		
Orthotylus marginalis	*c*	+			
Phytocoris longipennis	*c*		+		
Phytocoris ulmi	*c*		+		
Pinalitus cervinus	*c*		+		
Pinalitus viscicola	*l*		+		
Plagiognathus arbustorum	*c*	+	+		
Plagiognathus chrysanthemi	*c*	+			
Polymerus nigritus	*c*	+			
Polymerus palustris	*l*	+			
Psallus haematodes	*c*	+	+		
Psallus varians	*c*	+			
Salicarus roseri	*c*	+			
Stenodema calcarata	*c*	+	+		
Stenodema laevigata	*c*	+	+		
Stenotus binotatus	*c*	+			
Teratocoris antennatus	*l*	+	+		
Trigonotylus caelestialium	*c*	+			
Tytthus pygmaeus	*l*	+			
Nabidae					
Himacerus apterus	*c*		+		
Nabis ferus	*c*	+	+		
Nabis flavomarginatus	*c*		+		
Nabis limbatus	*c*	+	+	*8,10*	
Nabis rugosus	*c*	+	+		
Naucoridae					
Ilyocoris cimicoides	*c*	+			+
Nepidae					
Nepa cinerea	*c*	+		*3*	+
Ranatra linearis	*l*				+
Notonectidae					
Notonecta glauca	*c*	+			+
Pentatomidae					
Palomena prasina	*c*	+	+		
Pentatoma rufipes	*c*		+		
Picromerus bidens	*l*	+	+		
Zicrona caerulea	*l*	+	+		
Pleidae					

Plea minutissima	*c*	+			+
Reduviidae					
Empicoris vagabundus	*c*		+		
Rhopalidae					
Corizus hyoscyami	*l*	+			
Saldidae					
Chartoscirta cincta	*c*	+			+
Saldula saltatoria	*c*	+		*8*	
Tingidae					
Dictyla convergens	*l*	+			
Tingis ampliata	*c*	+			
Tingis cardui	*c*	+			
Veliidae					
Microvelia reticulata	*c*	+			+
Hemiptera-Sternorhyncha					
Psyllidae					
Psylla viscicola	*l*		+		
Hymenoptera					
Apidae					
Apis mellifera	*c*		+		
Bombus lucorum	*c*		+		
Bombus pascuorum	*c*		+		
Megachile ligniseca	*l*		+		
Formicidae					
Lasiius niger agg.	*c*		+		
Myrmica ruginodis	*c*			*7,9*	
Myrmica scabrinodis	*c*	+	+		
Sphecidae					
Crossocerus annulipes	*c*	+			
Crossocerus podagricus	*c*	+	+		
Ectemnius continuus	*c*	+			
Pemphredon lugubris	*c*	+			
Trypoxylon attenuatum	*c*	+			
Vespidae					
Symmorphus gracilis	*c*	+			
Vespula rufa	*c*		+		
Vespula vulgaris	*c*		+		
Lepidoptera					
Arctiidae					
Callimorpha dominula	*l*	+			
Spilosoma lubricipeda	*c*			*6*	
Thumatha senex	*l*	+			
Lasiocampidae					
Philudoria potatoria	*c*		+	*6*	
Lycaenidae					
Celastrina argiolus	*c*	+			
Lycaena phlaeas	*c*		+		

Lymantriidae					
Euproctis similis	*c*		+		
Noctuidae					
Acronicta rumicis	*c*		+		
Lacanobia oleracea	*c*			*7*	
Mythimna pallens	*c*			*10*	
Nymphalidae					
Aglais urticae	*c*	+			
Maniola jurtina	*c*	+			
Pararge aegeria	*c*	+	+		
Pyronia tithonus	*c*	+			
Vanessa atalanta	*c*	+			
Pieridae					
Pieris napi	*c*		+		
Pieris rapae	*c*	+	+		
Pyralidae					
Cataclysta lemnata	*c*	+			+
Sesiidae					
Synanthedon formicaeformis	*Na*	+			
Sphingidae					
Deilephila elpenor	*c*		+	*6,7*	
Mecoptera					
Panorpidae					
Panorpa communis	*c*	+			
Panorpa germanica	*c*		+		
Megaloptera					
Sialidae					
Sialis lutaria	*c*				+
Neuroptera					
Chrysopidae					
Chrysopa perla	*c*	+			
Chrysoperla carnea agg.	*c*	+	+		
Hemerobiidae					
Hemerobius humulinus	*c*	+	+		
Micromus variegatus	*c*	+	+		
Odonata					
Aeshnidae					
Aeshna cyanea	*c*	+	+		
Aeshna mixta	*c*		+		
Anax imperator	*l*	+			+
Coenagriidae					
Coenagrion puella	*c*	+			
Coenagrion sp. nymph					+
Enallagma cyathigerum	*c*	+			
Ischnura elegans	*c*	+			+
Lestidae					
Lestes sponsa	*l*	+			

Libellulidae					
Orthetrum cancellatum	*l*	+			
Sympetrum sanguineum	*l*	+	+		
Sympetrum striolatum	*c*	+	+		
Sympetrum sp nymph					+
Orthoptera					
Acrididae					
Chorthippus albomarginatus	*c*		+	*2*	
Chorthippus parallelus	*c*	+	+	*2,3*	
Tetrigidae					
Tetrix subulata	*c*	+		*2,10*	
Tetrix undulata	*c*	+		*2*	
Tettigoniidae					
Conocephalus dorsalis	*l*	+	+	*1,2,3*	
Leptophyes punctatissima	*c*	+	+		
Meconema thalassinum	*c*	+	+		
Pholidoptera griseoaptera	*c*		+		
Trichoptera					
Leptoceridae					
Oecetis furva	*c*				+
Triaenodes bicolor	*c*				+

The effect on Bats of the M4 Relief Road

Professor John Altringham

Introduction

Witness introduction

1. I am John Altringham. I hold a BSc in Biology (University of York) and a PhD in Zoology (St. Andrews University). I am Emeritus Professor of Animal Ecology and Conservation at the University of Leeds (Professor 1999-2016). I have conducted and published zoological and ecological research for 38 years and have written over 150 scientific papers and reports on a broad range of topics. I was awarded the Scientific Medal of the Zoological Society of London in 1994 "for distinguished work in zoology".

2. I have been actively involved in bat research and conservation for over 30 years. I am author of three major books on bat biology and conservation:

- Bats: Biology and Behaviour (1996) [1]
- British Bats (2003)[2]
- Bats: from Evolution to Conservation (2011)[3].

3. I am senior author of a review book, Bat Conservation: Global evidence for the effects of interventions (Synopses of Conservation Evidence Series 2013[4]). I have extensive field experience with wild bats in the UK and abroad, applying a wide range of techniques to their study. My research has been funded by government and by national and international conservation charities. I regularly advise Natural England, Natural Resources Wales, Scottish Natural Heritage, the Bat Conservation Trust and wildlife trusts on bat ecology and conservation issues. I am author of a number of guidance notes for Natural England and others related to best practice conservation. I run and contribute to training courses in bat conservation, survey and research and I am a past member of CIEEM. I am a member of a number of advisory groups, including the Natural Environment Group of the National Trust, an independent advisory body of expert volunteers, and the Yorkshire Dales Biodiversity Forum, a volunteer body that advises and assists the national park authority in formulating and delivering its conservation objectives. I am a regular advisor and contributor to BBC Natural History Unit programmes on bats and other topics.

4. Of particular relevance to this case is my interest in the effects of transport infrastructure on bats (and other animals). Our published research has demonstrated that operational major roads reduce bat activity and species diversity over more than 1 km either side of the road (Berthinussen & Altringham 2012a[5]) and that current mitigation practice is largely ineffective (Berthinussen & Altringham 2012b[6]). We have recently published a major DEFRA-funded report (Berthinussen & Altringham 2015a[7]). This summarises current knowledge in the field of road ecology related to bats, details our extensive further research that supports earlier conclusions, and provides detailed best practice guidance on survey, monitoring and mitigation for bats on transport infrastructure. This report was produced with the aid of a steering group whose members included representatives from the statutory nature conservation organisations of the UK and Highways England. I have also published recent review works on bats and roads and evidence-based conservation in general (e.g. Abbott et al. 2015, Berthinussen et al. 2013[8], Berthinussen & Altringham 2015b[9], Altringham & Kerth 2015[10]) and been an invited speaker at conferences in the UK, Australia and Denmark, on the subject.

Overview

5. Scope of evidence. My evidence will consider the likely effects on bats of the proposed M4 extension across the Gwent levels, through an assessment of the Environmental Statement (ES), the mitigation proposals within it and my own research experience. It will also include a brief discussion of well documented, long-term impacts of roads on wildlife that are not acknowledged by the Environmental Statement.

6. The bat surveys along the proposed route described in the ES use appropriate methods and are reasonable in scope. There are some gaps, such as those highlighted by NRW (4 May 2016)[11] and the

Bat Conservation Trust[12], but the data are sufficient to show that the footprint of the motorway falls on important bat habitat along most of its route and the road has the potential to do considerable damage to bat populations.

7. The ES (Chapter 10) assesses the likely impact of the construction of the road on bats as moderate adverse without effective mitigation. It is claimed that the package of mitigation measures proposed will reduce the impact to slight adverse. However, despite citing our DEFRA report (Berthinussen & Altringham 2015a) and quoting extensively from the best practice recommendations within it, the ES ignores the evidence we provide that shows the proposed mitigation will be at best high-risk and largely ineffective and at worst completely ineffective. The authors present, in Table 10.18, side by side with details of the proposed mitigation, the evidence they have collated which shows that most species will not benefit from the mitigation, and acknowledge the lack of evidence for its effectiveness for others. If they had included evidence from our paper and DEFRA report, they would have to conclude that the situation is significantly worse than that drawn from the flawed evidence they cite. In addition to passing over much important evidence, they do not appear to have taken on board the critical distinction between the use of a structure by individual bats and its effectiveness at protecting bat populations - something we have been discussing in our publications for some time (as far back as Altringham 2008[13]). Reports are cited that describe the use of overpasses and underpasses by small numbers of bats in support of their value as mitigation tools. There is no mention of the number of bats that no longer go near a site or cross the road, or those that cross the road at risk of being killed. The purpose of mitigation is to ensure that a very large majority of the bats present before construction continues to cross the road safely after construction. By these criteria, most mitigation is untested or failing (Berthinussen & Altringham 2012b). This study is apparently not cited at all (NB the online link to the references was broken), despite being a widely publicised, freely available, open source paper. Our work has been widely discussed in the media, we have run workshops and presentations, including some for CIEEM, yet it seems to have slipped under their radar.

8. Bat boxes are put forward as effective replacements to lost roosts. In fact, bat boxes and bat barns represent a high risk, poorly assessed mitigation 'solution' to lost roosts – there is no guarantee that they will work and a high probability that they will not. Stone et al. (2013)[14], in an analysis of Natural England (English Nature) derogation licence returns, found that even when existing roosts in buildings were retained after development, bats did not return to 26% of the roosts and the number of bats using those roosts they did return to fell by more than 50%. Too little published information is available on bat barns and similar structures for assessment, but anecdotal evidence suggests the odds are against effective uptake – at best, it is a high risk strategy. Stone et al. (2013) reported that only 13% of bat boxes erected for mitigation were used and no assessment can be made of their value as effective replacement roosts. My own experience, working with the Forestry Commission for over 10 years on the monitoring of hundreds of boxes, is that a small proportion are used transiently by small numbers of bats: evidence of occupancy was found in <10% of boxes. Stone et al. (2013) also highlight poor levels of compliance: 67% of licencees failed to submit post-development reports and post-development monitoring was conducted at only 19% of sites. Our experience, discussed in many of our reports, is that non-compliance is still an issue and most of the reports that are submitted are not fit for purpose.

9. Based on current evidence, over the road structures (with the probable exception of wide green bridges) are not effective at helping bats cross safely (Abbott et al. 2015[15], Berthinussen & Altringham 2012b, 2015a). Under the road solutions (culverts and underpasses) have the potential to be effective if large enough, sited on pre-existing commuting routes and well connected to the landscape (Abbott et al. 2015 Berthinussen & Altringham 2012b, 2015a). Unfortunately, almost all of those proposed in the ES are too small,

most will be placed well away from known commuting routes and many will be poorly connected to existing commuting routes. In combination, these factors are highly likely to make the mitigation ineffective.

10. The ES concerns itself almost entirely with impact during construction and makes no reference to the long-term, landscape-scale impact of the operational phase of the road. This is despite the fact that Berthinussen & Altringham (2012a, 2015a) are cited and extensively quoted, and this issue is a major part of our report. We have shown that major roads, whether under construction or long-established, are associated with lower bat activity and species diversity for at least 1-1.6 km either side of the road. The causes are multiple (habitat loss, degradation and fragmentation) and not all are well understood, but the effect is clear and widespread. The 'missing' bats have died or been displaced – and displacement probably also leads to population decline, since displaced bats will be in competition for resources with other bats. The authors of the ES appear not to understand this basic ecological principle - in the vague way they handle this issue, it appears they assume there is lots of empty habitat waiting for these displaced bats to move into. There is not, it is already occupied.

11. Persistent, landscape scale effects of operational roads are not unique to bats. There is a considerable body of evidence to show that many animal species are subject to similar effects, often of greater magnitude. The evidence can be concisely summarised through a recently published paper (Torres et al. 2016[16]). Based on an analysis of 232 species of bird and mammal, average bird species abundance is reduced by 50% within 200 m of major roads and average mammal species abundance is halved within 1 km. These are permanent effects of operational roads, not simply short-term disruptions due to construction. The causes of these dramatic effects are summarised in Fig. 1. No thought is given in the ES as to how these might be mitigated against, for bats or any other mammal or bird.

12. In Fig. 1, the cumulative effects of roads on animal populations. Habitat loss is due to the footprint of the road and ancillary structures. Reduced habitat quality is due to noise, light and chemical pollution. Collision mortality is direct roadkill. The barrier effect is caused by the reluctance or inability of animals to cross open spaces and/or being turned back by traffic, light and noise. A full discussion can be found in Altringham & Kerth (2015)[17].

13. In summary, in addition to there being no consideration of the long-term effects of the operational road on bats, there is considerable scientific uncertainty about the likely success of the short-term construction mitigation plan, and as such the plan does not meet the requirements of European law (Waddenzee Judgement 2004[18]), which demands that the success of the mitigation must be "beyond reasonable scientific doubt". The application should therefore be refused.

Detailed Commentary

14. I will restrict this commentary to key points in Chapter 10 of the ES. The absence of a detailed critique of other parts of this document, and other documents, does not imply I agree with the contents. There are numerous other points of disagreement. The ES is repetitive and many issue arise at least two or three times. I will comment only once on each. The numbers at the start of each section refer to the relevant paragraphs in Chapter 10 of the ES;

a) 10.8.384 *"the capture and translocation of any roosting bats to pre-installed bat roost boxes; and/or methods to encourage bats to leave the roosts prior to destruction e.g. use of deterrent lighting."* There is no evidence to suppose that the bat boxes will be a suitable alternative roost or that bats chased out of roosts will have suitable alternative roosts. This is not effective mitigation it is simply eviction.

b) 10.8.385 *"all roosting bats would be captured and relocated to bat roost boxes suitable for the species of bat being displaced."* Some species, including both horseshoe bats, do not use any of the widely available roost boxes, and we know very little about "suitability" when

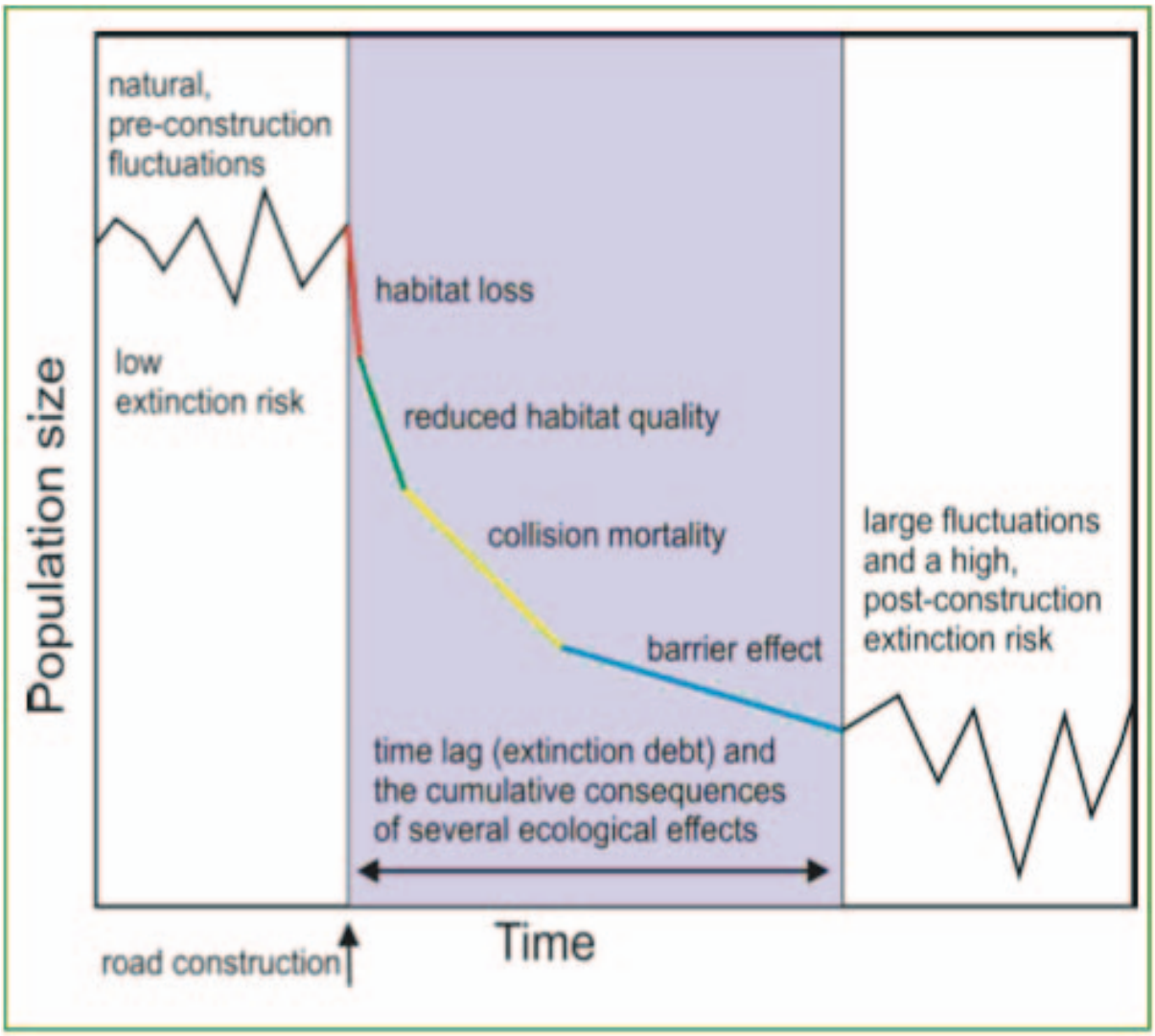


Fig. 1: Permanent effects of operational roads.

it comes to size, location, temperature and function (e.g. suitability as a nursery, mating site, etc.) for any species. Suitable here simply means the species may have been seen to use a similar box somewhere, sometime, for some unknown purpose. Again, this is not effective mitigation. Furthermore, if the habitat around the roost has been degraded by construction, no roost may be suitable, since location is an important part of roost choice in bats.

c) 10.8.386 *"Should displacement and relocation of bats result in the loss of, or reduced access to favourable foraging sites, alternative roosting sites and/or other bats in the area, the effect could be significant with regard to the long term viability of the population."* An acknowledgement of the severe consequences of the use of these high-risk displacement methods.

d) 10.8.387 *"Therefore, in order to minimise the impact of displacement, a bat barn would be provided north of Magor."* Also a high risk strategy – effectiveness has not been tested and the odds are probably against the adoption of such structures (Stone et al. 2013).

e) 10.8.388 *"Major roads can present a barrier to the movement of some bat species. Berthinussen and Altringham (2012) recorded a significant reduction in bat activity up to 1.6 km from an 80 km section of the M6 in Cumbria, England. This reduction in activity was considered in part to be due to the barrier effect of major roads."* They are a barrier to MOST bat species. Despite referring to our DEFRA report elsewhere, the ES does not cite the additional evidence contained in the report for this effect through the study of seven more roads: motorways and A

roads. This is negligent and misleading.
f) 10.8.391 *"Research commissioned by the Highways Agency (2011) confirmed that many bat species, in particular low-level gleaning species, will use underpasses……."* Reliant on a document that does not include recent developments in the field and makes the error of supposing that use by an unknown proportion of bats equates to effective protection of populations. This was a review of the poor evidence available at the time, not new research. The ES should be making better use of recent and more robust sources. A detailed species by species description follows, but almost all of it is anecdotal, qualitative and reliant on the wholly inadequate definition that use equates to effectiveness. In addition, the smallest underpass/culvert reported to be used by bats in this list was 1.2 m in diameter – significantly larger than the 0.9 m proposed for almost all of the culverts along the M4 route.

g) 10.8.393 *"Overbridges constructed as part of the Scheme would also provide potential crossing points for bats."* The ES itself presents evidence to suggest these will not be effective. Our published evidence adds weight to this conclusion.

h) 10.8.395 *"The construction of these potential bat crossing points would be completed as soon as practicable during construction".* "As soon as practicable", and similar phrases, are widespread in the ES and thus there is no guarantee that anything will be done at the right time.

i) 10.8.396 *"In order to improve the probability of bats finding and using crossing points (including culverts), in accordance with recommendations published by the Highways Agency (2011), crossing points would be constructed along, or as close as practicable to, sites where bat activity has been recorded to be high or very high".* Another get out of jail card. I will not labour the point with more. In the same section "This would reduce the impact of construction on species less flexible with regard to their habitat choice and ability to amend their commuting routes." This is no more than optimistic speculation. There is no evidence to support this argument.
j) 10.8.400 *"Whilst planting becomes established, in order to help guide bats to crossing points, artificial "bat corridors" (e.g. lines of hazel hurdle fencing) would be installed between crossing points and retained habitats in or connected to high and very high bat activity areas (Appendices 10.7 and 10.23 and Figure 10.8)."* There is no evidence to suggest this will work.

k) *"These bat corridors would be installed during night time hours between at least March and September inclusive (the main period of bat activity) and until landscape planting has become sufficiently developed to provide a permanent alternative."* Does this mean they will be moved every day? Given the failure to implement even one-off mitigation measures on many sites, this is a tall order.

l) Table 10.18 (p10-270 et seq.) This is a lengthy catalogue of mitigation measures that the table itself shows are very unlikely to work. The 900 mm diameter culverts are too small for most species to use at all, and probably for any to use effectively. Many of the culverts are displaced considerable distances from the known commuting routes and where attempts to divert bats to new crossing points have been studied (Berthinussen & Altringham (2012b, 2015a) this has been unsuccessful.

m) 10.8.403 *"Mammal exclusion fencing (as described in Chapter 2: Scheme Description) would be installed around the boundary of the new section of motorway and where necessary around additional construction areas. The fencing would help to guide some species of foraging and commuting bats towards box culverts and mammal crossings, thereby encouraging their use."* There is no evidence to suggest this would work, and anecdotal observations suggest it won't.

n) 10.8.405 A much more detailed lighting plan is needed to give any confidence.

o) 10.8.412 A much more detailed noise plan is needed to give any confidence.

p) 10.8.413 A much more detailed monitoring plan is needed to give any confidence - and it needs to be built around quantitative targets of effectiveness at the population level and of the effectiveness of individual mitigation solutions. What are the metrics and thresholds that will prompt action in the event of failure? What will this action be? What is Plan B in the event of failure?

q) 10.8.416 The assessment of impact is based on the assumption that the mitigation described will work. I have presented evidence to show that it is very likely that it will not work, so this assessment is over-optimistic at best.

r) 10.9.268 *"All replacement and new bat roosts required under the bat licence would be monitored by appropriately experienced ecologists during the construction period and for a an additional period after completion of the new motorway which would be defined in the European Protected Species licence. Monitoring of roosts would aim to determine use by bats and, where present, species and number of roosting bats present. Reporting of monitoring surveys is likely to be at least on an annual basis or as otherwise requested by NRW."* What if they bats don't use the roosts? Is there a plan B? Use is not enough – if the bats have lost a nursery roost, it needs to be replaced by a nursery roost. What will monitoring species and number tell you – what is the goal of this monitoring?

s) 10.9.269 *"Results would inform the need for any further mitigation measures, such as a relocation of bat roost boxes in order to increase use or provision of additional roost boxes."* If bats don't use the roosts provided, how will providing more of the same help? What information do you have to guide relocation?

t) 10.9.271 *"The retention of severed sections of habitat corridors (such as hedgerows), which are used by bats as commuting routes, too close to a new road may increase the risk of collision as bats may try to continue to use these commuting routes to cross the road (Highways Agency, 2011)."* That is the whole point of mitigation, to make it possible for bats to continue to use these flight lines by providing road crossing structures along them. To sever/remove these flight lines adds to the damage done by increasing the barrier effect and increasing fragmentation.

u) 10.9.272 *"In addition, planting would be designed so as to help guide bats towards alternative safe crossing points constructed along the route, i.e. box culverts and adjacent 900 mm mammal crossing"* A largely untested strategy. Berthinussen & Altringham (2012b) assessed one such attempt, which was not successful. And I can't help but point out again that a 900 mm culvert is too small.

v) 10.9.273 *"Mammal exclusion fencing would be installed along the operational boundaries of the new section of motorway, and would also be aligned so as to help direct low flying bats towards the alternative crossing points (i.e. box culverts, dry mammal crossings, underpasses and overbridges)."* Again an untested strategy, but anecdotal observations suggest it does not work.

Author email:
j.d.altringham@leeds.ac.uk

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Plate 5: M25 at Byfleet, England

Climate change and the case against the M4 Relief Road

Kevin Anderson

Introduction

Witness Introduction

1. Kevin Anderson is Professor of Energy and Climate Change in the School of Mechanical, Aerospace and Civil Engineering at the University of Manchester and is the Zennströmm professor of Climate Change Leadership at the University of Uppsala, Sweden. He is Deputy Director of the Tyndall Centre for Climate Change Research, the UK's leading academic climate change centre.

2. Professor Anderson is research active with recent publications in Science, Nature and Royal Society journals and he engages widely across all tiers of UK and Swedish government. Professor Anderson's research interests include: understanding the implications of rising emissions and the latest climate science for mitigation and adaptation policy; analysing opportunities for rapid decarbonisation of the UK's, Swedish and EU's energy system; and quantifying the role of international transport (aviation and shipping) in a low-carbon society. With his colleague Alice Bows, Professor Anderson's work on carbon budgets has been pivotal in revealing the widening gulf between political rhetoric on climate change and the reality of rapidly escalating emissions. His work makes clear that there is now little to no chance of maintaining the rise in global mean surface temperature at below 2^{o}C, despite repeated high-level statements to the contrary. Moreover, his research demonstrates how avoiding even a 4^{o}C rise demands a radical reframing of both the climate change agenda and the economic characterisation of contemporary society.

3. Professor Anderson has a decade of industrial experience, principally in the petrochemical industry. He was previously a Commissioner and Science Advisor on the Welsh Government's Climate Change Commission and is a Director of Greenstone Carbon Management - a London-based company providing emission-related advice to private and public sector organisations.

4. The Tyndall Centre

5. The Tyndall Centre for Climate Change Research is an academic organisation based in the United Kingdom that brings together scientists, economists, engineers and social scientists to research options for mitigating emissions and adapting to climate change. The Centre integrates its insights across local to global landscapes and in the context of the broader sustainable development goals.

6. The Centre, named after the 19th-century scientist John Tyndall and founded in 2000, has eight core partners: the University of East Anglia, University of Cambridge, Cardiff University, University of Manchester, Newcastle University, University of Oxford, University of Southampton, and the University of Sussex. Fudan University (Shanghai) joined the Tyndall Centre partnership in May 2011.

Summary of Evidence

Key Points

a) A rise in global mean surface temperature of 2^{o}C or more is now recognised by the international community as the threshold for dangerous climate change.
b) The most recent report from the Intergovernmental Panel on Climate Change (IPCC) was unprecedented in its emphasis on how an urgent and rapid transition away from fossil fuels is a prerequisite of avoiding such a 2°C rise.
c) The recent Paris Agreement tightened significantly the ambition of the international community to take action to limit global temperature rises associated with climate change to "well below 2^{o}C" and to work towards limiting warming to 1.5^{o}C.
d) The UK's current domestic climate change policies are premised on a 63% chance of exceeding 2°C and do not meet any reasonable interpretation of the clear equity dimension of the Paris Agreement (equity of carbon reduction). Consequently, the UK's position will need to be tightened considerably if it is to align with the explicit commitment enshrined within the Paris Agreement to take action to hold temperature

rises to "well below 2°C" and to "pursue … 1.5°C", and to do so on the "basis of equity".

e) Research has shown that for any chance of meeting this 2°C goal, a developed country like Wales should be aiming to reduce CO2 emissions by at least 10% per annum.

f) The impacts of induced demand associated with building a new road will almost certainly result in the scheme increasing overall CO2 emissions.

g) Investing over £1 billion in a scheme set to increase CO2 emissions, at a time where unprecedented reductions in carbon are required, is highly misguided and will impose still further misery on those poorer communities living in more climate-vulnerable landscapes as well as on future generations – including those within Wales.

h) If the Welsh Government is to uphold its repeated Climate change commitments and act in step with the Paris Agreement and its obligations under the Well Being and Future Generation Act (2015) for a 'low carbon society' (that takes account of global well-being), the M4 relief road cannot be justified.

Background

7. The latest report from the intergovernmental Panel on Climate Change (IPCC) is unprecedented in its emphasis on how an urgent and rapid transition away from fossil fuels is a prerequisite of avoiding a 2°C rise in global temperatures, characterised as dangerous climate change. Work by Anderson and Bows (2008, 2011) has translated such global carbon analysis into the implications for wealthier and poorer nations, with a Tyndall Centre report for the Welsh Government further refining the analysis to understand the repercussions for Welsh rates of mitigation (Calverley et al, 2009).

8. Global emissions in 2016 of carbon dioxide (CO2) from fossil fuels are over 60% higher than they were at the time of the first IPCC report in 1990. Moreover, the annual rate of growth in emissions in this new millennium is three times greater than during the 1990s. Even in the UK, with its strong rhetoric on mitigation, consumption-based emissions (taking account of carbon related to imports and exports) are essentially unchanged from what they were in 1990[1], despite the most significant economic downturn since the great depression.

9. Set against this backdrop of abject failure, the science of carbon budgets (IPCC 2014) combined with the maths of emissions paints a stark picture in relation to the mitigation efforts now required from relatively wealthy nations such as Wales. For there to be any reasonable chance of limiting temperature rises to 2°C or below, emissions from nations such as the Wales need to be falling by well over 10% per annum – a hugely challenging task.

10. The danger of climate change, and the need for urgent action, is recognised in the Climate Strategy for Wales (2010). The 3% per annum reduction target set out in the Strategy is acknowledged as a political, rather than scientific target, and the need for even greater reductions is made clear. The Strategy also underlines the need for the Welsh Assembly and wider public sector to lead by example.

11. It is essential that the scale of the challenge is not made even more significant by policy decisions that have a high potential to increase emissions, both in the short-term and by creating a lock-in to carbon intensive activities and infrastructure in the medium and longer term. Consequently, considerations of climate change have to be central to the decision-making process.

Scope of Evidence

12. It is clearly evident that insufficiently rigorous analysis has been presented by the Welsh Government to appropriately address the implications of the M4 proposal for the total level of greenhouse gas emissions.

13. The purpose of this evidence is to highlight the impacts that the scheme is very likely to have on emissions, to encourage a much higher profile for climate change in the decision making process and to for Wales to demonstrate integrity in relation to its international commitments as enshrined in the Paris Agreement. This evidence draws on and, where appropri-

ate, reproduces:

(i) The potential impact of the proposed M4 relief road on greenhouse gas emissions[2] (September 2015) by Dr Steven Glynn – (Sustainable Change Co-operative) and Prof. Kevin Anderson (Tyndall Manchester) - I am informed that this report was sent to the then Minister, Edwina Hart.

(ii) A statement on the Carbon Report for the proposed M4 scheme (April 2016) by Dr Steven Glynn (Sustainable Change Co-operative) and Prof. Kevin Anderson (Tyndall Manchester) - This report was submitted as an Annex to Wildlife Trusts Wales response to the Draft Orders.

Greenhouse Gas Emissions and Proposed Changes to the M4 Corridor

14. The draft Plan Consultation Document – M4 corridor around Newport (2013) – set out a number of reasons for the proposal. Primary among these is that the capacity of the road system is being reached, with implications for increased congestion and knock on effects for the local economy, safety, noise, and air pollution (including greenhouse gas (GHG) emissions). The document suggests that, "in the future, the situation is expected to deteriorate further" (p.9) as traffic is predicted to increase by over 20% by 2030 (see figure 5, p. 11). This would, according to the report, result in increased emissions due to the stop-start nature of traffic. With the preferred Black Route proposal, problems of congestion would, so the draft Plan claims, be significantly reduced, impacting on the assumed emissions.

15. Given the urgency of reducing carbon emissions, it is important that the proposals are carefully examined in relation to what they mean for total emissions. In this regard it is striking that an aim of the draft Plan is for "reduced greenhouse gas emissions per vehicle and/or person kilometre" (p.17). It is essential to understand that, from the perspective of climate change, emissions per vehicle are effectively irrelevant – it is overall emissions that count. Reducing emissions per vehicle does not necessarily deliver an overall reduction in emissions; historically, improved efficiency has typically being accompanied by increases in overall demand and hence emissions.

16. In the assessment of the preferred black route, the draft Plan does recognise the possibility that additional road capacity could lead to an increase in emissions in the medium term (p.31). However, that a new road is very likely to lead to increased demand (induced demand), with yet further greenhouse gas emissions, is not adequately considered in the plan. There is also no consideration of two other important factors that will result in additional emissions: the carbon associated with the construction material and processes; and any disturbance of soil that will result in further releases of CO2.

Induced Demand

17. The concept that new or improved roads induce more traffic has been recognised for many years. A report for the Department for Transport in 1994 concluded that, "induced traffic can and does occur, probably quite extensively" (The Standing Advisory Committee on Trunk Road Assessment (SACTRA), 1994, p.ii). While, in the short-term, an increase in traffic on the new road may be diverted from other roads, over the medium term it is very likely to result in an overall increase in traffic (Litman, 2014). The assessment in Goodwin (1996) is damning, arguing that new roads bring: unexpected short-term growth in traffic; greater long-term overall growth; greater peak period growth; and limited relief to alternative routes.

18. Induced demand is of particular relevance to the M4 relief scheme. SACTRA (1994) suggests that the issue is likely to be most prevalent for improvements to roads in and around urban areas and "strategic capacity-enhancing interurban schemes, including motorway widening" (p.iii). As well as increasing traffic levels, induced travel can also help "create more automobile dependent transportation systems and land use patterns" (Litman, 2014, p.28). In combination, these factors are very likely to result in the new road giving rise to increased, rather than decreased, GHG emissions.

19. An important report commissioned by the Norwegian Public Roads Administration has concluded that "road construction, largely speaking, increases greenhouse gas emissions" (Institute of Transport Economics, 2009, p.i). William-Derry (2007) has tried to quantify the degree of increase in GHG emissions – suggesting that each one lane mile of urban highway will, over 50 years, result in an additional 81600 tonnes[3] of CO2 due to the increased number of vehicles using the road. When a new road is built there will inevitably be an increased level of carbon emissions associated with that road. For example, the A46 Newark – Widmerpool scheme, which saw 17 miles of new dual carriageway constructed alongside the existing road, is estimated to have resulted in an addition of 28938 tonnes of CO2 emissions in the first year after opening. This equates to 425 tonnes per lane mile, and, if replicated for the M4 black route (14 miles, 3 lane carriageways), would see emissions of around 35700 tonnes.

20. The key question then is whether the increase in emissions on the new road would be offset by decreased emissions on the old route? The evidence on induced demand suggests strongly that they will not, and that total emissions will increase. Further evidence of induced demand and increasing emissions comes from another example – the widening of the M25 from J16-23. According to the Highways Agency this resulted, in the first year of opening, an 18576 additional tonnes of CO2. Given that it is not a new road, it would seem that the most obvious reason behind the increase is that more traffic was using the road. This is a clear example of induced demand in action[4].

Emissions Embedded in Construction

21. There is no consideration in the draft Plan of the fact that all construction projects result in additional carbon emissions. Should the M4 corridor proceed, it will inevitably result in significant emissions related to the carbon associated with the production of the materials used and the construction process itself.

22. For example, it is estimated that the carbon associated with the asphalt, aggregate and bitumen used in building roads is 40kgCO2/tonne[5]. Drawing on life cycle analyses, Williams-Derry says that:

> *"after accounting for the manufacturing of concrete, steel, and other energy-intensive construction materials, as well as fuel consumed by construction equipment, building a lane-mile of roadway releases between 1,400 and 2,300 tons of CO2" (p.2).*

23. He also highlights the fact that roads require ongoing maintenance and that, over 50 years, this could result in an additional 3100-5200tons CO2. Taking the A46 Newark – Widmerpool scheme as an example, figures from the Highways Agency show that 113082 tonnes of CO2 were released in the whole construction process, equating to 1663 tonnes of CO2 per lane mile. If replicated for the M4 black route, this would represent construction emissions of around 139500 tonnes of CO2[6].

Potential for Carbon Emissions from Disturbed Soil

24. The Gwent levels consist of up to 10m of alluvium and peat[7]. As Lindsay (2010) demonstrates, areas of peat sequester and store carbon, while also emitting methane. The balance between these two processes varies depending on the site, but, in most cases, has a positive effect in terms of reducing GHGs in the atmosphere (e.g. see Table 16, p.115).

25. Disturbing the peat as part of road construction could reduce the ability of the land to sequester carbon (as there will be less peat land), while remaining peat may, if it is degraded, start to emit CO2 and methane as it decomposes and lose carbon through other means. The actual impact that the proposed scheme would have is not clear at present, and further investigation is required. However, the potential for increased emissions should be recognised and the release of short-lived climate pollutants (such as methane) be given serious consideration.

Analysis of the M4 Carbon Report

26. The approach of the Carbon Report (Appendix 2.4 to the Environmental State-

ment) is to compare projected carbon emissions associated with two scenarios:

a. "do-minimum" – assumes that the already committed improvements are made to the road network, but that the M4 Scheme is not built;
b. "do something" – is the same as the do-minimum scenario, but with the new M4 Scheme assumed to be in place from 2022.

27. The main conclusion is that the carbon emissions in both scenarios, up to 2037, are broadly the same – i.e. that the new M4 scheme will not lead to an increase in emissions. Whilst we welcome this new report, which makes a serious attempt to quantify carbon emissions, there are however a number of important issues that need to addressed.

Insufficiently Rigorous Analysis

28. For the period analysed (2022-37), the Report finds that that traffic-related carbon emissions for the "do-something" scenario are, year on year, slightly lower than the "do-minimum" scenario. This is attributed to the reduced stop-start nature of traffic flow as congestion is reduced. The gap between the two scenarios decreases over time as 'induced demand sees "an increase in traffic inflow due to the provision of increased capacity" (p.10).

29. It should be noted that recent and rapid advances in automated vehicles are anticipated to deliver significant improvements in the efficient flow of vehicles on existing road infrastructure. Such advances are very likely to see major changes across the vehicle fleet within the 2022-37 timeframe, yet these are given insufficient consideration in the Report's analysis of stop-start congestion.

30. Although the Report recognises the well-established concept of induced demand, it makes no direct reference to the degree of induced demand that is considered and how it was derived. As previously mentioned, new roads typically bring short-term growth in traffic[8], something that appears to have been neglected in the Report. However, induced demand will continue to have an affect over the medium and longer-term and, given the 15-year period considered in the report, the impact this would have on carbon emissions does not receive due consideration.

31. Questions could be asked about this short period of analysis. The authors state that analysis further into the future is subject to considerable riddled with uncertainty; this is not only the case for both scenarios but also is an inadequate response to the wealth of empirical data arising from historical road expansion projects. It is important to note that if the Carbon report's traffic growth trend between 2022 and 2037 for both scenarios is projected forward, then 2038 is the first year where the carbon emissions from the "do-something" scenario exceed the "do-minimum" scenario.

32. To conclude, the Report presents a very partial analysis, and even then the details within it are not adequately explained. Its analytical time-frame and projected levels of induced demand are too constrained, with a reasonable extension of both of these likely to offer importantly different results. Given this, the Report does not sway my view that proceeding with the M4 scheme will lead to an increase in carbon emissions and play against Welsh Government's commitments under the Paris Agreement.

Limited Scope of the two scenarios

33. A second issue with the Report is that the scope of the two scenarios is very limited; a situation clearly reflected in their choice of names. "Do-something" implies that the M4 scheme is the only option that could be considered – it shuts down debate of genuine alternatives. What would the impact on carbon emissions be if a proportion of the potential £1.1billion budget were to be spent on alternative schemes to enhance public transport, cycling or indeed high-speed virtual communication? It is highly misleading to limit considerations to building the M4 scheme or not. If climate challenges are to be seriously addressed, greater imagination and higher levels of rigour are urgently required. Ultimately, the Report applies a very partial and twentieth century analysis to a system level and twenty-first century problem.

Such approaches are no longer appropriate for addressing contemporary problems, particularly when they need to be considered within the tight carbon budgets accompanying the Paris Agreement's temperature commitments.

The Paris Agreement

34. The Report essentially reduces the debate to whether the M4 scheme will increase or slightly decrease carbon emissions. This is insufficient in light of the recent Paris Agreement which, as set out above, tightened significantly the ambition of the international community to take action to limit global temperature rises associated with climate change to "well below 2^{o}C" and to work towards limiting warming to 1.5^{o}C.

35. A report undertaken for the Climate Change Commission for Wales, on the implications of Paris for Wales, concluded that for only a 33% chance[9] of staying below 2^{o}C, the Welsh carbon budget was limited to 11-18 years' of current emission levels. Moreover, if Wales is not to renege on the Paris 1.5°C commitment, as demanded by some of the poorest and most vulnerable nations (from Bangladesh through to the Association of Small Island States), then the timeframe and scale of action is far more demanding. In light of this, the question that needs to underpin all proposals is: how can this potential development be reconciled with the Welsh Government's commitments enshrined in the Paris Agreement?

36. In this regard, investing over £1 billion in a scheme that theoretically will see only a marginal reduction in emissions, and in reality is very likely to see an increase - at a time where unprecedented reductions in carbon are required - is highly misguided. The M4 scheme is emblematic of a failure to acknowledge the challenges enshrined in the Paris Agreement. If it proceeds it will illustrate the Welsh Government's disregard for its climate change commitments, and the impacts of unchecked emissions on future generations of Welsh citizens and those poorer and climatically vulnerable communities elsewhere in the world today.

Conclusions

37. At the same time as IPCC scientists deliver an uncompromising assessment of the climate change challenge, it is troubling that a government claiming an evidence-base for its policies is proposing the M4 relief road; a development that will almost certainly lead to an increase in total carbon emissions.

38. Much greater and more innovative thought needs to be given as to why the scheme is deemed necessary and what alternatives exist. At a more prosaic level, the draft Plan shows that traffic levels through Junction 26-27 of the M4 have barely changed since around 2000 (Fig 4, p.10), and yet, this static trend is assumed to end abruptly in 2012 followed by a predicted growth in traffic of over 20% by 2030. This assumption needs to be very carefully unpicked and analysed. By adopting a 'predict and provide' approach, there is a real danger that, as a result of induced demand, the growth in traffic will prove self-fulfilling.

39. Rather than assuming a growth in traffic, questions should be asked as to how the recent and prolonged levelling off in traffic growth can be maintained, and even reversed, while improving the overall quality of 'productive' travel options. While the draft Plan states that, "For a significant number of journeys, there are no convenient public transport alternatives to the car" (p. 14), it also goes on to say "The M4 around Newport is used as a convenient cross town connection for local traffic, with insufficient local road capacity" (p.15). These are exactly the type of journeys that could be made by other forms of lower carbon transport if they were available, accessible and encouraged.

40. If tackling climate change is a priority, and the 1.5 and 2°C targets are to be taken seriously, then the Welsh Government should not facilitate, or even permit, schemes that result in higher GHG (or even static) emissions and which lock travellers into high or still higher carbon lifestyles. Schemes such as the M4 extension, are far removed from the obligations set out in the Well Being and Future Generation Act (2015) for a 'low carbon society', and

for a 'responsible Wales', where global well-being needs to be taken into account. Climate change is a profoundly existential challenge to many hundreds of millions of the global poor living in climatically vulnerable communities. Decisions made in Wales will impact not only the quality of their lives but also whether such lives are actually viable. In the twenty-first century and with a wealth of science-based evidence making clear how our actions impact their lives, Wales has a real opportunity to demonstrate informed, cogent and moral leadership.

41. If the Welsh Government is to uphold its repeated Climate Change commitments and develop evidence-based policies guided by science, the M4 relief road cannot be justified.

Author email:
kevin.anderson@manchester.ac.uk

Notes:

1. http://www.globalcarbonatlas.org/?q=en/emissions

2. http://www.wtwales.org/sites/default/files/tyndall_centre_-_the_potential_impact_of_the_proposed_m4_relief_road_on_greenhouse_gas_emissions.pdf

3. Stated as 90000 US tons in William-Derry (2007)

4. These figures are taken from a reply sent by Highways Agency in response to a freedom of information request from Gareth Clubb, Friends of the Earth Cymru.

5. http://www.carbontrust.com/about-us/press/2014/01/lafarge-tarmac-carbon-trust-launch-low-energy-road-building-materials

6. Stated as 90000 US tons in William-Derry (2007)

7. http://www.ggat.org.uk/cadw/historic_landscape/Gwent%20Levels/English/GL_Features.htm#lanfor

8. Goodwin P B (1996) "Empirical evidence on induced traffic", Transportation, Vol.23 Issue 1, pp.35-54

9. The analysis showed that, when emissions from developing countries were taken into account, higher probabilities of staying below 2^{o}C were not possible.

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Plate 5: SP-160, or Rodovia dos Imigrantes, Brazil

Is the M4 Relief Road sustainable
Terry Marsden

Witnesses Information

1. I am Professor Terry Marsden and I currently hold the established chair of Environmental Policy and Planning in the School of Geography and Planning at Cardiff University. I am the Director of the Sustainable Places Research Institute at Cardiff.

2. I was Co-Director of the UK Economic and Social Research Council's Research Centre for Business Relationships, Accountability, Sustainability and Society (BRASS) at Cardiff University for 12 years and I was also Dean of the University Graduate College. With more than 25 years' experience working in the field of sustainability, I have a broad range of research and policy advisory experience based around the themes of international rural development, sustainability, sustainable land management and the rural environment. As Director of PLACE I am involved in funded projects concerning: constructing sustainable communities, food security and food networks in rural areas, the multi-level governance of the rural environment, and the theory and practice of sustainable place-making.

3. I am a Member of the Royal Town Planning Institute, Fellow of the Royal Society of Arts, The Royal Institution of Chartered Surveyors, the Learned Society of Wales, and Academician of the Social Sciences.

4. Over the past 20 years I have been awarded a series of almost continuous UK ESRC research grants which have been associated either with individual or joint standard grants, special research initiatives, or research centre grants. Total research council grants for which I have been a Principal Investigator constitute £11 million since 1989. I have also been in receipt of a series of EU grants, totalling 500K; and research grants from policy making bodies, totalling 500K. I have acted as an external examiner for 30 PhDs in the UK, the Netherlands and Australasia.

5. A full biography and publication list are supplied in Annex 1.

Is the M4 Sustainable?

1. Unfortunately, I have been unable to produce a detailed proof of evidence. As such, I have highlighted my main concerns below which I can explore in greater details at the Inquiry.

2. Wales has a leading international position and reputation in developing environmental and sustainable development policy both through the enactment of the Future Generations (Wales) Act 2015, the Environment Act (2015), and the climate emissions and change obligations associated with the PARIS COP21 process.

3. I regard the proposed M4 scheme as a legacy proposal in the sense that it was conceived in earlier periods when carbonised solutions still held legitimacy both in the transport sector and in the wider economy. This is no longer the case. The proposal in my view is thus seriously out of date, and not commensurate with the obligations Wales is making to developing a post- carbonised transition for existing and future generations. This entails now, to adopt and implement both the seven well -being goals, and the five ways of working embedded in the Future Generations Act as a central part of economic and spatial development planning in Wales. All public bodies must follow these principles.

4. Among a raft of more standard environmental negative impacts which have been well documented by others, I would like to concentrate upon the issue of sustainable and appropriate/ inclusive economic growth- a feature of the first well-being goal in the Future Generations Act. Much of the evidence and policy direction in Europe is now pointing in the direction of reinvesting in more integrated public transport systems, to encourage modal shifts both in commuter and commercial traffic, and the shifts in car use to more electric vehicles. In addition Welsh economic strategy, in my view, needs to embody these goals by adopting the principles of a low carbon/no-carbon 'circular economy' whereby economic, ecological and biosensitive systems replace waste inducing

systems with all their current environmental and health externalities (see for instance, EU, 2015[1]; Ellen McArthur Foundation Report, 2016[2]). This is also a more 'distributed' as opposed to concentrated economy which places a strong priority in , not least reducing journey times and spatial differences in access to travel and basic facilities. Carbonised road building does the opposite, it concentrates functions in particular places and then exacerbates the traffic needed between them such that they can prosper. Hence this proposal needs to be seen as part of an outdated spatial economic model.

5. There are thus also significant opportunity costs to these proposals involving the need and priority to invest public funding in more distributed ways which will benefit wider (non-mobile) parts of the population, increasing access and, indeed reducing congestion by improved traffic planning and modal shift. On grounds of public financial efficiency this proposal is no longer 'fit for purpose'.

6. I have also read the other Proofs of Evidence and/or Written Statements from:

- local communities,
- respected organisations such as the Wildlife Trusts, Woodland Trusts, Campaign for the Protection of Rural Wales
- the Future Generations Commissioner
- respected experts such as:
  a) Professor Sir John Lawton – Impact on Sites of Special Scientific Interest
  b) Professor John Altringham – Impact upon European Projected Species: Bats
  c) Professor Calvin Jones – Economic Impacts
  d) Professor Kevin Anderson and Professor Lorraine Whitmarsh – Climate Change
  e) Professor John Whitelegg, Professor Stuart Cole and Dr Steve Melia – Transport

7. As such, I am convinced that the Scheme does not adhere to the spirit, principles, ways of working or goals of the Well-being of Future Generations (Wales) Act 2015.

Author email:
MarsdenTK@cardiff.ac.uk

Notes:

1. EU Circular on the Circular Economy http://europa.eu/rapid/press-release_IP-15-6203_en.htm

2. Intelligent Assets: Unlocking the circular economy potential https://www.ellenmacarthurfoundation.org/publications/intelligent-assets

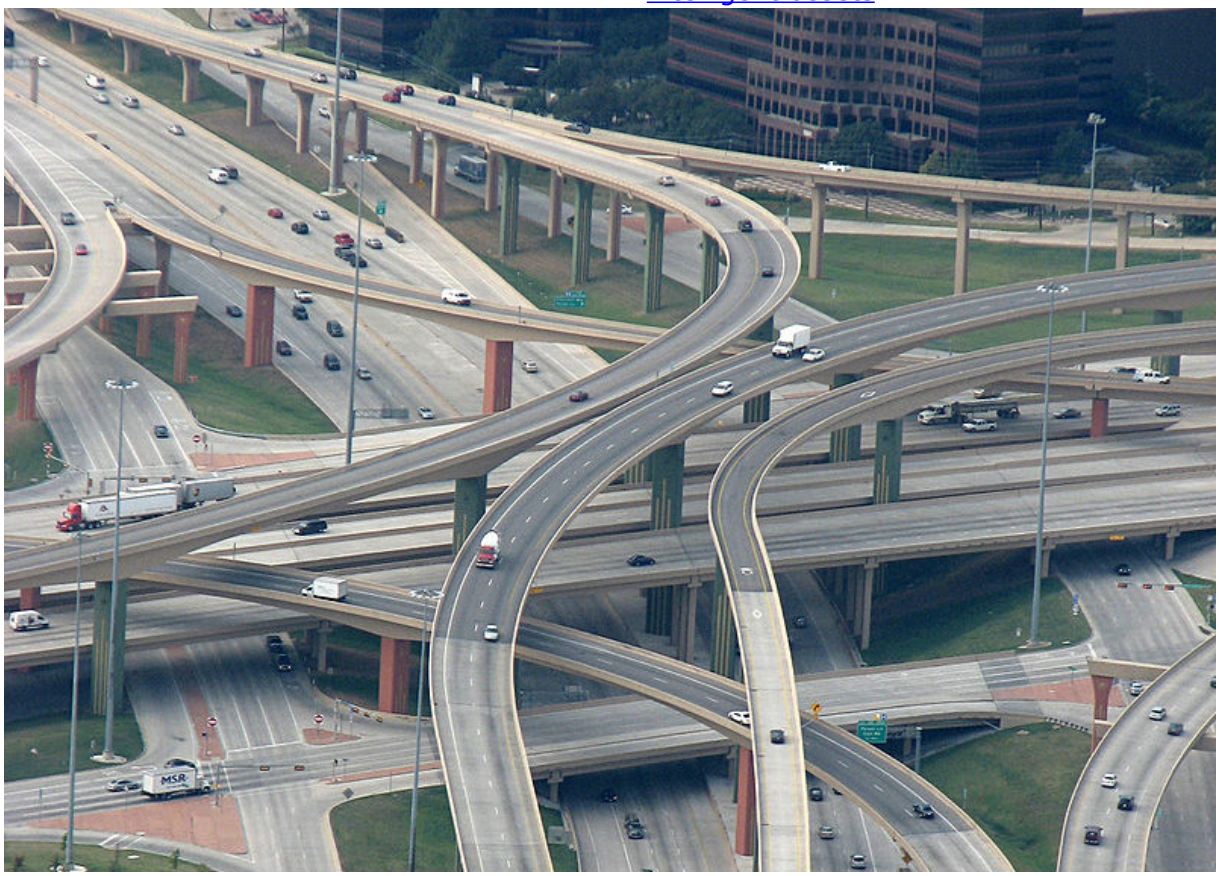

Plate 7: High-Five interchange, Dallas, USA

The M4 Relief Road and breaches of statutory duties

James Byrne and Lindi Rich

Legislative Context

1. In advancing the proposals outlined for the M4 CaN scheme the Welsh Government has breached the following statutory duties:

- The duties under sections 6 and 7 of the Environment (Wales) Act 2016 to:[1] [2]
  - 'Maintain and enhance biodiversity' including those on the Section 7 list[3]
  - 'apply the principles of sustainable management of natural resources'

- They duty under section 28G of the Wildlife and Countryside Act 1981[4]. This places a duty on public authorities (including Ministers), in exercising their functions so far as they are likely to affect the flora, fauna or geological or physiographical features by reason of which a Site of Special Scientific Interest (SSSI) is of special interest, to "take reasonable steps, consistent with the proper exercise of their functions, to further the conservation and enhancement of those features."

- Duties under the Wellbeing of Future Generations (Wales) Act 2015[5] requiring Welsh Ministers to maximise their contribution to achieving each of the wellbeing goals (section 3) which include A Resilient Wales (section4) is a "nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change)."

2. The design of the M4 CaN and choice of route and was drafted prior to the Wellbeing of Future Generations Environment (Wales) Act 2016 being brought into law. Therefore, the Welsh Government should have reviewed its proposals in the light of its commitments under this new Acts. It has failed to do so and as such the Welsh Government has not ensured it meets its own new legislative guidance as outlined in the Acts.

M4CaN - Consideration of Priority Species in Wales

3. The Welsh Government has failed to comply with its duty under section 7 of the Environment (Wales) Act 2016. It has not taken all reasonable steps to maintain and enhance living organisms included on the list published under this section.

4. For example, the Welsh Government have failed to undertake specific species surveys in the area affected by the M4 CaN scheme for species on the list including:

- Harvest mouse -recorded in the Magor Marsh area
- Polecat - existing records in the vicinity including road kills
- Brown Hare –existing records (see table
- Blood-vein (moth) – recorded in TATA land
- Cinnabar (moth) – Recorded on ABP land - docks
- Latticed Heath (moth) –recorded on ABP land - docks
- Shaded Broad-bar (moth) -recorded on ABP land -docks

5. The Welsh Government has subsequently failed to prepare any documents which outline the reasonable steps it plans to take to 'maintain and enhance' these living organisms which are known to be recorded in the vicinity of the M4 CaN.

6. We therefore put it to the Inquiry that the Welsh Government has not taken reasonable steps as required and it cannot be sure it will maintain and enhance those living organisms in respect for the M4 CaN scheme if it has not made any effort to find out the location of those species or the size and extent of those populations.

7. We have been working in tandem with the RSPB on a number of species matters and RSPB sent an email letter to Matthew Jones M4 Project Engineer dated 1st August 2016, requesting more information on matters of joint concern. A response letter was received dated 16th August 2016

8. The summary table received with this response states:

Species	Further Information Required (refers to our request)	Status (WG response)
Harvest mouse	No consideration to date. Specific survey required	No survey proposed nor raised by NRW at any time.
Polecat	No consideration to date. Specific survey required	No survey proposed nor raised by NRW at any time.
Invertebrates	Any further information to address the shortfall in the ES. This includes section 7 species: • Blood-vein moth • Cinnabar moth • Latticed Heath moth • Shaded broad-bar moth	We are not aware of any significant shortfall in the ES.

9. References to records of Section 7 list species in the M4 CaN documents are listed in this table:

Species	Survey completed for M4 CaN	References to species in M4 CaN documents	Specific surveys of population extent and mitigation statements for M4 CaN
Brown hare	No	One reference to existing records in the corridor 10.4.216	None
Harvest Mouse	No	One reference to existing records in the corridor 10.4.216	None
Polecat	No	One reference to existing records in the corridor 10.4.215	None
Shaded Broad-bar (moth)	Recorded on ABP land - Docks	Listed in appendix 10.31 terrestrial invertebrate survey 2015	None
Latticed Heath (moth)	Recorded on ABP land - Docks	Listed in appendix 10.31 terrestrial invertebrate survey 2015	None
Cinnabar	Recorded on ABP land - docks	Listed in appendix 10.31 terrestrial invertebrate survey 2015	None
Blood-vein (moth)	Recorded in TATA land	Listed in appendix 10.31 terrestrial invertebrate survey 2015	None
Unnamed species	Probably refers to one of the above invertebrates	Ecology chapter 10.4.489 no information given	?
Unnamed species	Probably refers to one of the above invertebrates	Ecology chapter 10.4.489 no information given	?

10. This shows the Welsh Government has failed to recognise, and not fulfilled, its responsibilities as required the Environment (Wales) Act 2016 e.g. its statutory duty towards Section 7 listed species in relation to the M4 CaN scheme.

Section 28G of the Wildlife and Countryside Act 1981

11. As highlighted above, Section 28G of the Wildlife and Countryside Act 1981 places a duty on public authorities (including Ministers), in exercising their functions so far as this is likely to affect the flora, fauna or geological or physiographical features by reason of which a Site of Special Scientific Interest (SSSI) is of special interest, "to take reasonable steps, consistent with the proper exercise of their functions, to further the conservation and enhancement of those features".

12. The Gwent Levels is one of the largest surviving areas of ancient grazing marshes and reen (drainage ditch) systems in Britain. They have been present since Roman times. It is the largest and most important area of its kind in Wales, of acknowledged UK-wide significance for its wildlife.

13. The mitigation strategy proposed for the SSSI is significantly and fundamentally flawed. In very simple terms, you cannot lose 125ha of ancient SSSI habitat (including the loss of 2,755m of SSSI reens and 9,373m of SSSI field ditches which contain the SSSI insects) and at the same time conserve and enhance those SSSI features.

14. The Environmental Statement ("ES") highlights a number of mitigation measures, which include the creation of new reens to offset the loss of existing reens through construction. The new habitat would be provided just over a 1:1 ratio. However, the Environmental Statement

- Gives no adequate indication the likely success of mitigation measures
- Adduces no adequate evidence that the mitigation will be successful. Such evidence should take the form of detailed research in before, during and after studies into strategies on similar habitats and species to mitigate/compensate for the impacts of recently constructed roads on protected sites such as NNRs and SSSIs. Creating new reens to mitigate for the loss of biodiversity is equivalent to cutting down ancient woodland but planting new trees (which is also proposed – see Woodland Trusts Proof of Evidence). This results in a loss of ecological integrity.
- States that some of the new reens will be located in areas of existing SSSI which already ecological rich.
- Gives no valid explanation why a ratio of 1:1 replacement was chosen. The inherently large time lags, uncertainty, and risk of restoration failure require offset ratios that far exceed what is currently applied in practice.

15. The mitigation proposed for the impact on the Gwent Levels such as the replacement of reens shows a misunderstanding of the nature of the restoration ecology and the ecology of the reens. This mitigation and compensation is neither sufficient nor satisfactory. The Gwent Levels landscape is unique and the ecological communities within it are unique, complex, inter-related and perpetuated by a long history of traditional management and are the product of adaptive evolution over hundreds, if not thousands, of years.

16. Therefore the Gwent Levels, by their very nature, cannot be recreated elsewhere, and if lost to development, will be lost forever. It is impossible, on the basis of the current state of scientific knowledge, to identify and package the raw materials involved and re-arrange them in a prescribed pattern to resemble the original. Nor can the same result be achieved naturally absent hundreds if not thousands of years of gradual progression.

17. Replacing ancient reens with freshly cut channels and claiming "a significant positive impact on biodiversity" is neither mitigation nor compensation. Restoration ecology is a relatively young scientific discipline and its effect in practical terms is very uncertain, with offsets rarely replacing the same biodiversity that is lost. Added to this, the success of mitigation measures which are implemented is rarely investigated and thus, the impacts of "mitigated schemes" are seldom certain.

18. English Nature Guidance on the impacts, mitigation and enhancement (Anderson, 1994[6]) states that habitat creation or translocation put forward for damage to SSSIs is totally unacceptable as mitigation unless it can be shown that the site can be recreated in full at minimum risk and within a short timespan. Such situations are only ever likely to occur on recently developed sites – therefore this cannot apply to the Gwent Levels. In most cases, the high value sites consist of long established habitats with great complexity, with small scale variation in plant and animal communities reflecting the underlying patterns of soils and ambient environmental factor. In many cases, the exact relationship between these factors, and the reasons for the complex, inter-related patterns found are not fully understood. It is impossible, therefore, to re-establish them.

19. Efforts to create new habitats do not compensate, nor usually provide, adequate mitigation for valued habitats, for example,

- They lack historical context and continuity over time.
- There is usually an inability to provide undisturbed soils, unaffected by human development, and in a complex pattern reflecting drainage, topography etc
- The impossibility of re-establishing plant communities which match these small scale variations in soils and water relations
- The loss of plant diversity and richness compared with a high value site. Many plants are not available as seed, do not germinate readily from seed, or are not present in the seed bank. Few can colonise naturally subsequently.
- If plant communities are deficient, so will the animal populations. Habitat recreation is mostly dependant on animals reaching the new site unaided – some have poor powers of dispersal and cannot. Others will not find the desired habitat requirements, prey or symbiotic relationships. The complex inter-relationships between species will not be re-established and a more simple, less diverse ecosystem will result.
- It is usually impossible to mimic the hydrological requirements of damp or wet habitats.
- If habitat and species transferal is to be attempted– it will only move a proportion of the plants, the most sensitive, and those with the most demanding requirements, which are usually the rarest, tend to disappear. Only a small proportion of the animals / invertebrates are transferred and not all can recolonise. If part of the site is removed, both parts lose their ecological integrity and the reduced size of the resulting patches can result in reduced diversity and edge effects.

20. In relation to creating new SSSI habitat, these habitats are lacking in most of the aspects of biodiversity which confer high value to the site and furthermore, it is most unlikely to acquire it in the future. Therefore, neither habitat creation nor translocation provides adequate compensation or acceptable mitigation for the loss of all or part of high value sites.

21. Curran et al 2014[7] (see Annex 1) state that mitigation and compensation (or biodiversity offsets) are often seen as a policy mechanism to balance development and conservation goals. Many offset schemes employ habitat restoration in one area to recreate biodiversity value that is destroyed elsewhere, assuming that recovery is timely and predictable. Recent research has challenged these assumptions on the grounds that restoration implies long time delays and a low certainty of success. Their results indicate that in the best case,

- species richness converges to old growth reference values within a century,
- assemblage composition up to an order of magnitude longer (hundreds to thousands of years).

22. Active restoration significantly accelerates the process for all indices, but the inherently

- large time lags,
- uncertainty,
- and risk of restoration failure require offset ratios that far exceed what is currently applied in practice – such as the just over 1:1 ration employed by the M4 ES.

23. Restoration offset policy therefore leads to a net loss of biodiversity.

24. Another report by Suding (2011)[8] (see Annex 2), which looked systematically at mitigation projects worldwide, found that when restoration was being used to help the recovery of a degraded system, between two thirds and half were unsuccessful. When restoration aimed to generate new habitat, success rates were lower still.

25. Evidence from other studies[9] where such mitigation is more commonplace (US, Germany and Australia) also show that offsets in practical terms rarely achieve a similar ecological value to the site lost. Since biodiversity is dynamic, there are always risks that re-creation of such complex habitats will not achieve their intended aim – meaning they are a 'promise' rather than a certainty.

Previous Mitigation on the Gwent Levels

26. We know from previous development on the Gwent Levels and attempts at reen mitigation that mitigation and compensation for development on the Gwent Levels does not work. For example, another development on the Gwent Levels (a Construction of Distribution Depot, Associated Trailer Parks and Car Parking for Europark) had similar mitigation and compensation plans drawn up. The Countryside Council for Wales (now Natural Resources Wales) approved plans to create new reens as mitigation for the watercourses to be lost through the development. These new features were supposed to help maintain the SSSI conservation interest. The Environmental Statement prepared by Chapman Warren for the Europark development stated:

- 'The proposals would……..have no adverse effect on any interest of acknowledged importance'. (Section 11.2).
- '…..while it is not possible to guarantee that the particular notable species presently found in Petty reen could be retained on the site in Petty Reen, or the compensatory reens, appropriate management would increase the chances that a high diversity of invertebrate species could be maintained on the development site'. (Section 6.25).

27. However, the post construction monitoring reports raise serious concerns about negative impacts on the nature conservation value of the SSSI resulting from the development. The 2nd Annual Report reaches the following conclusions:

- All surveys conducted indicate a substantial impact on the reens as a result of the construction of the Tesco Distribution Centre.
- The ecosystems affected displayed different rates of recovery, or no recovery at all
- The aquatic invertebrate communities identified in the baseline survey have shown a continued decline throughout the survey period.
- These loses in abundance and diversity must be as a result of construction works.

28. Another development involving the erection of 76,000 sq m distribution centre with parking, loading and offices, included fourteen mitigation conditions concerning habitat creation, site management to protect water courses and monitoring were attached to this application. However, monitoring reports produced by Hyder Consulting raised serious concerns about negative impacts, resulting from development, on the nature conservation value of the SSSI. The main issues are:
- The site has failed to recover from a large discharge of sulphate during the early stages of the development and from other sources, such as the lorry park, since then.
- High sulphate levels resulted in white and red algal blooms, and sulphur bacteria blooms in the reens on site.
- This in turn led to a reduction in the abundance and diversity of important invertebrate and plant species.
- High levels of other pollutants and poor water quality have also been recorded throughout the monitoring period.
- Further mitigation work, not considered necessary at the time of the application, was required in an attempt to deal with these issues.
- Sulphate levels in the balancing pond have stabilized at around 241 mg/l, far in excess of the 200 mg/l level deemed

serious by CCW
- pH levels remain consistently high and in excess of acceptable levels
- Since development ceased floral diversity has improved marginally in some reens, while in others it has decreased further.
- Very few rare or notable plant species have been recorded since development began.
- Only 2 notable aquatic/semi aquatic invertebrate species were found on site at the end of the monitoring period. And amongst the semi aquatic invertebrates there has been a substantial decrease in diversity.

29. In both cases conditions, or a combination of conditions and a Section 106 {Land Use Planning} Agreement, designed to protect the nature conservation interest of this nationally important site have failed to achieve their objectives. At both sites significant losses in diversity and abundance of important invertebrate and plant communities has resulted. At the end of the monitoring period neither site had recovered to anything like their pre-development nature conservation value.

Conclusion

30. It is of enormous concern that the proposed development of the motorway will have far larger effects on the environment than these two developments. The above demonstrates that the nationally important nature conservation value of the SSSI cannot be adequately safeguarded through mitigation or compensation strategies. Far too many variables exist in semi natural environments for all eventualities to be foreseen and adequately mitigated against.

31. If it cannot be ascertained that the proposal will not have an adverse effect on the integrity of the site (no reasonable scientific doubt remains) or the effects on integrity are uncertain but could be significant, permission should not be granted.

32. Therefore, the proposed construction of the M4 CaN motorway conflicts with statutory duties under the following enactments -

* Section 6 and 7 of the Environment (Wales) Act 2016
* Section 28G of the Wildlife and Countryside Act 1981
* Wellbeing of Future Generations (Wales) Act 2015

Annex 1 - Is there any Empirical Support for Biodiversity Offset Policy?

Ecological Applications, 24(4), 2014, pp. 617–632 2014 by the Ecological Society of America

Abstract: Biodiversity offsets are seen as a policy mechanism to balance development and conservation goals. Many offset schemes employ habitat restoration in one area to recreate biodiversity value that is destroyed elsewhere, assuming that recovery is timely and predictable. Recent research has challenged these assumptions on the grounds that restoration implies long time delays and a low certainty of success. To investigate these assertions, and to assess the strength of empirical support for offset policy, we used a meta-analytic approach to analyze data from 108 comparative studies of secondary growth (SG) and old-growth (OG) habitat (a total of 1228 SG sites and 716 OG reference sites). We extracted species checklists and calculated standardized response ratios for species richness, Fisher's alpha, Sorenson similarity, and Morisita-Horn similarity. We modeled diversity change with habitat age using generalized linear models and multi-model averaging, correcting for a number of potential explanatory variables. We tested whether
(1) diversity of passively and actively restored habitat converges to OG values over time,
(2) active restoration significantly accelerates this process, and
(3) current offset policies are appropriate to the predicted uncertainties and time lags associated with restoration.

The results indicate that in the best case, species richness converges to OG reference values within a century, species similarity (Sorenson) takes about twice as long, and assemblage composition (Morisita-Horn) up to an order of magnitude longer (hundreds to thousands of years). Active restoration significantly accelerates the process

for all indices, *but the inherently large time lags, uncertainty, and risk of restoration failure require offset ratios that far exceed what is currently applied in practice. Restoration offset policy therefore leads to a net loss of biodiversity,* and represents an inappropriate use of the otherwise valuable tool of ecosystem restoration.

Annex 2 - Toward an Era of Restoration in Ecology: Success, Failures and Opportunities Ahead

Katharine N. Suding
Department of Environmental Science, Policy, and Management, University of California,
Berkeley, California 94720;
email: suding@berkeley.edu

3.2. Restoration as Compensation for Habitat Loss Biodiversity trading programs (which include biodiversity compensation, offsets, and biobanking)have proliferated internationally and are promoted by policy makers as facilitating both conservation and development. In this paradigm, restoration offsets the destruction of natural ecosystems. For instance, the wetland permit program established under the U.S. Clean Water Act allows wetland impacts to be offset through compensatory wetland mitigation (US Army Corps Eng. & EPA 2008). Although these policies operate under many assumptions that are similar to those in the recovery paradigm (see Section 3.1), planners face additional challenges relating to fair offset evaluation and spatial relocation. *In compensation, estimation of the likelihood of restoration success is essential because future gain is uncertain whereas the immediate loss is permanent (Moilanen et al. 2009). Even when the area restored is larger than the area lost, compensation seldom succeeds in restoring structure, composition, or function (Hilderbrand et al. 2005, Matthews & Endress 2008, Quigley & Harper 2006, Reiss et al. 2009, Tischew et al. 2010, Zedler & Callaway 1999)*. For instance, Reiss et al. (2009) assessed the success of 29 wetland mitigation banks in Florida. They found that 40% met permit criteria, whereas 17% were not close to compliance. In an assessment of 16 fish habitat compensation projects throughout Canada,which required reporting of fishery production, Quigley&Harper (2006) found that *63%of the sites experienced net losses in productivity whereas 12% achieved a net gain. Similarly, only a third of restoration goals were achieved in compensation projects to counteract impacts of road construction (Tischew et al. 2010).*

Given this uncertainty, how much habitat compensation is required to offset the loss of high quality habitat and result in no net loss? In biodiversity trading policy, this difference is often referred to as an offset ratio (Moilanen et al. 2009) and in many ways reflects a quantification (albeit often debatable) of anticipated restoration success. For instance, Quigley & Harper (2006) *report that although policy required offset ratios to be on average approximately 7:1 (area gained to area lost), the mean offset ratio actually implemented was 1.5:1, which resulted in only 6 out of 16 cases reaching no net loss in terms of habitat productivity*. In dry grasslands in Switzerland, Dalang & Hersperger (2010) estimate offset ratios that approach 200 in some cases, certainly not a viable conservation option. Moreover, in some cases, policy expectations may go beyond the capability of science. For instance, the 2008 revision of the U.S. Clean Water Act includes the creation of new stream habitats, a largely uncertain endeavor (Stokstad 2008).

Spatial connectivity and temporal lags are other critical issues in habitat compensation. To maintain regional biodiversity, trading programs must replace ecological interactions and functions lost in development. A common pattern is to replace small focal systems lost in urban areas with aggregated ones in more rural areas (BenDor et al. 2009), although we know little about spatial dependencies and how they vary among different ecosystem components (e.g., biogeochemistry versus avian population structure). *In addition, restorations take time to provide the same functions that established habitats provide; the lag between habitat loss and creation can substantially affect population viability (Maron et al. 2010).*

Author email:
JByrne@wtwales.org

Notes:

1. Environment (Wales) Act - Section 6 (Biodiversity and resilience of ecosystems duty)

(1) A public authority must seek to maintain and enhance biodiversity in the exercise of functions in relation to Wales, and in so doing promote the resilience of ecosystems, so far as consistent with the proper exercise of those functions.

2. Environment (Wales) Act - Section 7 (Biodiversity lists and duty to take steps to maintain and enhance biodiversity)

(1) "The Welsh Ministers must prepare and publish a list of the living organisms and types of habitat which in their opinion are of principal importance for the purpose of maintaining and enhancing biodiversity in relation to Wales.

(3) Without prejudice to section 6, the Welsh Ministers must—

(a) take all reasonable steps to maintain and enhance the living organisms and types of habitat included in any list published under this section, and

(b) encourage others to take such steps

(5) In exercising their functions under this section, the Welsh Ministers must apply the principles of sustainable management of natural resources

3. Section 7 list can be found here

4. Wildlife and Countryside Act 1981 (as amended) – Section 28G

5. Well-being of Future Generations (Wales) Act 2015 Section 3 and Section 4

6. Penny Anderson (1994) – Roads and Nature Conservation: Guidance on the impacts, mitigation and enhancement – Produced for English Nature

7. Curran et al (2014) Is there any empirical support for biodiversity offset policy?

8. Suding K.N (2011) 'Toward an era in restoration ecology: successes, failures and opportunities ahead' Annual Review of Ecology, Evolution, and Systematics 42:465-487.

9. European Environmental Bureau – EEB Priorities for 'EU No Net Loss Initiative' http://www.eeb.org/EEB/?LinkServID=AE82914E-5056-B741-DB98744CF8393912&showMeta=0

Plate 8: M25 Roadworks, England

The flawed economic case for the M4 Relief Road

Calvin Jones

Introduction

Witness Expertise and Experience

1. I am currently Professor of Economics at Cardiff Business School. I have 25 years' experience examining issues related to the development of the South Wales economy, and the broader Welsh economy, in both the public sector and academia.

2. I have been involved in numerous economic advisory committees for the UK and Welsh Governments, various third sector organisations and others. I sit on the Institute of Directors' Wales Policy Committee, and the Institute for Welsh Affairs Re-Energising Wales steering group. I have worked on an extensive range of projects for and with a variety of firm, from large multinationals such as Tata to SMEs and social enterprises. I am widely published in several languages, and I have particular expertise in energy economics, sustainable development, tourism, major sports events and the impact of the digital economy.

3. My brief evidence here relates specifically to the likely economic impact of a new M4 Relief Road, both directly and indirectly.

Scope of Evidence

4. The scope of my evidence relates to the economic models put forward for the Welsh Government[1] as the basis for their economic forecasting in respect of the proposed M4 motorway development.

The Proposed M4 Relief Road will not improve South Wales' Economic Prospects

5. I have seen zero substantiated evidence that a problem with road connectivity is a significant downward pressure on economic or employment growth in the region. There is little evidence that such a relationship is discernible anywhere in Europe, especially when reasonable provision already exists (Vickerman et al, 1999). The issue of intangible benefits from increased connectivity, as well as 'access to markets' is often cited as an important element. However, as the First Minister has noted on a number of occasions, Wales has in recent years enjoyed its best ever performance in Inward Investment[2] including investment in south Wales by car manufacturers[3,4], an activity that a priori would be more susceptible to connectivity issues. It is difficult to imagine an even greater step change in performance would follow road investment.

6. The main reasons behind the economic problems of South Wales are long-standing (d since Marquand in 1936) and have repeatedly been identified[5] as:

- lack of economic variety and headquartered firms;
- low levels of entrepreneurship;
- limited aspirations; and
- poor skills and qualifications.

7. Globalisation, reduced demand for lower-skilled workers and the fragmentation of work have, since 1991, exacerbated these issues. The work of Cooke and Morgan (1998), Richard Florida et al (2008), Castells (2011) and many others make it clear that it is internal economic structures, relationships, exploitation of the knowledge economy and skills and attitudes that create successful regions. A new M4 motorway addresses none of these issues. It is notable that the Basque Country, in many ways similar to Wales but with (arguably) even worse hard-connectivity, is the richest part of Spain with a distinctive economy built on well-functioning internal networks, good education, skills and governance and admirable innovation and knowledge transfer (Navarro et al 2014).

8. South Wales is currently a dysfunctional economy for a variety of reasons. With a new motorway it will simply be a dysfunctional economy with a high quality new road.

The Development of the Black Route disrupts Wales' Economic Development Narrative

9. The focus on a new relief road, and on the Black Route specifically, is at odds with Welsh Government Policies that seek to

build a distinctive economic development narrative for Wales. Specifically there are tensions with:

- The Wellbeing of Future Generations (Wales) Act 2015 which requires Public Sector agencies to work towards low-carbon and holistic measures of progress and development[6];
- The new Cardiff City Deal that has inclusive growth as a target[7]; and
- A desired modal shift away from private transport for both leisure and work[8] and the development of the South Wales Metro.

10. Whilst these tensions might be manageable in a narrow sense – for example in the Welsh Government's attempt to show the Black Route meets the precepts of the Future Generations Act – they will significantly damage the broader Welsh Government narrative that Wales is a sustainable, green country with abundant and well-managed natural resources within which to do business[9]. This is particularly worrisome given the increasing importance of green energy and policy in the eyes of key global business players[10].

11. Moreover, the M4 proposal is particularly problematic because of the limited support for the Black Route outside of large businesses and hauliers (and only certain sections of Welsh Government itself), the outright hostility of many parts of civic society[11], business [12] and the political classes[13,14] , and the perception that the decision making process has been narrow, non-transparent and lacked evidence, a rigorous Cost-Benefit study or any integrating overview with wider policy. In many ways, whether this is a bad decision is a separate issue to whether it is a badly made decision, but both have resonance with wider business and other audiences.

Black Route Investment may exacerbate Intra-regional and Social Disparities

12. A key issue at hand is not whether an M4 Relief Road is a good investment taken in isolation but rather whether it is the best use of scarce (and borrowed) development finance. A number of elements suggest not.

13. Firstly the areas that the M4 would most directly affect (Cardiff/Vale of Glamorgan and Monmouthshire/Newport) are respectively the 1st and 3rd richest NUTS3 areas of Wales in terms of GVA per head[15]. Allocating the bulk (or all?) of Wales' borrowing ability to improving connectivity here would be extremely divisive. Moreover, the arguments in favour of such concentration – around 'economic agglomeration' – are on detailed inquiry far less strong than usually assumed, not relevant to the case at hand and being supplanted by notions that a place-based inclusive approach is required (Barca et al, 2012).

14. Secondly, across the region between 25-30% of households do not own a car[16], with car ownership correlated strongly with other poverty and income measures. Poorer people in the area would therefore rarely use the road themselves which means the most direct benefits would be enjoyed by those regional residents who are already more affluent. Investments in public transport have a far greater impact on the poorer (Lucas et al 2016).

The Proposed M4 Relief Road brings Limited Socio-economic or Environmental Co-benefits

15. Constraints on public resources means that investments must demonstrate, where possible, a big 'bang for the buck' and indeed, where possible, different kinds of 'bangs'. Investments aimed at improving economic performance or socio-spatial functioning can have a number of co-benefits, for example investment in cycling and green infrastructure can improve access to work but also health outcomes, access to other services, and environmental quality and use whilst reducing climate emissions (Mulley et al 2013). The development of renewable energy may, where novel technologies are involved, lead to new discoveries and a strong export industry (Waters & Aggidis 2016). Meanwhile non-economic investment can have positive socio-economic consequences, especially when spread geographically and temporally – think for example of climate- or fuel poverty-related domestic retrofit that creates jobs where people live, and engages and upskills local SMEs[17].

16. The provision of a new motorway will a priori generate very limited co-benefits.

Cost are likely to be Far More than Anticipated will Largely 'Leak' from Wales

17. The work of Brent Flyvbjerg and colleagues over many years[18] demonstrates a number of points:

- Mega projects – especially those over $1bn - almost always exceed their expected budgets;
- This is true across a long time period and all continents: 'good' governments do no better;
- Poor accountability increases risk;
- On average, road projects go over budget by 20%;
- Transportation project leaders typically overstate demand for the proposed infrastructure; and
- The only interpretation of the evidence is that mega-project proponents – including politicians, firms and the media – systematically misinform parliaments and the public about likely costs and project risks.

18. This evidence is worrisome for Wales where accountability on the proposed M4 Relief Road has been poor, and care should be taken that those supporting the most expensive are doing so on the basis of genuine regional rather than private/organisational/political returns (Jones, 2001). Additionally of concern is the impact any cost-overruns might have on Welsh Government budgets, particularly in light of Brexit (and the withdrawal of potentially supportive EU funds across a number of areas), and the concurrent funding of the South Wales Metro.

19. It is also worth noting that the benefits from procurement will likely leak in large part from the region. Wales has a paucity of large 'Tier 1' contractors who are able to bid for the largest construction or design lots, despite many years of policy concern in this area, and this will be the case even if Brexit provides more scope for local contracting. The geographic location of the project raises the prospect that much of the labour and plant will be sourced from across the border in England, which might be less the case for a project located deeper into Wales.

The Proposed M4 Relief Road is Not a Future-Oriented Investment

20. Human society, in the West at least, appears on the cusp of radical change in productive, distributive and consumption systems due to the impact of digital technology, even leaving aside the key ecological and energy challenges that will change the way we live.

21. Most relevant here are the huge strides being made in the development of connected and autonomous vehicles, with new technology entrants[19] reinforcing the safety-related work of car manufacturers, and with autonomous freight vehicles to be tested on UK roads imminently[20]. The roll out of such vehicles raises the prospect of far higher nose-to-tail traffic flows, with a very significant decrease in the sort of accidents that are an issue for the existing M4.

22. Whilst the technology is proceeding apace, regulations (and the rate of fleet turnover) mean we cannot know how long it will take for such technology to become ubiquitous (Brett, 2016). However, over the lifetime of a new road there is a substantive risk that capacity relevant to current trend-based projections will constitute a massive over-build in the light of autonomous passenger and freight travel. Combine this with modal shift, and potentially an aggregate reduction in demand for work travel as automation proceeds apace, and it is clear that a 'now based' assessment of the worth of a new road ignores key, quickening and irreversible socio-technical trends.

Deep Place Study

23. An in-depth study[21] by Dr Mark Lang of Cardiff University's Sustainable Places Research Institute stated that:

> *"Some of the key economic priorities that have emerged in Wales, notably the proposed construction of an M4 relief road around Newport, appear to offer little to the well-being of future generations. They also appear to offer very little to the people and town of Pontypool, who like other communities have not been engaged in the con-*

versation around setting the economic policy agenda."

24. The Ellen MacArthur Foundation[22] argues that the values of the Circular Economy - extending the use cycle length of an asset; increasing the utilization of an asset or resource; looping or cascading an asset through additional use cycles; regenerating natural capital – can be supported by intelligent assets. This entails using the growing 'internet of things', the knowledge of location, condition and availability of assets, to significantly increase global GDP whilst also reducing global carbon emissions. In short, you do not need to solve a 21st century problem with a 1960s solution.

Economic Appraisal Report (EAR)

25. I have not had sufficient time to fully analysis the Revised Economic Appraisal Report but hope to be more familiar with it by the time I give evidence to the Inquiry. In summary, however, managing large-scale transportation infrastructure projects is difficult due to frequent misinformation about the costs which results in large cost overruns that often threaten overall project viability[23]. In this case, the EAR fails to include some significant costs or dis-benefits that are likely to make the scheme poor or low value for money (VfM).

a) The following Benefit: Cost Ratios (BCRs) are associated with the following VfM categories[24]:
- BCR of less than 1 = poor value for money
- BCR between 1 and 1.5 = low value for money
- BCR between 1.5 and 2 = medium value for money
- BCR between 2 and 4 = high value for money
- BCR above 4 = very high value for money

The UK Government specifications also state that following a basic VfM assessment: "Non-monetised impacts are then considered to ascertain whether those impacts are great enough to shift a scheme into a different category. The final VfM category is then assigned." However, the significant ecological (and ecosystem services[25]) impacts do not appear to be considered in the BCR. This is inconsistent with the new legislation in Wales e.g. the Environment (Wales) Act 2016.

b) The EAR states (section 4.1.4) investment costs (i.e. capital costs) are "Excluding VAT and Inflation". However:
- construction inflation is running at approximately 8-10% per annum (Prof Stuart Cole) which is highly important as the scheme is unlikely to finish until the mid-2020s; and
- VAT remains at 20%

Thus, excluding VAT and inflation is likely to mean a significant under-estimate of the cost which in turn could significantly affect the BCR.

c) The EAR (section 4.2.6) also estimates 60-Year Maintenance Costs (£530.3m) and greenhouse Gas Benefits (£5.7m). However, maintenance costs do not appear to be included in the BCR calculations. Also, Professor Anderson has highlighted this scheme will likely increase greenhouse gas emissions nor reduce them[26].

d) Out of the 16 Local Authority Areas to gain the calculated wider economic benefits Bristol, North Somerset and South Gloucestershire rank 3, 4 and 5 respectively (section 6.2.4). Therefore, much of the benefit actually accrues to English areas on the other side of the Severn. However, it is unclear if the English 'benefits' affect the BCR for an M4 relief road whose cost is being picked up by the Welsh taxpayer.

e) To help show a more positive VfM the Government have agglomerated all the benefits over 60 year period, adding £500m to other benefits (section 6.2.6). However, again they have not included 60 years' worth of maintenance costs or VAT.

f) The Sensitivity Analysis
- Section 7.3.2 highlights that *"under a low traffic growth scenario, the benefits of the scheme are reduced such that the initial BCR for the scheme falls slightly below one to 0.94"* (this BCR still does not take account of VAT, maintenance and inflation). This projection

of low growth is a real possibility considering the significant economic uncertainty around Brexit.
- Section 7.4.2 states *"in the scenario that tolls are removed, the Initial BCR for the scheme increases to 1.83"* because it states that toll removal is *"the publicly stated position of many Welsh Assembly members who consider the tolls to be a tax on the Welsh economy".* However, considering the economic uncertainty around Brexit[27], with the risk of current and future reductions to the Welsh Government's block grant, it is equally possible that the tolls remain at the present value or go up. However, that scenario was not modelled.

26. The Environment and Sustainability Committee of the last Welsh Assembly (2011 – 2016) held an inquiry into the M4. The Report makes for good reading, in particular it highlighted that, *"Given the lack of clarity on the assessment of alternative options, wider public transport measures, the Metro proposals and the potential impacts of electrification* **it is difficult to conclude on the basis of current information that a convincing case for the long-term value for money of this potential investment has yet been made***".* I believe that this statement still holds true.

Conclusion

27. It is my considered opinion that if the rationale for an M4 Relief Road is one of economic development it is misguided, being based on no substantive evidence base. Whilst there is certainly a problem with existing M4 provision, the costs of congestion (which are suffered to a similar or often worse degree by other UK conurbations) do not justify the very significant investment in the Black Route. Neither is there any evidence of the 'catalytic' effects on mobile investment that are often held to emerge from better connectivity – indeed we are already outperforming in this area. I also consider that for the reasons outlined above, the Black Route is a very poor use of Wales' new (but limited) capacity to borrow, and evidence suggests the project is very unlikely to come in at budget. In summary, a rigorous 'blank sheet of paper' approach to the developmental use of any new borrowing powers would be very unlikely to place a £1bn+ road at the top of the list.

Author email:
calvin@econactive.co.uk

Notes:

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2. BBC (2014) Inward investment in Wales 'highest for nearly 25 years' http://www.bbc.co.uk/news/uk-wales-28392774

3. TVR to create 150 sports car jobs in Ebbw Vale http://www.bbc.co.uk/news/uk-wales-35775158

4. Aston Martin creates 750 jobs in St Athan http://www.bbc.co.uk/news/uk-wales-35640339

5. Bryan & Jones, 2000 for an overview; https://www.bevanfoundation.org/commentary/shape-wales-come/

6. http://gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en

7. http://cardiffcapitalregioncitydeal.wales/seeking-regional-voices-support-findings.html

8. e.g. via the Active Travel Act http://www.senedd.assembly.wales/mgIssueHistoryHome.aspx?IId=5750

9. http://gov.wales/newsroom/businessandeconomy/2016/160303-green-growth-forum/?lang=en

10. See for just one example Google https://www.google.com/green/energy/#investments

11. Federation of Small Business's http://www.walesonline.co.uk/business/business-news/m4-decision-billion-pound-mistake-7438438

12. Wildlife Conservation organisations http://www.wtwales.org/wildlife/m4-road-proposals

13. Environment and Sustainability Committee, Welsh Assembly, Inquiry into the Welsh Government Proposals for the M4 around Newport (July 2014) http://senedd.assembly.wales/documents/s29494/Report%20-%20July%202014.pdf

14. http://www.southwalesargus.co.uk/news/11700003.Former_minister_John_Griffiths_opposes_any_new_M4_route/

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16. http://www.racfoundation.org/assets/rac_foundation/content/downloadables/car%20ownership%20rates%20by%20local%20authority%20-%20december%202012.pdf

17. http://gov.wales/topics/environmentcountryside/energy/efficiency/arbed/?lang=en

18. https://scholar.google.co.uk/scholar?q=FLYVBjERG+mega+projects+cost&btnG=&hl=en&as_sdt=1%2C5

19. See https://www.google.com/selfdrivingcar/ and Tesla's Autopilot for example.

20. http://www.autocar.co.uk/car-news/industry/autonomous-lorries-be-tested-uk-motorways-year

21. Dr Mark Lang - All Around Us The Pontypool Deep Place Study http://www.cardiff.ac.uk/__data/assets/pdf_file/0004/490450/Pontypool-Deep-Place-Study-2016.pdf

22. Ellen MacArthur Foundation (2016). Intelligent Assets: Unlocking the Circular Economy Potential.

23. Cantarelli, C. et al 2010. "Cost Overruns in Large-Scale Transportation Infrastructure Projects: Explanations and Their Theoretical Embeddedness," European Journal of Transport and Infrastructure Research, 10 (1): 518.Link to published article: https://arxiv.org/ftp/arxiv/papers/1307/1307.2176.pdf

24. Highways Agency Specification 2013-14 Technical Note https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361412/PS_2013-15_-_4.19_The_Percentage_of_Major_Project_Spend_which_is_Assessed_as_Good_or_Very_Good.pdf

25. The UK National Ecosystem Assessment (UK NEA) was the first analysis of the UK's natural environment in terms of the benefits it provides to society and continuing economic prosperity. http://uknea.unep-wcmc.org/

26. Dr Glynn & Prof. Kevin Anderson (2015) - The potential impact of the proposed M4 relief road on greenhouse gas emission http://www.wtwales.org/sites/default/files/tyndall_centre_-_the_potential_impact_of_the_proposed_m4_relief_road_on_greenhouse_gas_emissions.pdf

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Plate 9: M25, England

The M4 Relief Road will not solve congestion problems or improve local economic performance

John Whitelegg

Qualifications and Experience

1. My name is John Whitelegg. I am a Visiting Professor in the School of the Built Environment at Liverpool John Moores University and a transport consultant.

2. My professional background is geography, economic development and as an economic development officer in a UK local authority.

3. My PhD was in the area of industrial location theory and change over time in the opening, closing, decline and growth of the firm.

4. I have worked on transport projects for over 40 years, written 10 books on transport and now edit the journal "World Transport Policy and Practice". The projects include ex-post evaluation of job creation and inward investment following new highway and motorway investments, the impact of new highways on air quality and greenhouse gases and the performance of non-highway building measures on reducing congestion and pollution and stimulating local economic performance.

5. I have presented evidence on various matters at the public inquiries into the Birmingham Northern Relief Road, the Heysham M6 link, the Broughton (Lancashire) Bypass, Heathrow Terminal 5, Manchester Runway 2, Redhill Aerodrome, the Thames Gateway Bridge, Walton Bridge (Surrey), the Westbury Bypass and the BAA appeal against the decision of Uttlesford District Council to refuse planning permission for the expansion of Stansted Airport.

6. I am an advisor to the World Health Organisation on road safety and the author of transport strategies and plans for Kolkata (India) and Beijing (China).

Scope of this evidence

7.My evidence will cover the following 4 topics

7.1 Road building on the scale suggested around Newport is incompatible with sustainability considerations and objectives. I identify specific WAG policy statements and documents that demonstrate this incompatibility.

7.2 New road building generates new traffic (so-called "induced traffic") and adds to congestion problems in and near urban areas and city regions. This additional congestion defeats the economic justification/rationale for new roads and additional road capacity is "consumed" by trip purposes not directly related to a strong local economy.

7.3 The evidence nationally and internationally is very clear and new road building is just as likely to drain jobs away from a local economy as it is to attract them.

7.4 The principles that underpin Transport Appraisal have not been followed. The road building option has achieved a dominant position in a wider discussion of regional economic, public health and sustainability when the non-road building options have not been clearly specified or "worked up" in sufficient detail to be tested against the road building option.

8. Road building on the scale suggested around Newport is incompatible with sustainability considerations and objectives.

8.1 Following on the Paris agreement on climate change and the acceptance by the Uk government of the need to keep temperature increases to no more than 2 degrees Celsius and to aim for no more than 1.5 degrees Celsius, the issue of CO2 reduction is one of the most important public policy and sustainability issues that any national or devolved government has to pursue.

8.2 The Welsh Assembly Government (WAG) has acknowledged the importance of climate change in its legislative programme. The title on the WAG web site summarises the policy imperative very well indeed:

Reducing Welsh emissions

The Environment (Wales) Act 2016 sets out the approach to help Wales reduce its carbon emissions.
http://gov.wales/topics/environmentcountryside/climatechange/emissions/?lang=en

8.3 The M4 relief road around Newport will add 980,000 tonnes of Carbon Dioxide, the main greenhouse gas implicated in climate change.

8.4 The WAG states very clearly: "The Environment Act is a major step change which fully recognises the implications of the Paris Agreement and aims to accelerate action to tackle it across all sectors." Opting for the M4 relief road when there are many alternatives to a huge addition to the greenhouse gas inventory does not align with the declared policy objective of "accelerating action to tackle [it] across all sectors". In the transport sector a decision has been taken to make things worse and the case of the M4 relief road does not deal with the rejection of low carbon/zero carbon options and the insertion of a "carbon maximum" option.

8.5 The main heading on the WAG web site "Reducing Welsh Emissions" would be far more accurate if it were re-worded to read "Reducing Welsh Emissions but not yet and not in the transport sector and not in South East Wales".

8.6 A report from a group of independent researchers at the University of Leeds and prepared for the national Committee on Climate Change examined the relationship between carbon emissions and the cost of major infrastructure projects:

Embodied greenhouse gas emissions of the UK National Infrastructure Pipeline, May 2015,
Scott, Giesekam, Owen and Barrett
Sustainability Research Institute, University of Leeds

8.7 There are two sources of greenhouse gases from the M4 relief road. The first is so-called "embodied" greenhouse gases and this is described in the above report. The second is operational greenhouse gases (vehicle exhaust emissions). This second category is not discussed here but is referred to in s9.9

8.8 Embodied emissions are the full supply chain emissions associated with the initial creation of an asset. Typically this includes emissions from: raw material acquisition, transport, processing and manufacturing of building materials; distribution of materials to site; and energy used on-site in assembly. In the infrastructure sector these are commonly referred to as capital carbon emissions to accord with the concept of capital cost.

8.9 Embodied emissions do not include operational emissions which in the case of the M4 relief road will be the greenhouse gas emissions generated by the traffic using the new road and as I show in section 9 of this proof of evidence these greenhouse gases will be larger than those associated with current traffic levels because of the phenomenon known as "induced traffic". New roads generate new traffic and this is discussed in s9. The authors do comment on new road capacity:

> *"This study does not calculate the operational emissions from using the infrastructure e.g. the additional travel emissions from extending the road network"*

8.10 Embodied greenhouse gases can be very accurately calculated by a methodology that is in the public domain and described in the Leeds University report. It is not described here.

The key findings are summarised in Table 1 (p101)

8.11 I have assumed that the cost of the M4 relief road is "approximately £1 billion" but I am aware that new road construction very often exceeds the cost estimates that are fed into BCA and as a consequence the BCA used to inform the approval process is over-optimistic. I am also aware that FoE Cymru estimate a total cost of £2.3 billion

Source of £1 billion cost estimate:

http://gov.wales/topics/transport/

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Carbon intensity (kgCO2e/ £)	1.11	1.09	1.08	1.06	1.04	1.03	1.02	1.01	0.99	0.98
Total NIP expenditure minus wages at 2010 prices (£M)			27,184	28,314	24,386	24,074	25,194	19,512	19,045	71,451
NIP expenditure minus wages at 2010 prices (£M) for projects under construction			23,963	20,779	15,134	13,135	11,133	4,945	4,755	6,856
Embodied emissions for desired expenditure (Kt CO2e)			29,334	30,120	25,580	24,906	25,194	19,670	18,929	70,098
Embodied emissions for projects under construction (Kt CO2e)			25,857	22,104	15,875	13,589	11,363	4,980	4,726	5,726

Table 1: Carbon intensity, spend and embodied emissions of the UK's NIP to 2021
NIP= National Infrastructure Pipeline

roads/schemes/m4/corridor-around-newport/?lang=en

Source of £2.3 billion cost estimate:

http://m.southwalesargus.co.uk/news/14343225.M4_relief_road_will_cost___2_3_billion_say_environmental_campaigners/

For ease of calculation and subsequent ease of uplift I will take the "approximately £1 billion" cost estimate as the basis for calculating embodied greenhouse gas emissions.

8.12 Referring to table 1 above from the Leeds University report we can see that the calculation produces an estimate of embodied kgCO2eq of 0.98 per £spent (2021 estimate). I therefore calculate that the embodied CO2 in the M4 relief road is 1 billion x 0.98kg= 980,000,000 kgs or 980,000 tonnes.

8.13 If the out-turn cost of the M4 relief road should be greater than the estimated cost of "approximately £1 billion" then the 980,000 tonne CO2 burden calculation can be adjusted. In the case of the FoE Cymru estimate it would be multiplied by 2.3.

8.14 This additional burden of 980,000 tonnes of CO2 is an avoidable and unacceptable move in the wrong direction. Numerous UK and WAG documents have emphasised that we must achieve an 80% reduction in greenhouse gases on a 1990 base by 2050. This huge additional burden makes this task much more difficult than it need be and is directly contrary to the intentions, aspirations and objectives of The Environment (Wales) Act 2016

8.15 The point I am making was very clearly put by Paul Stinchcombe QC of 4-5 Grays Inn Sq (now at 39 Essex Chambers) at the Stansted Airport public Inquiry on 30th May 2007:

29. We invite you in particular, to reject the two arguments advanced in Mr Rhodes' evidence[1] *for ignoring the carbon emissions of the Appellant's proposed increase in aviation: first, that climate change is not an issue to be addressed in individual planning applications because the effect on global temperatures of any individual proposal, even the thousands of additional flights that the Appellant proposes, would be insignificant; and second, that aviation emissions are properly to be addressed by other means in any event, the introduction of aviation into international carbon emissions trading as contemplated by The Future of Air Transport Progress Report*[2]*.*

30. So far as the first argument is concerned, Mr Rhodes is simply wrong. The carbon emissions of any proposed development is manifestly a material planning consideration to be taken into account when deciding whether or not it should be permitted. Moreover, it is especially so in an application such as this, whereby permission is sought to increase aviation - known to be a major contributor to global warming. In particular, the proposed expansion at Stansted would emit in the range of 2.124m tonnes to 4.248m tonnes of additional CO2e (carbon dioxide equivalent)[3]. Quite simply, that has to be a relevant consideration to take into account, given the consistent thrust of every recent policy document - that global warming is a threat of such gravity that we must make decisions now to dramatically reduce emissions, not increase them incrementally.

31. Indeed, Mr Rhodes' first argument is a paradigm of the incrementalist approach which so threatens the environment. Rather than take into account the carbon emissions of all proposed developments, he would have us take into account the carbon emissions of none since individually they will make no measurable difference to world temperatures.

32. The Government will not achieve its carbon emissions targets that way. It might, however, if it decides not to pander to the unconstrained demand to fly, but seek instead to test rigorously any such proposal against the evidence adduced in each particular case of economic need and benefit.

NB The paragraph numbers (29-32) refer to the original submission by Paul Stinchcombe QC at the Inquiry in 2007.

Source: Opening submission on behalf of Stop Stansted Expansion at the public inquiry on 30th May 2007. Planning Inspectorate ref: APP/C1570/A/06/2032278

8.16 This departure from legislative intention is a serious matter. It is even more serious that it is a specific WAG decision made in the full knowledge that there are many low carbon and zero carbon alternatives to the most damaging option, the one that is before this Inquiry. This perverse and unreasonable decision brings the whole UK and WAG governmental effort on climate change into disrepute and should be brought to a halt

8.17 I submit that on these grounds the M4 relief road should be rejected.

8.18 At this point and to avoid duplication I would refer the Inquiry to the proof of evidence submitted by Professor Terry Marsden which I fully endorse and support

9 New road building generates new traffic (so-called "induced traffic") and adds to congestion problems in and near urban areas and city regions

9.1 Professor Phil Goodwin, one of the UK's leading transport experts, a government advisor and a member of the Standing Advisory Committee on Trunk Road Assessment has described the phenomenon known as "induced traffic" or more commonly as "new roads generate new traffic". He says:

It was way back in 1925 that the opening of a new section on the Great West Road demonstrated "the remarkable manner in which new roads generate new traffic", as Bressey wrote in 1937, but the notion was soon forgotten. Glanville and Smeed at the Road Research Laboratory rediscovered it in 1958, however, as did Foster, at Oxford, in 1963, and it was also remembered long enough to appear in Ministry of Transport advice in 1968, which said:

"Generated traffic on large schemes has often amounted to between 5% and 25% over and above the normal forecast traffic level… larger in exceptional cases."

Within three years the advice disappeared, however, (nobody ever said why) and generated traffic was routinely not calculated for road schemes and the DoT even took a legal case to the House of Lords to prevent such forecasts being challenged by objectors.

But the evidence kept re-appearing: a GLC study demonstrated it empirically in 1985, as did Martin Mogridge and his colleagues in 1987, and it was sharply reinforced in 1988 after the M25 exceeded its long term forecast traffic growth within months of opening.

9.2 He goes on to say:

In 1994 SACTRA, the Standing Advisory Committee on Trunk Road Assessment, published its best-known report, on what it renamed 'induced' traffic. The average traffic flow on 151 improved roads was 10.4% higher than forecasts that omitted induced traffic and 16.4% higher than forecast on 85 alternative routes that improvements had been intended to relieve. In a dozen more detailed case studies the measured increase in traffic ranged from 9% to 44% in the short run and 20% to 178% in the longer run. This fitted in with other evidence on elasticities and aggregate data. The conclusion was:

"An average road improvement, for which traffic growth due to all other factors is forecast correctly, will see an additional [i.e. induced] 10% of base traffic in the short term and 20% in the long term."

"For 80 years, every eight years on average, there has been the same experience, the same conclusions - even, for goodness sake, more or less the same figures."

Source: Local Transport Today LTT450 24 August, 2006

Source: http://stopcityairportmasterplan.tumblr.com/post/19513243412/induced-traffic-again-and-again-and-again

9.3 The SACTRA report was published in 1994. Its research and conclusions are very important indeed and have not been refuted by any subsequent independent research. Its main findings were:

Considering all these sources of evidence, we conclude that induced traffic can and does occur, probably quite extensively, though its size and significance is likely to vary widely in different circumstances (para 10, page (ii))

These studies demonstrate convincingly that the economic value of a scheme can be overestimated by the omission of even a small amount of induced traffic. We consider that this matter is of profound importance to the value for money assessment of the road programme (paragraph 12, page iii)

Induced traffic is of the greatest importance where the network is operating or expected to operate close to capacity (paragraph 13, page iii)

Source:
SACTRA (1994) Trunk Roads and the Generation of Traffic, Standing Advisory Committee on Trunk Road Assessment, Department of Transport, London, HMSO

http://www.bettertransport.org.uk/sites/default/files/trunk-roads-traffic-report.pdf

9.4 Professor Phil Goodwin then brings the story up to date with a review of a major report "Beyond Transport infrastructure" published in 2006:

This report looked in detail at three big schemes on the A27, A34 and M65, and a further ten schemes on the A5, A6, A41, A43, A46, A66, A500 and A1033. These were schemes undertaken after SACTRA's 1994 report had been finished and accepted.

They reported:

"Careful scrutiny of the traffic flow data suggests that traffic growth after the scheme opened has been significantly higher than growth on other nearby road corridors or national traffic growth."

They also said that:

"In all three case studies the current traffic flows are near or already in excess of what was predicted for 2010. In towns with bypasses, such as Newbury and Polegate, the new roads did significantly reduce the town centre traffic

levels. However, these reductions are not as great as originally forecast and there has subsequently been regrowth in traffic levels on the bypassed roads. The net effect in combination with the new road is generally a considerable overall increase in traffic."

Their final conclusion is remarkably restrained. After noting the Highways Agency's own explanations for the extra traffic growth (which were intriguingly similar to those rejected by SACTRA 12 years earlier), they write:

"Nevertheless, in view of the fact that many of the schemes reviewed have demonstrated significant increases in traffic volumes (in the range of 10-35%, within a period of one to two years after opening), there would seem a strong case to consider the issue of induced traffic in more detail in future evaluations."

So 1925, 1937, 1958, 1963, 1968, 1985, 1987, 1988, 1994, 1996, now 2006: for 80 years, every eight years on average, there has been the same experience, the same conclusions - even, for goodness sake, more or less the same figures. The evidence has been consistent, recurrent, unchallenged by serious countervailing evidence but repeatedly forgotten. CPRE have done us a service, I think, but really it should just not have been possible for them to find, 12 years after SACTRA, the same mistakes.

Source:
Beyond Transport Infrastructure. Lesson for the future from recent road projects, CPRE, 2006

http://www.transportforqualityoflife.com/u/files/Beyond-Transport-Infrastructure-fullreport%20July2006.pdf

9.5 Induced traffic is very important because of the effects it has on traffic forecasts, time savings, Befit Cost Ratios (BCR) and Value for Money (VFM). A large amount of induced traffic will usually have the effect of cancelling out or minimising the travel time savings that have been predicted for a road scheme and then converted into a monetary estimate of benefits. The benefits will therefore be much less in situations where induced traffic materialises than they would be without this induced traffic. Road improvements and bypasses that have been justified on optimistic BCRs will fail to perform at the predicted level and the promised reductions in congestion that have fed political support will not materialise

9.6 A recent article by Naess, Nicolaisen and Strand put this very succinctly. The authors take the view that "the traffic generating effects of road capacity expansion are still often neglected in transport modelling" and this omission "can lead to serious bias in the assessments of environmental impacts as well as the economic viability of proposed road projects, especially in situations where there is a latent demand for more road capacity". They demonstrate empirically that if induced traffic is not fully taken into account or ignored "the results show lower travel time savings, more adverse environmental impacts and a considerably lower benefit-cost ratio when induced traffic is partly accounted for than when it is ignored". The authors conclude "By exaggerating the economic benefits of road capacity increase and underestimating its negative effects, omission of induced traffic can result in over-allocation of public money on road construction and correspondingly less focus on other ways of dealing with congestion and environmental problems in urban areas".

Source:
Naess, P, Nicolaisen, M and Strand, A (2012) Traffic forecasts ignoring induced demand: a shaky foundation for cost-benefit analyses, European Journal of Transport Infrastructure Research (EJTIR), Issue 12 (3), pp 291-309

http://www.ejtir.tbm.tudelft.nl/issues/2012_03/pdf/2012_03_02.pdf

9.7 John Elliott (a national expert on induced traffic) in an article in the journal "World Transport Policy and Practice" (February 2016) has provided an update on the debate on induced traffic. He says:

"There is very strong evidence (but not as widely known as it should be) that road building can increase traffic levels

enormously within a few years of opening and is likely to cause more congestion in the area rather than reducing it. Mechanisms which can account for a substantial proportion of the additional traffic are mode and destination change. These are often modelled for larger schemes but rarely do the results of the modelling reproduce what actually happened after opening. Occasionally land use effects are modelled though usually are not; completely new trips and peak narrowing are sometimes mentioned qualitatively. Psychological and social mechanisms are not usually in the competence of traffic models."

"Many of the road schemes presently being proposed by the government are in the vicinity of cities and conurbations, in places where it is recognised that there is serious congestion. However all the evidence suggests that enlarging roads in such places will increase traffic and is likely to cause more congestion in the area, rather than reducing it, within a very few years. Even the arguments on calculated or predicted economic benefits seem very spurious indeed. While many Transport Planners, especially those who might read WTPP journals, are well aware of the level of induced traffic and its consequences, government should also be well aware and be adjusting policies accordingly. It should be noted that the Local Government Technical Advisers Group has outlined these issues to government on a regular basis - the last occasion was in December 2014 to the House of Commons Scrutiny Committee on the Infrastructure Bill."

Source:
Will the government's spending on expanding the national road network deliver anything useful? Have they properly taken into account induced traffic and extra congestion likely to be caused elsewhere?

John Elliott BSc, CEng, MICE, FCIHT, MCMI.

John Elliott has studied induced traffic and its effects in some detail for over 30 years and has presented his findings in various papers and submissions to government and the House of Commons Transport Committee. John has had a career in Local Government and the private sector including being chief traffic engineer of Westminster City Council, head of policy and projects assessment at the Greater London Council, a Director of Technical Services and planning of a large District Authority and a main board director of a security and parking company. He has served on the Local Government Technical Advisers Group National Transport Committee for over 20 years and is presently Vice Chair of the Committee.

http://worldtransportjournal.com/wp-content/uploads/2016/02/9th-Feb-final-opt.pdf
pages 37-41

pages 37-41

9.8 In paragraph 9.2 I referred to the empirical finding about increased traffic flows after new road building:

"In a dozen more detailed case studies the measured increase in traffic ranged from 9% to 44% in the short run and 20% to 178% in the longer run"

Induced traffic on this scale translates directly into increased greenhouse gas emissions from operational sources (vehicles). This adds to the weight of evidence I have presented in s8 about embodied greenhouse gases and confirms my assessment in s8 that this road proposal is a major blow against WAG, UK Government and EU climate change targets and ambitions.

9.9 For the avoidance of doubt it is my settled view that the decision making process around the M4 relief road cannot be regarded as sound and reliable if it does not follow the findings of the SACTRA 1994 report and the detailed empirical evidence presented in the CPRE, 2006 report "Beyond Transport Infrastructure" report, and the detailed review of induced traffic by an acknowledged expert in this field (John Elliott in World Transport Policy and Practice, 2016).Induced traffic renders the VFM calculations unsound and undermines the BCR and it would not be in the best

traditions of evidence-based UK decision taking on major investments to proceed with a very expensive project that is based on deeply flawed calculations.

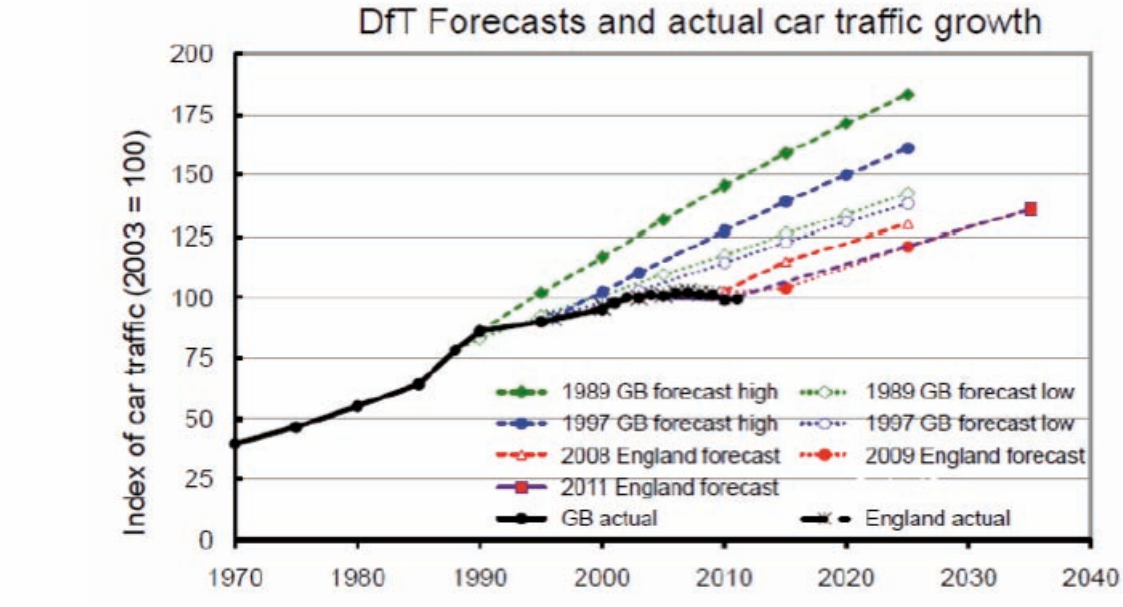
9.10 It is most regrettable that the Welsh Government report on traffic forecasting issued in December 2016 makes no reference to the SACTRA report (para 9.3 above) or induced traffic or the many studies showing that corridor level traffic volumes are much greater than predicted in the years following the opening of a scheme. The simple fact that a major government report on newly generated traffic has been ignored exposes the inadequacies of the arguments in favour of the M4 relief road. For the avoidance of doubt the existence of newly generated traffic means that traditional traffic forecasting excludes an important component of growth that is created by the project itself. It also means that predicted travel time savings do not materialise because the newly generated/ induced traffic adds to congestion and as a consequence reduces travel time savings and it means that the benefit-cost ratios and VFM calculations are inaccurate.

The Welsh Government document referred to is as follows:
Welsh Government
M4 Corridor around Newport
Revised Traffic Forecasting
Report
M4CaN-DJV-HTR-ZG_GEN-RP-TR-0003
P01 | December 2016

http://gov.wales/docs/det/publications/161214-revised-traffic-forecasting-report.pdf

9.11 The Welsh Government report on traffic forecasting also ignores the reality of exaggerated and inaccurate forecasts made in the past. The traffic engineering and modelling world is well aware that forecasting is based on flawed assumptions and this has eben expertly illustrated by Professor Phil Goodwin in his many writings and presentations e.g.

A progressive, systematic and continuing tendency for long term trends in car use to be over-forecast.
(not attributed to peaking or saturation, but to faulty external input data)



Source: Phil Goodwin, University of the West of England
file:///C:/Users/JohnW/Downloads/WC2012_goodwin_peak_car%20(1).pdf

9.12 The black line in Professor Goodwin's diagram (para 9.11) shows that actual traffic growth is much less than predicted traffic growth. This in turn means that the arguments made in support of road building, as in the case of the M4 relief road, are based on unreliable traffic forecasts. A decline in traffic volumes would suggest that the case for a new road or an increase in road capacity is very weak. The reasons for lower out-turn traffic data are many and discussed in the traffic and transport literature. They embrace a clear shift in choices and preferences on the part of younger people away from the car, the success of travel plans (heavily promoted by DfT) and the success of best practice city-wide transport strategies of the kind not yet seen in the Newport-Cardiff corridor. The successes of Reading buses, Brighton buses and Nottingham's Workplace Parking Levy combined with Nottingham's bus and tram projects are well documented and show that it is possible to reduce car travel and boost alternatives to the car. It is remarkable that this very important dimension often referred to as "demand management" is absent in the Welsh Government's traffic forecasting work and its consequences are serious. The lack of attention to demand management artificially and unreasonably boosts the case for new road building and supports very expensive infrastructure projects that damage the countryside, nature reserves and the environment.

9.13 The promotion of new road building at very great expense against a background characterised by lack of serious attempts to develop and fund non-road building options (so-called "predict and provide") is poor quality public decision-taking and should be rejected.

10 *The evidence nationally and internationally is very clear on wider economic impacts and new road building is just as likely to drain jobs away from a local economy as it is to attract them*

10.1 In 1959 Britain opened its first motorway (the Preston bypass, now the M6). We have now had 57 years' experience of adding high quality, generously proportioned and expensive transport infrastructure to our national landscape and we still do not know the degree or extent of its impact on simple variables such as numbers of jobs created, new firm formation, the growth of firms, re-location versus new investment, regional inequalities, disadvantageness and the widening of opportunities for all sections of society. James Drake writing in his book "Motorways" in the early 1960s argued:

> *"..the proximity of a motorway makes a town far more attractive from an industrial point of view. Adequate road communications are always a prime consideration of an industrialist looking for a site for his new works; a convenient connection to the motorway system is a great advantage."*(page 26)

James Drake would be very surprised indeed to learn about the significant unemployment and structural economic problems of areas very well served by motorways in the 21st century (Glasgow, Skelmersdale, Hull, Blackburn and Burnley). High quality transport infrastructure is not a "magic bullet" cure for deeply rooted economic and social problems.

10.2 The research evidence in support of the general proposition that adding highway infrastructure including bridges and roads will inevitably and necessarily lead to a reversal of economic decline and an increase in job opportunities is just not there.

10.3 The research evidence that points to the absence of such a clear link does exist and has frequently been confirmed by economists, geographers and regional development specialists. Table 10.1 lists a selection of the published research material that refutes the proposition of an

unambiguous link between transport investment and local economic gain. The clear evidence of these studies is that it would be perverse to proceed with a large transport infrastructure investment on the unsubstantiated assumption that such an investment will lead inexorably and unambiguously to job creation in disadvantaged areas and to the removal of social exclusion.

10.4 The research evidence in Table 10.1 is reinforced by official and governmental evidence and this is summarised in Table 10.2

10.5 The Inspector's report into the proposed M74 motorway in Glasgow is especially relevant to a discussion about the impact of additional highway capacity in South Wales. Most if not all the issues relevant to the debate around social exclusion, relative disadvantageness, business growth, job creation and new transport infrastructure were dealt with in a thorough manner by the Inspector and have a direct transferability to the sub-region centred on Newport. The Inspector came down firmly against the M74 and accepted the case made by the objectors (Table 10.3)

10.6 An objective assessment of the weight of evidence both scientific and public policy would lead inevitably to the rejection of a proposal that claimed economic and social gains from a large item of transport infrastructure. It would further reject the assertion that such investments could maintain accessibility improvements over time as traffic levels rise and erode the temporary gains made in the few months following opening of a scheme.

10.7 The clear view of the Royal Commission on Environmental Pollution in its 1994 report "Transport and the Environment" still stands as a significant and telling finding from an authoritative, independent and prestigious government body:

> *"In the Treasury's view it is not possible to generalise about the importance of transport infrastructure as a factor in bringing about economic growth in depressed or deprived regions..a recent study concluded that road building is not the key to economic growth in the regions..indeed it seems that good roads can sometimes speed the decline of less prosperous areas by allowing their needs to be met conveniently from sources outside the area"* (para 2.14, page 15)

10.8 The importance of this finding has not been addressed by the supporters of the M4 relief road around Newport

10.9 The evidence from authoritative, independent sources on the economic impact of major infrastructure schemes, including roads, points unequivocally to "not proven" and in some cases negative. The negative dimension is specifically mentioned in the RCEP (1994) report quoted in paragraph 10.7 above and in the SACTRA (1999) report listed in Table 10.2. The results of studies of the economic impact of completed transport projects "do not offer convincing general evidence of the size, nature or direction of local economic impacts."

10.10 The SACTRA report (1999) is central to the consideration of any claims made for the M4 relief road in terms of regeneration, job creation, inward investment and local economic gain. SACTRA, a Uk government committee, has concluded that "there is no convincing general evidence" in support of these desirable outcomes and that improved highway connectivity can also lead to the "2-way road effect" where economic activity drains away from less prosperous regions to stronger regions.

10.11 The conclusion of the Inspector at the M74 inquiry quoted above (paras 11.96-11.99) mark the conclusion of a very thorough and rigorous evaluation of the evidence and the simplistic argument that new motorway capacity would solve congestion and regeneration problems was found to be flawed and rejected. The supporters of the M4 relief road around Newport have presented no evidence to refute the findings of the RCEP (para 10.7), SACTRA (Table 10.2) and the M74 Inspector (Table 10.3)

10.12 A 2015 report reviewed over 2000 studies of the economic impact of trans-

Author	Date	Headline Finding
Dodgshon, J S	1973	Little evidence of transport development encouraging regional development
Cleary, M J and Thomas R E	1973	The Severn Bridge..(has produced) no significant relocation of manufacturing establishment as a consequence of the bridge
Gwilliam, KM	1970	Little evidence of a transport-economic development link
Gwilliam and Judge	1978	(M62)..as far as regional development is concerned we have seen little strong evidence to suggest that the motorway is a powerful influence on inter-regional location of activity
Leitch Committee Report,	1977	Largely rejected the view that trunk road construction engenders economic growth
Bonnafous, A	1979	Regional development is not a normal consequence of the improvement in the transport supply…it can, on the contrary, aggravate inequalities of development
Blonk, W A G	1979	A new link between an area of concentration and an underdeveloped region improves the flow of traffic not in one direction but two. This entails a risk of competition from outside and a draining of resources for the underdeveloped region
Sharp, S	1980	Transport investment, by itself, is unlikely to encourage economic growth in less prosperous regions…the effect of providing improved transport facilities to a poorer region is even more uncertain
European Conference of Ministers of transport (ECMT)	1991	When companies are deciding where to locate their activities, transport is a secondary criterion.. by and large businesses do not consider transport costs to be an important factor as they average only 3-5% of operating costs
ECMT (Plassard)	1991	Nagoya in Japan has lost 20% of its employment since the opening of the high speed rail link between Tokyo and Osaka
Goodacre, C	1993	(M65) local authorities through which the M65 passes have not performed any better than those through which the road does not pass
Whitelegg, J	1994	The analysis of variation in economic performance and variation in accessibility has found no evidence of a positive relationship.
Lawless and Dabinett	1995	The link between transport investment and regeneration is weak because the two policy areas are poorly co-ordinated
ESRC Urban and Regional Seminar Series (quoted in Cole, 2005, page 425)	2002	Found very little evidence of positive benefit to Kent as a result of the Channel Tunnel
Cole, S	2004	Road improvements in North Wales (A55) and South Wales (M4) opened up the region to new competition from outside (the two-way road effect)
OECD	2002	Greater social inclusion was unlikely to be achieved through improved accessibility and transport alone but also required parallel initiatives including work skills, housing and social policy
University of Kent	2004	(The Channel Tunnel) has not had the expected impact on economic development locally or more widely in Kent

Table 10.1: Published scientific work on transport investment and local economic gain

RCEP, 1994	In the Treasury's view it is not possible to generalise about the importance of transport infrastructure as a factor in bringing about economic growth in depressed or deprived regions..a recent study concluded that road building is not the key to economic growth in the regions..indeed it seems that good roads can sometimes speed the decline of less prosperous areas by allowing their needs to be met conveniently from sources outside the area (para 2.14, page 15)
SACTRA 1999	The SACTRA report on Transport and the Economy was the culmination of a 3 year inquiry chaired by Eileen Mackay CB into claims of economic benefit from road schemes. The report notes (summary, page 17, paragraph 11) that the contribution of road construction to sustainable economic growth of a mature economy, with well-developed transport systems, is likely to be modest. It states that the results of studies of the economic impact of completed transport projects "do not offer convincing general evidence of the size, nature or direction of local economic impacts". The report goes on to state "Our studies underline the conclusion that generalisations about the effects of transport on the economy are subject to strong dependence on specific local circumstances and conditions."
SACTRA 2000	While in certain circumstances transport schemes may bring added economic benefits to an area needing regeneration, in other circumstances the opposite might occur. Better communications will enlarge markets for goods, services and workers: the area as a whole may gain or lose from this depending on the structure and competitiveness of the local economy. It follows that there is no simple, unambiguous link between transport provision and local regeneration. http://www.dft.gov.uk/stellent/groups/dft_econappr/documents/page/dft_econappr_504831.hcsp
Inspectors Report into the M74 motorway extension in Glasgow, 2004	http://www.scotland.gov.uk/library5/transport/m74r-00.asp M74 will encourage traffic growth (11.85); business benefits will be short lived and/or will disadvantage other areas in Scotland (11.86); will worsen social exclusion (11.88); the M74 extension should not be authorised and the compulsory purchase orders should not be confirmed (11.99)
Professor David Begg, Chairman of CfIT	Summing up, David Begg cautioned against what he described as an "infrastructure junky" approach. The starting point needed to be asking what kind of communities we want to see and how transport can help deliver them. Conference organised by the Office of the Deputy prime Minister C4: Opening up potential - the role of transport in sustainable communities
TfL, 2004, para 131, page 33 of TfL/61	TfL, 2004, para 131, page 33 of TfL/61 "when accessibility is improved in areas of very poor accessibility, there is no guarantee that this will be associated with an increase, on average, in either employment or population density"

Table 10.2: UK government documents on transport and the economy

11.96	Drawing these numerous elements together, the evidence has shown that the proposal would be likely to: • seriously hinder the achievement of important Scottish Executive commitments and objectives for traffic reduction, public transport improvements, and CO2 emissions; • have very serious adverse impacts on the environment of communities along the route, both during construction and in operation; • be at variance with policies to promote social inclusion and environmental justice; • temporarily ease traffic congestion, to the benefit of car commuters and road freight transport, but that these benefits would be progressively lost due to continuing traffic increases, in the absence of measures to restrain and reduce traffic; and • make a positive contribution to the local economy in Glasgow, South and North Lanarkshire, Renfrewshire, and East Renfrewshire, at the expense of the Forth valley, the Stirling area, Ayrshire, Inverclyde, and West Dunbartonshire.
11.97	Drawing these various strands together, and looking at all the policy, transport, environmental, business, and community disadvantages of the proposal as a whole, it must be concluded that the proposal would be very likely to have very serious undesirable results; and that (in the context of the advice in the SACTRA report, the transfer of jobs from other parts of Scotland, and the potential harm to existing businesses along the route) the economic and traffic benefits of the project would be much more limited, more uncertain, and (in the case of the congestion benefits) probably ephemeral.
11.98	In this context, it cannot be concluded that the public benefits of the proposal would be sufficient to outweigh the considerable disadvantages that can be expected, nor that it is necessary in the public interest to acquire compulsorily all of the properties where objections to the CPO have been maintained.
11.99	Accordingly, on the basis of the consideration of the material put forward by objectors..and those who support the project, the conclusion is that this proposal should not be authorised, and that the compulsory purchase order should not be confirmed.

Table 10.3: Extracts from the final report of R M Hickman, Inquiry Reporter into the proposed M74 extension in Glasgow, July 2004
Source: http://www.scotland.gov.uk/library5/transport/m74r-13.asp

port infrastructure projects including new roads and concluded:

- The economic benefits of transport infrastructure spending – particularly as a mechanism for generating local economic growth – are not as clear-cut as they might seem on face value.
- Arguments for spending more in areas that are less economically successful hinge on the hope that new transport is a cost-effective way to stimulate new economic activity. We do not yet have clear and definitive evidence to support that claim.
- Our findings raise fundamental questions about scheme appraisal and prioritisation, and about the role of impact evaluation in improving decision-making around transport investment.
- Evaluations of economic impact rarely consider the negative economic impacts of transport improvements – they could export economic activity to neighbouring regions by improving market access and workforce mobility.

Source: http://www.whatworksgrowth.org/policy-reviews/transport/

10.13 The finding that *"The economic benefits of transport infrastructure spending – particularly as a mechanism for generating local economic growth – are not as clear-cut as they might seem on face value."* is a serious matter at a time of very large government cuts in public spending and a proposed £1 billion plus project on 14 miles of new highway around Newport. Such a large expenditure requires much more certainty about the impacts and that certainty is not there.

10.14 In spite of the very large literature casting doubt on the links between building new roads and undiluted economic gains to the areas served by that new road the Welsh Government has re-emphasised its belief in the wider economic benefits that are expected to flow from the M4 relief Rd. This can be found in:

Welsh Government
M4 Corridor around Newport
Revised Wider Economic Impact Assessment
M 4 C a N - D J V - G E N - Z G - G E N - R P - TR-0004
P04 | December 2016

h t t p : / / g o v . w a l e s / d o c s / d e t / publications/161214-revised-economic-appraisal-report.pdf

10.15 The "Wider Economic Impact assessment" (WEIA) makes a completely unsubstantiated assertion in the Executive Summary:

> *"This research has indicated that spatial factors – the lack of economic mass or density and the relative peripherality of Wales – play a role in determining Wales' relative performance. This hypothesis is supported by UK and international evidence on the link between transport and economic performance"*

No evidence at all is presented in support of this assertion either by definition of peripherality or size of economic mass or in a rigorous ex-post situation looking at economic performance. An "ex-post" approach would be to identify an area defined as "weak" in terms of connectivity or peripherality and then build a new road to improve the situation and then use the same measure of economic success to compare before and after. This approach to evidence has not been adopted and we are left with unsubstantiated assertions.

10.16 A frequently used measure of economic success is GDP (Gross Domestic Product) per capita e.g.

https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html

In this CIA (Central Intelligence Agency, USA) data set the UK is ranked 37 by size of the GDP per capita measured in US dollars. The UK is listed at $42,500 per capita. This means 36 countries have a higher GDP per capita and are, therefore, economically more successful. A number of countries that can be defined as "peripheral" have much more successful economies (all data is per capita):

Isle of Man (rank 7) $83,100
Ireland (rank 11) $69,300
Guernsey (rank 22) $52,300

It can be concluded that peripherality is not linked to economic performance.

The Welsh Government also uses another undefined term "economic mass". It can be assumed that The Netherlands, Denmark and Sweden have a smaller economic mass than the UK and GDP per capita is as follows:

UK	$42,500
Netherlands	$50,800
Sweden	$49,700
Denmark	$46,600

It can be concluded that "economic mass" is not related in any predictive capacity to economic performance.

10.17 The case for a new road based on reference to peripherality and economic mass is illogical, misleading and not supported by data.

10.18 The Executive Summary in the WEIA relies on a level of vagueness and assertion that has no place in the evaluation of a £1.1 billion project:

> *"More generally, the M4CaN is expected to contribute positively to perceptions of South and South West Wales as a location for investment. This conclusion is supported by many in the business community. Furthermore, the vast majority of overnight holidaymakers to Wales travel by car. Therefore, it would be reasonable to assume that the majority of tourists visiting South and South West Wales will experience the M4 around Newport during their visit. Delays caused by disruption on the M4 corridor will impact negatively on visitor's perceptions of South and South West Wales as a place to visit."*

There is no evidence that "perception" works in this way. Businesses make complex decisions based on a large number of factors including as a minimum the cost of acquiring or leasing land and buildings, the availability of a skilled workforce, labour costs, house prices, high quality schools, attractive countryside nearby and prevailing levels of taxation and incentives. To reduce all these factors to a vague concept of perception linked to an experience on the M4 is not credible and lacks substantiation. To make a similar point about tourist visits is also stretching credulity. Many millions of tourists visit the Lake District and Cornwall each year in spite of difficult journeys by car and there is no evidence that they are persuaded to take holidays in Warrington (highly connected at the junction of the M6 and M62) rather than Grasmere or Penzance.

10.19 The WEIA Executive Summary emphasises the impact of the proposal on reducing journey times and reducing transport costs and generating an economic benefit based on the monetarisation of those time savings:

> "The EAR sets out that the M4CaN scheme will result in lower journey times and reduce transport costs for businesses in the study area defined for this assessment. Even before the effects of traffic incidents and abnormal delays are considered, cost savings for businesses in the study area are estimated to be £30m (2016 prices) each year by the design year of 2037. In practice, however, the scheme will also improve journey time reliability and will reduce the delays associated with traffic incidents which will result in further cost savings and efficiency benefits for businesses."

There are two problems with this approach to economic impact assessment. Firstly it takes no account of newly generated traffic discussed in section 9 of my evidence. If, as the evidence suggests, there is an increase in newly generated traffic, then this reduces journey time savings and reduces the amounts claimed in benefits from the valuation of time. The proposal makes no attempt to carry out a sensitivity analysis of newly generated traffic. A sensitivity analysis would test the time saving estimates and their monetary value against different level of newly generated travel. The second problem is the degree to which time savings and reduced transport costs are translated into tangible benefits e.g. newly carted jobs and inward investment. The transport literature over many years (including SACTRA, "Transport and the Economy" (1999) has pointed out the "2-way road effect". If there is a reduction in transport costs it becomes possible for a company based in Bristol or Swindon (for example) to service its entire South Wales market from those locations and to terminate any activities it may have in Newport, Cardiff, Bridgend or Swansea. The economies of scale that flow from this locational strategy are very large and are made possible by reduced transport costs.

10.20 The 2-way effect is very important. The SACTRA reort, "Transport and the Economy" (1999) is very clear

> *"10 We consider these theories, which deal with the linkages between transport improvements and economic activity, to be strong. They are internally consistent, and provide insight into a complex pattern of effects leading in different directions, not all of which are intuitively obvious - notably, for example, the 'two-way road' argument: this*

reminds us that improved accessibility between two countries (and, similarly, between cities, areas or regions) may sometimes benefit one of them to the disbenefit of the other. We emphasise that these theories as a whole should be subject to empirical testing before any of them can be taken as proved"

Further, we cannot assume simplistic cause and effect t links between a large new road and positive economic consequences

"11 In the search for empirical evidence, we find that direct statistical and case-study evidence on the size and nature of the effects of transport cost changes is limited. Some authors have claimed that national programmes of public investment, including road construction, lead to high rates of social return measured in terms of economic growth and productivity improvement. Other authors suggest that such effects do occur but on a smaller scale than has been claimed, and that, in general, any contribution to the sustainable rate of economic growth of a mature economy, with well-developed transport systems, is likely to be modest. Our investigations support the latter assessment. We have also reviewed available evidence from specific local studies seeking to detect economic impacts from completed transport investment projects in the recent past. The state of the art of this important field is poorly developed and the results do not offer convincing general evidence of the size, nature or direction of local economic impacts."

Source: SACTRA (1999) Transport and the Economy, Department of Environment, Transport and Regions

http://webarchive.nationalarchives.gov.uk/20050301192906/http:/dft.gov.uk/stellent/groups/dft_econappr/documents/pdf/dft_econappr_pdf_022512.pdf

10.21 The WEIA has provided no evidence based on completed highway projects that there are economic gains to be harvested as a result of building new roads. References to SACTRA and the A55 (para 3.4.6) and Merthyr (para 3.5.4) are not supported by the SACTRA document. No data is provide on the impact of the A55 in the SACTRA document and the impact on Merthyr of the A470 improvements is described as "marginal" (para 5.115 of SACTRA, 1999)

10.22 An important conclusion in SACTRA (1999) is relevant to the evaluation of any economic evidence supplied in support of the M4 relief road:

Empirical evidence of the scale and significance of such linkages is, however, weak and disputed.

Given the very clear SACTRA conclusions and given the lack of case study evidence from the promoters of similar UK projects showing links between infrastructure and local economic performance, the M4 relief road fails the test of soundness.

10.23 Para 3.9.1 of the WEIA stretches our understanding of the word "evidence" beyond normal limits:

3.9.1 The evidence presented here supports the view that investment in roads and highway infrastructure has positive effects on economic performance

The evidence of SACTRA (1999) and numerous other studies quoted in my proof of evidence shows that there is no clear link between building a new road and local economic gains.

10.24 Whitelegg (1994) carried out a detailed scientific study looking at 4 areas of England and Wales and examining data on economic performance before the construction of new highway infrastructure and after construction. Four areas were chosen for this analysis:

1. NE Lancashire
2. Humberside and Doncaster
3. East Midlands
4. West Glamorgan.

The West Glamorgan area was relevant to the subject under examination at this Public Inquiry:

"In the case of West Glamorgan both

Travel to Work Area are located less than 12 minutes driving time from the M4. Neath/Port Talbot and Swansea have been compared in accessibility terms to the M5/M4 junction and to Reading."

The conclusion across all 4 areas was very clear:

"The analysis of economic performance and accessibility has produced results that could not be clearer. The R2 statistic ranges from 0.010 to 0.30. Only in the case of Figure 6 and access to Manchester airport from Humberside and the East Midlands does the R2 statistic rise above 0.04. There is no relationship between accessibility and economic performance."

"The analysis of variation in economic performance and variation in accessibility has found no evidence of a positive relationship. Areas of poor accessibility out-perform areas of high accessibility and areas with very similar accessibility characteristics have very different economic performance characteristics. This should not come as a surprise. The accumulated evidence from previous studies points unequivocally to the same conclusion. There is no basis in experience or empirical evidence for road investment stimulating economic development."

Since this report was published in 1994 there have been many opportunities for central government, the Welsh Government, local authorities, development agencies and construction companies to replicate the analysis and carry out a rigorous statistical analysis comparing specific economic indicators with specific measures of accessibility. To the best of my knowledge this has not been done and on one side we have scientific evidence that there is no relationship between accessibility and eceonomic performance and on the other side we have vague, subjective assertions without data and analysis that there is a relationship. I suggest that it is not in the best traditions of British governance and decision-taking to spend £1.1 billion on the basis of vague assertion and the rejection of scientific evidence

Source:
Whitelegg, J (1994) Roads, jobs and the economy, Eco-Logica Ltd, Lancaster

http://worldtransportjournal.com/wp-content/uploads/2015/02/GPRoadsJobsEconomy.pdf

11 The principles of Transport Appraisal have not been followed and the adoption of a road-building option has not followed careful evaluation of all options including the non-road building options

11.1 The world has moved on a great deal since the time when the perception of a transport problem was automatically met with the bypass, additional lanes or road widening response.

11.2 The UK government's guidance on transport appraisal, known as WebTag, makes it very clear that there should be a sequential approach to dealing with transport problems followed by option listing and scoping and concluding with a clear and transparent comparison and evaluation of the options leading to the selection of the best performer.

11.3This sequential approach has not been followed in the case of the M4 relief road.

11.4 In addition to the lack of sequential approach the decision-making processes leading to the matter now before this public inquiry did not include the richness and diversity of non-road building options. They were not given the opportunity to reveal how they would perform when compared to the road building option.

11.5 The sequential approach is very clear in WebTag and the Welsh Government report on forecasting referred to in para 9.9 above relies on this same DfT WebTag guidance:

The three stages in the Transport Appraisal Process are as follows:

- Stage 1 – Option Development. This involves identifying the need for intervention and developing options to address a clear set of locally developed objectives

which express desired outcomes. These are then sifted for the better performing options to be taken on to further detailed appraisal in Stage 2. See Section 2.
• Stage 2 – Further Appraisal of a small number of better performing options in order to obtain sufficient information to enable decision-makers to make a rational and auditable decision about whether or not to proceed with intervention. The focus of analysis is on estimating the likely performance and impact of intervention(s) in sufficient detail. See Section 3.
• Stage 3 – Implementation, Monitoring and Evaluation. See Section 4.

Source: Transport Analysis Guidance. The transport appraisal process, January 2014, DfT, Transport Analysis Guidance

https://www.gov.uk/guidance/transport-analysis-guidance-webtag

11.6 The WebTag document identified in paragraph 11.5 is very clear that there are principles that must be followed:

T*here must be a clear rationale for any proposal and it must be based on a clear presentation of problems and challenges that establish the 'need' for a project.*

There must be consideration of genuine, discrete options, and not an assessment of a previously selected option against some clearly inferior alternatives. A range of solutions should be considered across networks and modes.

There should be an auditable and documented process which identifies the best performing options to be taken forward for further appraisal.

There should be an appropriate level of public and stakeholder participation and engagement at suitable points in the process. In most cases this should inform the evidence-base which establishes the 'need' for an intervention, guide the option generation, sifting and assessment steps, as well as informing further appraisal in Stage 2.

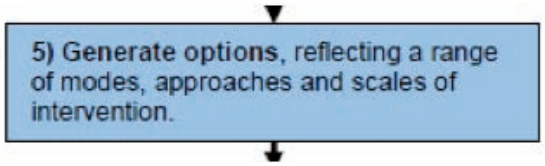
Source: paragraph 1.1.5 of https://www.gov.uk/guidance/transport-analysis-guidance-webtag

11.7 There is no evidence in the M4 relief road proposal that "genuine, discrete options" have been identified and pursued and " and no evidence of the requirement to include "A range of solutions… across networks and modes."

11.8 For the avoidance of doubt "a range of solutions "across networks and modes" would include the "smarter" options discussed below in and the systematic application of workplace travel plans across the whole Cardiff-Newport corridor to reduce single occupant vehicle use (SOV) and encourage modal shift to non-car alternatives and there has been no detailed evaluation of the extent to which significant improvements in rail based commuting opportunities could reduce vehicle numbers on this same corridor

11.9 Figure 1 below is taken from the same document referred to in paragraphs 11.5 and 11.6 and clearly shows that a wide range of options "across modes and networks" must be factored into the discussion about solutions and preferred options. This has not been done in the case of the matter before this inquiry.

11.10 There is no sign in the gestation of the M4 relied road proposal of the requirement to carry out step number 5 in Figure 1



11.11 The lack of robust and wide ranging option generation is a particularly serious defect in the case for the M4 relief road. The WebTag document referred to above is very clear indeed:

"2.8.2 It is important that as wide a range of options as possible should be considered, including all modes, infrastructure, regulation, pricing and other ways of influencing behaviour. Options should include measures that reduce or influence the need to travle, as well

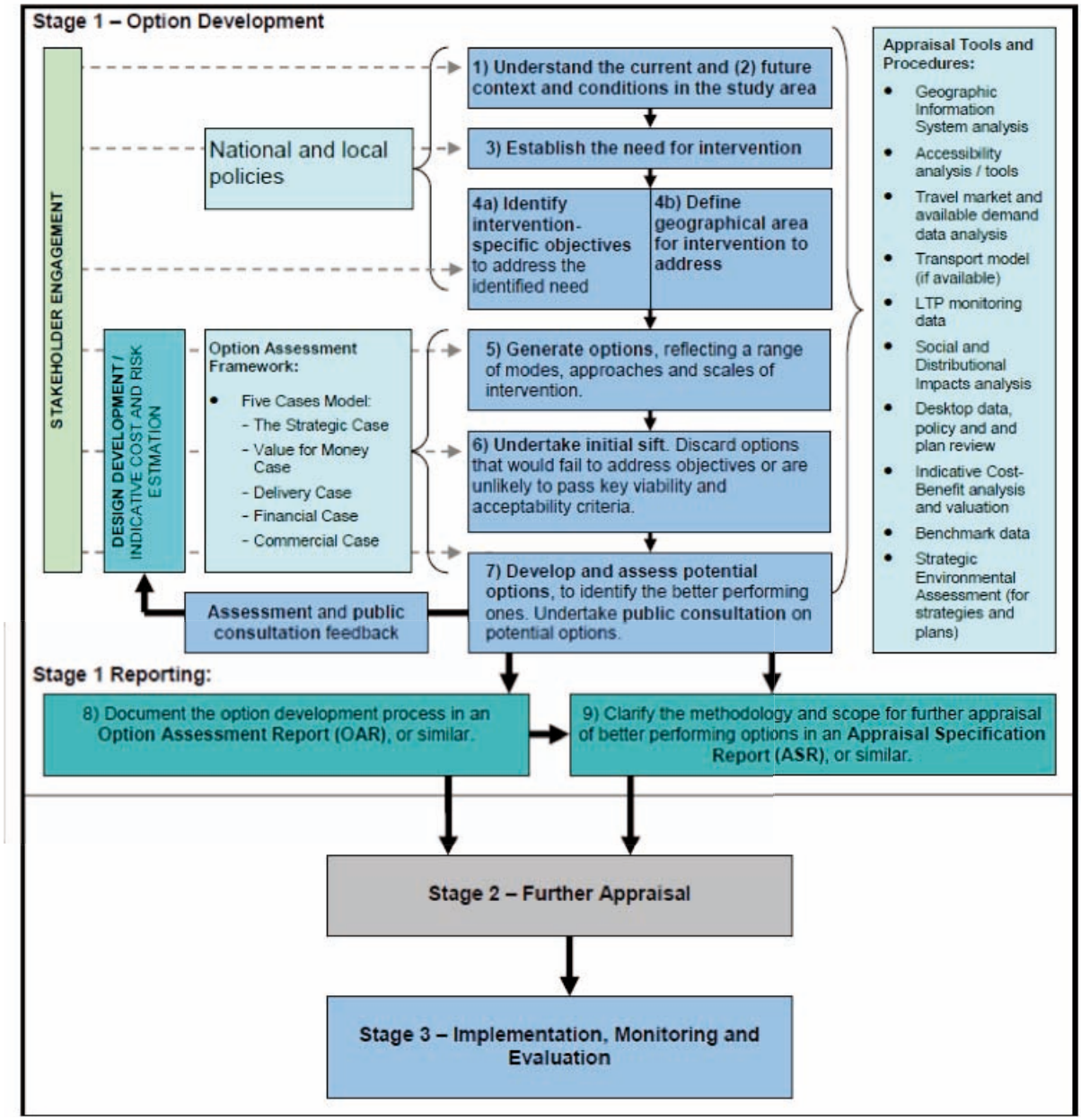


Figure 1:
Source: https://www.gov.uk/guidance/transport-analysis-guidance-webtag

as those that involve capital spend. Revenue options are likely to be of particular relevance in bringing about behavioural change and meeting the Government's climate change goal."

11.12 It is abundantly clear that the promoters of the M4 relief road have sidestepped any matter related to regulation, pricing and the reduction of the need to travel. Indeed a major expansion of road capacity can be expected to reinforce existing behavioural choices and the use of the car and cannot contribute to behavioural change or the Government's "climate change goal".

11.13 The importance of wide option generation is reinforced by paragraph 2.8.3 in the WebTag document:

"2.8.3 Studies should not start from an assertion about a preferred modal solution, or indeed that infrastructure provision is the only answer. Following the Eddington Transport Study, Sponsoring Organisations will be looking to encourage the better use of existing infrastructure and avoiding "solutions in search of problems". IKn this context, it is recognised that small schemes can represent high value for money."

11.14 It is very difficult indeed to avoid the conclusion that the M4 relief road from

the beginning has been a "preferred modal solution" and a "solution in search of problems"

11.15 Options must also be assessed one against another in terms of the business case and if wider modal options and behavioural change options are simply excluded from detailed evaluation it is difficult to see how the requirements around Value for Money and business case objectives can be met:

> *"2.10.3 Potential options should be assessed against the 'Transport Business Case' criteria using the Option Assessment Framework set out in Appendix A."*

11.16 The neglect of option generation goes wider than WebTag considerations and includes the work of Highways England (formerly the Highway Agency.)

11.17 The Highways Agency has made a substantial contribution to corridor level traffic management and traffic generation through a distinctive approach to demand management that is directly relevant to the A350 corridor.

11.18 The Highways Agency describes this approach as follows:

> *Introduction*
>
> *The Influencing Travel Behaviour programme is designed to promote sustainable travel and reduce congestion on England's 'strategic road network'. Through this the Agency aims to cut congestion by influencing travel behaviour, providing access to information to help people make *smarter travel choices and introducing demand management measures in areas prone to congestion.*
>
> *Our strategy in taking this forward aims to balance the needs of people to travel with the available capacity of the road network. We aim to support the country's economic success whilst addressing environmental objectives. Key to achieving this is to reduce the amount of traffic on the road, in particular, the demand for private car journeys.*
>
> *Congestion*
>
> *Traffic Congestion seriously affects our economy, quality of life and environment. The Highways Agency's plans to improve motorways and trunk roads will help to tackle congestion. However, road building alone will not solve the problem.*
>
> *The Department for Transport's congestion target challenges us to make journeys more reliable on the strategic road network. The Influencing Travel Behaviour Programme has been identified as being able to contribute to meeting this target.*

Source: Highways Agency, Tackling congestion by influencing travel behaviour

http://www.highways.gov.uk/knowledge/9561.aspx

11.19 The Highways Agency has developed travel plans for both car traffic and HGV traffic at several sites including Blythe Valley, Shellhaven (a freight travel plan) and Wellingborough East. Wellingborough East is of particular relevance to the West Wiltshire Trading Estate since it is a growth area for jobs and economic activity. These plans are designed to deliver economic benefits whilst at the same time reducing traffic that would normally be generated by the developments and thrown onto the highway system. Information on these travel plans can be found on the Highways Agency web site http://www.highways.gov.uk/knowledge/18297.aspx

11.20 The Highways Agency has developed a strategy for the A45 corridor (Northampton) designed to cope with large traffic generators on this corridor and reduce the traffic generation from key sites. The A45 plan is directly relevant to the A350 corridor but regrettably best practice on travel plans, spatial planning and traffic reduction has not been implemented on the A350 corridor.

11.21 The "smarter choices" agenda has been accepted and promoted by government and a full list of specific measures described as "smarter choices" can be

found in a DfT report on the use of smarter choices in LTPs:
http://www.dft.gov.uk/pgr/sustainable/smarterchoices/smarterltps/pdfinitial-findltps

11.22 A recent review of all the "smarter choices" results and documented case study material concluded:

There is a growing body of practical experience and understanding of the role for smarter choice measures in transport policy. Such interventions provide a number of different ways of encouraging better informed traveller attitudes, and more benign or efficient ways of travelling. The results reported here suggest that within approximately ten years, such measures have the potential to reduce national traffic levels by about 11%, with reductions of up to 21% in peak period urban traffic. Moreover, they represent relatively good value for money, with schemes potentially generating benefit: cost ratios which are in excess of 10:1.

The full list of "smarter choices" can be found in the main DfT report of that title:

http://webarchive.nationalarchives.gov.uk/20100304134509/http://dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt

11.23 The main findings of the DfT smarter choices research project were as follows:

"In recent years, there has been growing interest in a range of transport policy initiatives which are now widely described as 'soft' measures. Soft measures usually seek to give better information and opportunities which affect the free choices made by individuals, mostly by attractive, relatively uncontroversial, and relatively cheap improvements. They include:

- *Workplace and school travel plans;*
- *Personalised travel planning, travel awareness campaigns, and public transport information and marketing;*
- *Car clubs and car sharing schemes;*
- *Teleworking, teleconferencing and home shopping."*

"Following this review, we can say that sufficient evidence now exists to have some confidence that soft factor interventions can have a significant effect on individual travel choices."

"The assessment focuses on two different policy scenarios for the next ten years. The 'high intensity' scenario identifies the potential provided by a significant expansion of activity to a much more widespread implementation of present good practice, albeit to a realistic level which still recognises the constraints of money and other resources, and variation in the suitability and effectiveness of soft factors according to local circumstances. The 'low intensity' scenario is broadly defined as a projection of the present (2003-4) levels of local and national activity on soft measures. The main features of the high intensity scenario would be

- *A reduction in peak period urban traffic of about 21% (off-peak 13%);*
- *A reduction of peak period non-urban traffic of about 14% (off-peak 7%);*
- *A nationwide reduction in all traffic of about 11%."*

Extracts are from three "Smarter Choices" report, section 14.1, Conclusions

http://webarchive.nationalarchives.gov.uk/20100304134509/http://dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/chapter14conclusions.pdf

11.24 A reduction of peak hours traffic around Newport as a result of these non-road building measures by 21% is sufficient to deliver significant amounts of congestion relief without triggering the phenomenon known as "induced traffic" or more colloquially referred to as "new roads generate new traffic". The cost of implementing these measures is much lower than a new highway and the BCA is much higher and the Value for Money is correspondingly much superior to road building.

11.25 On BCA the report concludes that each £1 spent on soft measures could produce benefits of about £10 on average"

"With these rather cautious assumptions, our calculations suggest that soft factor interventions offer very acceptable value for money. Using current DfT practice for estimating the value of the effects on travel times of a reduction in the number of vehicles, each £1 spent on soft measures could produce benefits of about £10 on average, and considerably more in congested conditions. Inclusion of values for potentially positive effects on safety, health or the environment would further increase the value for money. This gives a good margin of robustness to changes in assumptions or methods of calculation."

11.26 In congested urban areas and in wider city-region areas there is considerable potential to reduce congestion in the peak through the workplace travel plan (WTP):

"Workplace travel plans typically reduce commuter car driving by between 10% and 30%, though the best ones achieve significantly more than that. Typical cost to the local authority is £2-£4 per head. So far, city authorities prioritising workplace travel plans have typically managed to engage with organisations representing about 30% of the workforce, whilst county authorities have managed to engage with organisations representing about 10%."

11.27 I have designed a WTP at two sites referred to by DfT as best practice examples (1) Derriford Hospital in Plymouth and (2) Pfizer Pharmaceuticals in Sandwich in Kent. Both achieved reductions in car commuting of over 10% and the WTP approach has been documented in the world's first WTP standard (British Standards Institution, PAS500) PAS 500 has a very powerful contribution to make to reduce congestion without road building:

BSI PAS 500:2008 National specification for travel plans

Finding ways to make the best possible use of transport infrastructure and minimizing loss of time and economic damage is a clear priority and an activity in which all businesses and sectors of the economy can engage.

Workplace travel plans (WTP) offer one proven methodology for bringing about this change.

A travel plan is a long-term management strategy for an organisation and its various sites that seeks to deliver transport objectives through positive action and is articulated in a document that is regularly reviewed. It provides a coherent approach to transport management that brings benefits to commuters, business travellers, businesses and the urgent need to address climate change, congestion and air pollution problems.

This Publicly Available Specification (PAS) defines requirements for developing and implementing a WTP, including public availability, resources and claims of conformity.

It is intended for use by any organisation planning or developing WTPs and applies to all WTPs and all the situations in which WTPs are initiated, developed and implemented. This includes WTPs:

- initiated as part of an organisational policy to manage transport impacts for the benefit of staff, the environment, corporate social responsibility, the reduction of congestion, the better management of parking and to foster good relationships with neighbours
- submitted with planning applications and/or transport assessments as part of the development control process
- designed to reduce pollution from motor vehicles as part of an air quality strategy.

PAS 500 is applicable in all situations where the term "travel plan" is likely to be used and is deemed relevant to all those involved in the travel plan process. It applies to all the main components of transport generated by a particular site. These include:

- commuter trips made by staff
- trips made by staff in undertaking their duties
- visitors to the site
- contractors involved in carrying out projects at a particular site

- students travelling to university and college campuses
- trips made by all those carrying out work related tasks at premises covered by the travel plan
- trips made by delivery vehicles.

WTPs generate benefits to the business, the local economy, the individual members of staff, the community, the environment and increase the quality of life for all those who live and work in the area or location addressed by the travel plan

Source: http://shop.bsigroup.com/ProductDetail?pid=000000000030180397

11.28 The combination of policies, interventions and measures described by the then Highways Agency, the WebTag requirement to consider wider networks and modes and the government's smarter choices agenda have a great deal to offer to deliver all transport policy objectives in and around Newport and on the key strategic Newport-Cardiff corridor. It is regrettable that they have not been pursued with vigour, substance and determination and have not been appraised in a clearly audited fashion so that all observers can see how they perform in comparison to the M4 relief road.

11.29 It is also impossible to demonstrate a sound business case for the M4 relief road and Value for Money superiority when a large number of non-road building options, public transport improvements and behavioural change interventions have been given such a low priority and not worked up as valid alternatives to highway construction.

12 Conclusions

12.1 The M4 relief road around Newport has been promoted and justified on the grounds that it will reduce congestion and contribute to local economic viability in the Newport area and in the wider sub-region.

12.2 I have shown that the project as a whole is not in conformity with Welsh Assembly Government sustainability policies (section 8)

12.3 This non-conformity is a serious departure from legislative intention (Environment Act (Wales) 2016)) is a serious matter. It is even more serious that it is a specific WAG decision made in the full knowledge that there are many low carbon and zero carbon alternatives to the most damaging option, the one that is before this Inquiry. This perverse and unreasonable decision brings the whole UK and WAG governmental effort on climate change into disrepute and should be brought to a halt.

12.4The M4 relief road is directly contrary to WAG, UK government and EU climate change policies and renders the task of reducing greenhouse gases much more difficult than it need be and represents a serious departure from legislative commitments. It is perverse and unreasonable for a well-directed Government to sign up to serious Climate Change policy objectives and then identify a preferred project option that maximises those same greenhouse gases that it is committed to reduce.

12.5 I have shown (section 9) that there is a remarkably robust and wide ranging body of evidence on the impact of road building and adding additional highway capacity and the outcome that additional traffic levels are generated. The so-called "induced traffic" impact is clear and evidence-based. The M4 relief road proposal has not adopted a rigorous review of induced traffic and incorporated the findings from ex-post empirical evidence into the development of a road building option and the exclusion of non-road building options. The lack of attention to induced traffic means that congestion level will not be reduced and a great deal of public money will be deployed in ways that cannot deliver the primary objectives of the project. It also means that VFM and BCA calculations are unsound and it cannot be right to proceed with a project based on flawed VFM and BCA calculations.

12.6 I have shown (section 10) that assumptions and aspirations around a local economic stimulus and/or a regeneration benefit triggered by new road building is unproven. It is also likely that new road building will drain away economic activ-

ity as a result of improved connectivity with stronger regions. This finding is contained in the 1994 SACTRA report, a UK government report, and remains unchallenged. It is unacceptable that a major public investment of the scale contemplated by the matter before this Inquiry should proceed when there is an evidence base pointing to highly uncertain and contradictory outcomes that have not been addressed by the promoters.

12.7 I have shown (section 11) that there is a well-developed approach to Transport Appraisal in the UK. This is described in WebTag. This is based on very clear steps involving a wide ranging option listing process that incudes all modes and non-road building alternatives. This process has not been followed in the case of the M4 relief road. The proposal is not in conformity with guidance on Transport Appraisal and it is not acceptable to proceed with a very expensive project that has so blatantly ignored guidance.

12.8 The M4 relief road has been promoted and developed in an evidence-free environment and cannot deliver its key objectives. It is a road building solution to a complex web of problems that has ignored the large number of ways in which specific problems can be clearly described and specific solutions based on evidence can be designed to target those specific problems. It is very expensive and deeply flawed and has been justified on inaccurate VFM and BCA calculations.

12.9 There is a very strong case for going back to the drawing board and designing solutions to problems where there is evidence that they do work and they do have very high BCA ratios. South East Wales and the Newport sub-region require an intelligent, evidence based answer to a number of problems and this new road is neither intelligent nor evidence-based. Progress in a genuinely sustainable development and sustainable transport context focussing on sub-regional problems and needs requires this road proposal to be rejected and we can all begin to work on interventions that will deliver key objectives.

12.10 It is also contrary to legislative commitments and should be rejected.

Author email:
johnwhitelegg@phonecoop.coop

Plate 10: Ontario highway 401, Canada

Does Transport Investment Really Boost Economic Growth?

Dr Steve Melia

Abstract

The SACTRA (1999) report on Transport and the Economy found strong theoretical grounds for believing that transport investment could boost national economies but that the empirical evidence was "weak and disputed". This study asks whether a different conclusion should be drawn today.

The different approaches to evaluating the relationship between transport investment and economic output are reviewed: cross-sectional and time series, regional, cross-regional and national. The range of elasticities calculated is large: mostly positive but sometimes negative. There is fairly strong (but highly variable) evidence that transport investment (measured in a variety of ways) can influence local economic output and/or employment. At national levels there is strong evidence of cross-sectional and longitudinal associations between these factors but the issue of causality (what causes what?) remains unresolved.

Various methods used to address the issue of causality are reviewed. Studies using Granger causality produce mixed findings; in some cases economic growth precedes transport investment; in others transport investment precedes economic growth. Some local or regional studies have found negative 'spillover effects' of transport investment on surrounding areas. None of the studies reviewed has empirically demonstrated that transport investment boosts national GDP or employment growth. Claims to that effect are (still) based on theoretical analysis, which should be treated with caution for several reasons, particularly: the aggregation problem and deadweight loss. The aggregation problem means for example, that increased productivity in the area around a new road will not necessarily increase national production. Deadweight loss is the negative economic impact of taxation, or deferred taxation when infrastructure is financed by borrowing.

Given the uncertainty surrounding these findings, the study concludes that claims made about the national economic benefits of transport investment are not robustly supported by the underlying evidence. It is more appropriate to view transport investment as a facilitative factor rather than a causal factor.

1 Policy Context and Purpose of the Article

In 1999 the Standing Committee on Trunk Road Assessment of the UK Parliament conducted a comprehensive review of the evidence on the relationship between transport and the economy. They found "a strong theoretical expectation" that transport investment would lead to a "range of different wider economic impacts" but that quantitative empirical evidence was "weak and disputed" (SACTRA, 1999 p. 7-8). They concluded that in mature economies the impact of transport investment was "likely to be modest" but emphasised the uncertainties and dependency on "local circumstances and conditions".

In 2005, the UK Department for Transport published a consultation document with proposals to update the project appraisal system to capture wider economic benefits from transport investment (DfT, 2005). They noted SACTRA's reservations about the evidential uncertainties but stated that "positive wider economic benefits are more likely" because of imperfect competition, which left scope for infrastructure improvements to boost the economy. In more recent years, the UK government has significantly increased spending on transport infrastructure, particularly road building (and longer-term plans for high speed rail), emphasising the economic benefits expected to flow from this investment, including growth in: GDP, productivity and employment (H M Treasury, 2013, DfT, 2017a, DfT, 2017b). In its plans for nationally significant infrastructure projects, the Treasury sets out three criteria one of which states that projects must "have the potential to drive economic growth" (H M Treasury, 2016 p.17).

WebTAG, the project appraisal system used in England (and with some variations in other parts of the UK) today enables es-

timates of 'wider economic impacts' to be added to the monetised benefits of proposed projects, increasing their Benefit to Cost Ratios (BCRs) (DfT, 2014). The validity of this procedure has been a key issue of contention at a recent public inquiry into a proposed extension to the M4 motorway in Wales, in which the author gave evidence (Melia, 2017).

The aims of this paper are to consider whether the evidence available today might lead to different conclusions from those of SACTRA (1999) and to analyse the policy implications of what is known and not known about the relationship between transport investment and the economy. Section 2 outlines the theoretical reasons supporting and challenging the view that transport investment boosts national economies. It concludes that a positive relationship cannot be inferred on theoretical grounds (as DfT 2005 did); empirical evidence of the relationships and causal mechanisms is needed.

Section 3 briefly summarises some of the more recent empirical evidence and its interpretation. It takes as its starting point four recent meta-analyses (Melo et al., 2013, Bom and Ligthart, 2014, Holmgren and Merkel, 2017, Elburz et al., 2017) and two analytical summaries (Venables et al., 2014, Laird and Venables, 2017) Venables et al., (2014) was written for the DfT, who have cited it in support of their approach (DfT, 2017b) as did the Welsh Government at the M4 inquiry (Welsh Government, 2017b).

Section 4 discusses the implications of the evidence and uncertainties for transport appraisal and national transport policy, using the UK as an illustration although the principles would also apply elsewhere.

2 Theoretical Frameworks and their Limitations

Most of the literature in this area starts from a neoclassical framework, assuming rational, utility-maximising firms and individuals, for example. This analysis will begin by accepting that framework; where some of the assumptions underlying that framework have been contested, the implications will be discussed. The appropriateness, desirability and even (in the long-term) feasibility of GDP growth have all been contested (Meadows et al., 1972, Jackson, 2009), but that will not be discussed here. As GDP growth is a stated objective of governments in the UK and elsewhere, the aim is to examine the effectiveness of pursuing that objective through investment in transport infrastructure.

Following Laird and Venables (2017) the main theoretical reasons for hypothesising a (positive) relationship between transport investment and GDP are as described below. That study was concerned with welfare benefits, including private user benefits, which do not directly contribute to GDP, but in other respects the framework is appropriate. As much of this literature (particularly in the UK) has been concerned with refining the process of CBA for transport appraisal, a distinction has often been drawn between business user benefits and the other headings below. Business user benefits will be directly measured by a CBA, whereas the other mechanisms would only influence CBAs if an additional adjustment is made to reflect 'wider economic impacts' (as suggested by DfT, 2014).

It is often stated (by Venables et al., 2014 and, DfT, 2005, for example) that these additional impacts can only occur where market imperfections exist. This presupposes a counterfactual of perfectly competitive markets, where all of the benefits would be captured by the user benefits. It implies that the perfect (presumably private) market would supply all necessary transport infrastructure. A more realistic assumption is that some factors of economic life, such as land-use planning and transport infrastructure, are necessarily controlled or influenced by public authorities. Where one or more of these factors is constraining economic output, then public investment may facilitate increased output.

Section 4 will return to the question of CBA and 'wider economic impacts' after considering the main question – whether transport investment causes change in national economic output. The four mechanisms

below overlap and may be difficult to isolate. To answer that main question we do not necessarily need to separate them – identifying their combined impact would be sufficient.

2.1 Positive Mechanisms of Transport Infrastructure Investment

2.1.1 Business User Benefits
The largest element of economic benefits from most large transport projects tends to flow from direct user benefits, including the value of business time saved and other savings from reduced transport costs. These savings are presumed to be a direct benefit to businesses, which will increase GDP through increased output (and productivity) and/or increased profits, the latter being more likely in imperfect markets where producers exercise market power.

2.1.2 Productivity Increases through Proximity and Agglomeration
A substantial literature has demonstrated a positive relationship between economic density – the clustering of economic activity in towns and cities – and output. Rosenthal (2004 based on a review of earlier studies) estimated that doubling the size of a city is associated with an increase in output of between 3% and 8%. Melo et al., (2009) also found a positive relationship, although there was evidence of positive publication bias amongst their sample of studies. Several reasons have been hypothesised to explain agglomeration effects; Puga (2010) concluded that the literature had been relatively unsuccessful in distinguishing between the different reasons for it but factors are believed to include: greater availability of skilled labour, clustering of specialised suppliers, and increased innovation (Gordon and McCann, 2005).

Expansion of a conurbation in order to access those gains will generally require some investment in transport infrastructure. It has also been inferred that transport improvements, which reduce generalised travel costs for businesses and employees (the proximity effect), can extend the geographical reach of these agglomeration benefits, particularly into the hinterland of city regions (Gordon and McCann, 2005).

2.1.3 Labour Market Improvements
Transport improvements may increase labour supply, by increasing the pool of employees available to employers at particular locations, and also because some people who were previously unemployed might decide that travel to a job opportunity becomes worthwhile.

2.1.4 Land-Use Changes
Where transport infrastructure is constraining the development or redevelopment of land, improvements to that infrastructure may facilitate increased economic activity on that land. Greenfield industrial development and urban intensification around transport hubs would be two examples. Agglomeration benefits would only be one part of the additional output generated.

2.2 Countervailing Mechanisms

Although the explanations above seem plausible there are several countervailing mechanisms, which complicate the picture. Seven of these mechanisms will be considered in turn.

2.2.1 Deadweight Loss
Deadweight loss is the additional burden placed on an economy by taxation. In the illustrations provided by SACTRA (1999 p.48) the cost of financing investment in a transport project was assumed to fall on (undefined) transport users. This causes travellers to reduce their number of trips, and by implication transport suppliers to reduce their output. Similar analyses would apply to most forms of taxation (land taxation is a more complicated exception). The overall implication is that raising £1bn from taxation will cause an economy to shrink by more than £1bn, counterbalancing whatever benefits are obtained from the additional public spending.

2.2.2 Opportunity Costs
A related issue is the opportunity cost of other public spending foregone. If budget constraints in other areas (public housing, for example) are constraining output then spending more on transport at their expense may reduce GDP growth. The use of CBA across all forms of public spending would not necessarily address that problem. Even assuming that all CBAs were

correctly calculated and that only those projects with the highest BCRs were implemented (which is not the case for transport projects in the UK: Eddington, 2006) a large part of CBA benefits derive from private user benefits, which do not directly affect GDP.

2.2.3 The Aggregation Problem

A defining feature of the neoclassical framework is that macroeconomics is grounded in microeconomics, so that an aggregate demand function for a national economy can be derived from demand in individual markets. This implies that a transport improvement that reduces costs in one or more local markets (and does not increase costs anywhere else) would cause a small increase in the size of the national economy. This aggregation mechanism is one of several assumptions, which have been contested by economists from outside the neoclassical paradigm, who argue that the relationship between micro markets and the macro economy may not be derived in that way; the relationship may be unpredictable and unstable (see for example: Keen, 2011). Assessing the validity of the aggregation assumption would fall outside the scope of this article; we may simply note that it is contested.

2.2.4 Induced Traffic

The largest part of the economic benefits from road schemes usually derives from time savings, which may be eroded if the road expansion induces more traffic and increases congestion. An earlier report from SACTRA (1994) confirmed the traffic-inducing properties of road expansion, a conclusion which has never been seriously challenged since then, although the magnitude and patterns of induced traffic remain uncertain and contested (Sloman et al., 2017, Highways Agency, 2013). Induced traffic will erode the time-saving benefits of road capacity expansion on which the first three of the positive mechanisms above all depend. Mogridge (1997) has demonstrated how road expansion in urban areas may increase overall congestion. Road capacity expansion is likely to increase the total volume of travel and hence the total user benefits, even if congestion increases. However most trips in the UK are for non-business purposes (DfT, 2016a) so the main impacts of road capacity expansion may be an increase in private user benefits, a loss of business time and an increase in the transport costs of businesses. The net effect of those three changes could be a reduction in GDP.

2.2.5 Spatial Changes and Urban Sprawl

Transport infrastructure investment changes the spatial distribution of economic activity, although not always in expected ways. The "two way road" problem discussed in SACTRA (1999) can cause economic activity to shift away from areas where roads are improved. Road-building (in particular) enables conurbations to expand; this is an essential element of the agglomeration benefits explained above. It may also enable conurbations to 'sprawl' i.e. to reduce in density or concentration, imposing higher costs, particularly on public services, which must be paid for through taxation or charges (Burchell et al., 2002, Balaguer-Coll et al., 2013).

2.2.6 Constraints as a Spur to Innovation

Conventional CBA assumes that a constraint on economic activity (current or planned) will reduce that activity. So if firms are subject to higher costs because of road congestion, or measures aimed at reducing traffic to avoid road building, they will reduce their output and possibly raise their prices. Porter (1991) proposed what became known as 'the Porter Hypothesis': that environmental regulation may spur innovation, increasing output in ways that were unforeseen when the regulations were introduced. The hypothesis remains controversial but there is some evidence to suggest that it does occur in practice (Ambec et al., 2013). If so, then similar mechanisms may apply to constraints on movement, whether these result from demand management measures or passive constraint due to congestion. Constraints on movement which encourage clustering within larger cities may be one explanation for the greater incidence of innovation observed within such cities (part of the agglomeration effect).

2.2.7 Climate Change and Longer-term Uncertainties

Where road-building or other transport investments cause increases (or prevent reductions) in carbon emissions, they may contribute to climate change with serious

longer-term implications for economic output as well as human welfare (Stern, 2006). Whether mechanisms such as carbon pricing (incorporated into WebTAG) will prove effective in averting climate change may be open to doubt. These longer-term uncertainties do not feature in the empirical analysis outlined below.

2.2.8 Implications of the Countervailing Mechanisms

The magnitude and prevalence of the countervailing mechanisms are as contested and uncertain as the four positive mechanisms. For this analysis it is not necessary to prove or to quantify those countervailing mechanisms, only to note that they might occur in practice and that collectively they might outweigh the positive mechanisms. If so, a positive impact of transport investment on GDP cannot be cannot be assumed based on theoretical analysis, nor can it be inferred (or quantified) from evidence on the individual factors. So for example, evidence of increased productivity of businesses around a new road or railway station does not demonstrate that the road or railway has caused an increase in national GDP. Empirical evidence of the overall impacts and causal mechanisms is needed.

3 Empirical Evidence and its Interpretation

3.1 Evidence from Recent Meta-Analyses

A vast and growing number of studies have examined relationships between various measures of transport investment (or in some cases, transport volumes) and various measures of economic output. This section will briefly summarise some of the most recent evidence.

The last two meta-analyses listed in Table 1 build on the earlier two; Holmgren and Merkel (2017) include all the studies used by Melo et al. (2013) plus some additional studies. Most of the underlying studies analyse changes in national economies, of one or several countries; some use regional data instead or as well as national data. Elburz et al. (2017) focus specifically on the regional studies. Most of the studies focus on road infrastructure; some also consider other modes. Most of the studies include some breakdown by industry sector and/or mode of transport investment. Cross-sectional, panel and time-series studies were included. Most use GDP as the measure of output; some use GVA (Gross Value Added) and a few use employment.

The underlying studies generate a wide range of elasticity estimates, with more positive than negative. Elburz et al. (2017) found 45% of estimates were positive, 11% were negative and 44% were insignificant. Holmgren and Merkel (2017) found 23% of estimates were negative.

There is no clear consensus on which types of investment are more likely to produce what types of impact or where. Melo et al. (2013) found significant differences in the impacts on different industry sectors and they found stronger positive impacts in the US than in European countries. By contrast Elburz et al. (2017) found stronger positive impacts in Europe and no significant differences between industry sectors. Bom and Ligthart (2014) found mainly positive "spillover effects" from regions benefiting from infrastructure improvement towards their surrounding regions, whereas Elburz et al. (2017) found mainly negative regional spillover effects.

3.1.1 Publication Bias

Publication bias, already mentioned in the context of agglomeration effects above, was also investigated by three of the four meta-analyses. By comparing the estimates of output elasticity and their standard errors Melo et al. (2013) found no evidence of publication bias, whereas

	Studies	Estimates
Melo et al. (2013)	35	563
Bom and Ligthart (2014)	68	578
Holmgren and Merkel (2017)	78	776
Elburz et al., (2017)	42	912

Table 1: Numbers of Studies and Elasticity Estimates Used in Recent Meta-analyses

Bom and Ligthart (2014) and Holmgren and Merkel (2017) both found evidence of publication bias, weighted towards more positive impacts. Holmgren and Merkel (2017: abstract) note that "the estimated effects exhibiting high precision are clustered around zero. This is to say that the higher the reliability of the estimate, the closer it is to zero."

3.1.2 What Causes What?

All of the meta-analyses recognise the problem of "reverse causality" that GDP growth might influence investment in transport infrastructure, instead of, or as well as, vice versa. The language used to describe this issue is revealing. Melo et al. (2013) talk about "correcting for reverse causality" (Melo et al., 2009 p. 704); Holmgren and Merkel state that "the relationship between infrastructure and GDP might actually be reversed" (Holmgren and Merkel, 2017 p. 15). Reflecting the assumption of the underlying studies, these statements imply a nul hypothesis, that association between the variables is primae facie evidence of transport investment boosting economic output unless there is evidence of reverse causality.

Only a minority of the underlying studies attempt to correct for reverse causality. A few more recent studies which have specifically investigated this problem using Granger causality tests (essentially testing what came first – the investment or the GDP growth); these have produced mixed results. Beyzatlar et al. (2014) found mainly bi-directional causality for the EU-15 countries between 1970–2008. Meersman (2017) found uni-directional causality from transport investment to economic output for Belgium for the period 1980 to 2012. Maparu and Mazumder (2017) found uni-directional causality from economic output to transport investment for India between 1990 and 2011.

3.2 Interpretations of the Evidence

Faced with this inconclusive picture Bom and Ligthart (2014) prefer to interpret their findings as evidence of a positive causal relationship, notwithstanding the evident uncertainties (a position also taken by some earlier meta-analyses e.g. Bhatta and Drennan, 2003). Melo et al. (2013) avoid using the language of causality but conclude that public investment in transport infrastructure is associated with a "modest" increase in output. Elburz et al. (2017) come to no direct conclusion on the substantive question preferring to "give a clear picture of the model building process" that should be followed. Holmgren and Merkel (2017) urge caution, pointing to the strong political forces favouring a positive interpretation, which may explain some of the publication bias they found. They criticise the practice of adding 'wider economic impacts' to CBAs and conclude that macro-studies of this kind are "not a good instrument for deciding which projects to invest in the future" (Holmgren and Merkel, 2017 p. 21).

In their report for the DfT Venables et al. (2014) conclude that there is strong evidence that transport investment can influence the location, and possibly the overall quantity, of economic activity but nowhere do they state that empirical evidence has demonstrated this (an interpretation that was placed on that report by counsel for the Welsh Government in the M4 public inquiry). Laird and Venables (2017), a related article, concludes that "transport investments are likely to have impacts (positive and negative) over and above conventionally measured user-benefits" but emphasise the uncertainties and knowledge gaps that still exist.

4 Implications of Uncertain Evidence

Although the review in Section 3 is not exhaustive, it is sufficient to illustrate that the claim that public investment in transport infrastructure boosts national economies has not been proven. The proliferation of studies and meta-analyses has not resolved the fundamental uncertainties, which led SACTRA (1999) to write of "weak and contested" empirical evidence. Their reference to the importance of local conditions also remains valid but neither the theoretical nor the empirical evidence shows how the causal impacts of local infrastructure improvements on national economies can be robustly measured.

Research evidence in the social sciences is rarely conclusive; conclusions usually involve interpretations of uncertain evi-

dence. The key question in this case is whether the elasticities – more positive than negative – coupled with evidence of the positive mechanisms outlined in Section 2.1 should be sufficient to infer that transport investment can, or does, boost national economies. Section 2.2 gave some reasons for treating the theoretical arguments with some caution. Possible publication bias is one reason for treating the empirical findings with caution. There are some others.

4.1 What Causes What? Still Unresolved

Most studies in this field start from an assumption that associations between transport investment and GDP growth are primae facie evidence that the former causes the latter. A few test for "reverse causality". If we take a longer-term view, the opposite would be more logical. The resources to pay for transport infrastructure are all generated by the economies it services. In the longer-term it is difficult to conceive how transport infrastructure could continue to expand without economic growth, whereas the opposite scenario, where economic growth is 'decoupled' from transport infrastructure growth is conceivable, whether it has actually occurred or not.

Where tests of Granger causality are correctly performed (in a minority of studies) the initial hypothesis is less important. Those studies have been inconclusive but testing which factor changes first would not necessarily establish the direction of causality in any case, for at least two reasons:

- Where public authorities upgrade transport infrastructure in areas or regions where development is planned (if the plans are fulfilled) economic output will increase in those locations, whether the transport infrastructure helped to cause the increase or not. This would affect those studies that use regional or local data.
- The relationship between taxation and public investment is complicated by the abilities of governments to borrow and print money. Public spending that is not directly financed by taxation will boost economic output in the short-term, regardless of the form that spending takes. Where governments decide to expand public infrastructure during, or immediately following, recessions (as the UK government has done in recent years) the investment is likely to be followed by economic growth, whether the former causes the latter or not. This would affect studies that use national data.

For these reasons we should expect to find more positive than negative elasticities of economic output with respect to transport investment (or vice-versa). Such findings tell us nothing about the causal relationships.

4.2 Wider Economic Impacts and Transport Appraisal

Following the guidance in WebTAG it has become more common to estimate wider economic impacts from major transport projects and to add these to boost the project BCRs. In the Welsh Government's case for the M4 extension these increased the overall BCR from 1.62 to 2.34, tipping the project over the critical threshold of 2.0, which the UK Government describes as 'high value for money' (Welsh Government, 2017a).

Adding the wider economic benefits to a project BCR in that way would only be valid if it was known that those wider benefits would be entirely additional at the national level. In 2016 the DfT consulted on updated WebTAG guidance, which included a default assumption that any economic benefits created by a transport project would be entirely displaced from elsewhere unless promoters were able to "present credible evidence of additionality" (DfT, 2016b p. 3). This effectively invites scheme promoters or their consultants to demonstrate what decades of international research has failed to demonstrate: that local investment in transport infrastructure can cause increases in national GDP (or employment). The procedures recommended to demonstrate additionality refer to positive mechanisms such as labour market improvements and agglomeration effects (DfT, 2016c, DfT, 2016d). The countervailing mechanisms outlined in Section 2.2, which might negate any additionality, are not mentioned in that con-

text. Based on the evidence reviewed in this article it is difficult to see how scheme promoters could demonstrate such claims – and quantify them with sufficient accuracy – in a robust way consistent with the wider body of research evidence.

Goodwin and Turley (2005), who interviewed transport planners following the publication of DfT (2005) found that boosting the BCRs, making schemes more likely to attract funding, was the main attraction of wider economic impact assessments for scheme promoters. There is a parallel here with the evidence of publication bias discussed above. The belief that transport infrastructure projects boost economic output is useful to many parties involved in transport planning, construction and even transport research. In such circumstances we should not be surprised to find scheme promoters reporting economic benefits that are additional at the national level.

4.3 Transport Policy In Pursuit of a Hope

The wider economic literature on the causes of economic growth is no more conclusive than the specific literature reviewed here. Different hypotheses are tested with interest focussed on different causal variables such as international trade (Singh, 2001), energy consumption (Soytas and Sari, 2003) education (Hanushek and Woessmann, 2012) and fiscal decentralisation (Thiessen, 2003), amongst others. In some of those relationships transport fulfils a facilitative intermediary role. If it does exert a causal impact, then compared to the range of other causal factors, its influence will be small.

In recent years in the UK, as in many other countries, promoting economic growth has become the principal objective of transport policy. This is mainly to be achieved through increasing road capacity to facilitate more movement by motor vehicles (DfT, 2017b, H M Treasury, 2013), a policy which conflicts with many social and environmental objectives (RCEP, 2007, Chapman, 2007). So current policies are effectively trading the certainty of environmental damage for the hope of a small increase in economic growth. The analysis in this paper suggests that hope may be illusory.

Although the claim that transport investment can cause higher GDP is unproven, there is clearly a causal relationship between economic growth and demand for transport infrastructure. The nature of that demand will vary depending on the type of economic growth. So in the context of a rising population low-density development on the edge of a city will create more motorised movements and hence more demand for road infrastructure whereas urban intensification will create more demand for public transport and sustainable modes, and a need to constrain urban traffic growth (Melia et al., 2011). To ask of individual projects in those two scenarios 'which ones will create the greatest economic benefit?' would be spurious; transport is not the primary factor causing economic growth in either scenario.

It is more valid, therefore, to view transport infrastructure as a facilitative factor, responding to the needs of the economy and society. There is always more than one way to respond to those needs. The current focus on economic benefits as the main objective of transport policy is obscuring the real challenge, of how to satisfy the mobility needs of a growing population on a land mass that is not growing.

Author email:
Steve.Melia@uwe.ac.uk

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Plate 11: Cattle, M6, England

Closing statement at the Public Inquiry by the Gwent Wildlife Trust, Friends of the Earth, CPRW and the Woodland Trust

The Zeitgeist

Wales, and the world, are facing a 'man-made perfect storm' of truly cataclysmic proportions, comprising synergistic crises of:

- catastrophic climate change (devastating hurricanes, droughts, floods, heatwaves and irreversible sea level rise), and.
- the mass extinction of biodiversity, or as one recent study calls it "biological annihilation", representing a "frightening assault on the foundations of human civilisation".

These crises unfold before our eyes as a steady process of environmental degradation - a phenomenon of subtle but relentless momentum – driven by the 'business as usual' forces which can be summed up as unsustainable development.

Halting the loss of biodiversity and avoiding increasingly dangerous levels of climate change will require unprecedented effort and coordination from governments, businesses, charities and civil society. This cannot be achieved without a major cultural shift in government away from short-term political expediency to a way of making decisions which gives much more regard to the needs of future generations.

Many countries, including the UK and Wales, have signed up to international Conventions and agreements to urgently tackle these issues. These international commitments include:

- The UN's Sustainable Development Goals[1]
- The Convention on Biological Diversity,
- The EU Biodiversity Strategy[2], and
- The Paris Climate Change Accord[3]

to name a few.

In fact, Wales has recently legislated to address these issues of biodiversity loss and climate change through important pieces of internationally acclaimed, world leading legislation, namely:

- The Well-being of Future Generations (Wales) Act 2015 - which legislates for sustainable development.

Nikhil Seth, Director of Division for Sustainable Development, Department of Economic and Social Affairs, United Nations said of this Act:

"The Wales future generations Act captures the spirit and essence of two decades of United Nations work in the area of sustainable development and serves as a model for other regions and countries. 'One Wales, One Planet' captures it all. We hope that what Wales is doing today the world will do tomorrow. ***Action, more than words, is the hope for our current and future generations.***[4]*"*

- The Environment (Wales) Act 2016 – which legislates to

- halt the loss of biodiversity and restore the resilience of ecosystems by requiring public bodies such as the Welsh Government to maintain and enhance biodiversity and the resilience of ecosystems, and
- combat climate change (reducing greenhouse gases in Wales by at least 80% by 2050)

These Acts are the considered resolution of the Welsh Parliament and should not be interpreted as mere window dressing. They are a legislative recognition that a changed approach is necessary and the way that things have previously been done was not working.

The Environment Act also requires NRW to produce a State of Natural Resources Report (SoNaRR) and Welsh Government to produce a Natural Resources Policy.

The first State of Natural Resources Report[5] (SoNaRR) was published in 2016 and stated[6] that:

- "many of our natural resources and the resilience of Wales' ecosystem are continuing to decline…
- It is unlikely that ecosystems across Wales have sufficient resilience and this will impact on their capacity to provide services and benefits into the future…

- all habitats have problems with all four attributes of resilience
- Natural resources are continuously declining or are being used faster than can be replenished
- The health and resilience of our ecosystems is being compromised; this includes targets not being met or 'limits' in danger of being breached"

Welsh Government produced the Natural Resources Policy[7] over the summer. This policy states that:

- To build resilience into our ecosystems we need to: Proactively develop resilient ecological networks to maintain and enhance the wider resilience of Wales' ecosystems. The evidence shows that diversity is declining and that land and sea use change, including *urbanisation, is leading to fragmentation and loss of habitats and species, and soil sealing. Building on the protected sites Wales, our aim is to improve resilience and reverse the decline of biodiversity in Wales. Reversing this trend, by better managing existing areas and creating new ones will also provide important wider benefits for society* (page 10)

- Through the Wales National Transport Strategy and Finance Plan *we are promoting a more sustainable road transport network and a modal shift away from roads for people and freight. This will reduce emissions and the impacts that transport has on our environment and our health.* We are committed to improving active travel opportunities and promoting public transport. In taking this action forward we will: take action on our transport network that enhances the resilience of our ecosystems and reverses the decline of biodiversity. We will also explore opportunities for wider ecosystem service delivery, such as carbon, water and flood management (Page 28).

The intention and spirit of the Acts is to drive radical change in how all public service decisions are made – a single shared purpose for Wales. Welsh Government itself is also accountable under the Acts, which presents a huge challenge to civil servants and Ministers.

It is not just the objecting bodies that hold this view, but the opinion of the person who is employed by Welsh Government to promote sustainable development by acting as guardian of the ability of future generations to meet their needs, the Future Generations Commissioner, Mrs Sophie Howe. Part of her role is to encourage public bodies, including the Welsh Government, to take greater account of the long-term impact of their actions. In her recent letter to the Inquiry, which challenges Welsh Government's M4 Team's interpretation of the Well-being Act, Sophie Howe stated that:

- I anticipate that applications not demonstrating how the sustainable development principle has been applied would not be progressed as they would not be compliant with the duty to carry out sustainable development under the Act.
- historically it has not been uncommon for the economic benefits to be given precedence but this is one of the reasons why legislation was needed to redress the balance between the different needs and the different core elements leading to decisions which are sustainable in the long-term.
- Under the Act, we must look for solutions which address the four pillars of well-being together and select the one which delivers best against the four pillars of well-being [Economic, Environmental, Social and Cultural]. One pillar cannot override the others.
- I expect public bodies to demonstrate that they are seeking to take decisions which deliver the best outcomes across all four pillars of well-being. The projects and decisions must contribute to all of them as if they were one. The new Act requires public bodies to take holistic decisions and to cease making decisions which harm critical elements of well-being, including social, economic, environmental and cultural elements.
- I would expect that decisions only contributing to one or two pillars of well-being to be disregarded.
- The balancing in this revolutionary Act means giving as equal as possible weight to each element and not allowing one to tip the scale…rather than an exercise of trade-offs. The Act moves us away from the traditional trades-offs approach to one of balancing in a more literal sense

Sophie Howe has also commented on the Natural Resources Policy statement, indicating the need to "*take action on our transport network that enhances the resilience of our ecosystems and reverses the decline of biodiversity"*. She also stated that *"The M4 proposals seem to directly contradict this policy statement as the scheme and the mitigation do not seem to support this aspiration"*.

The Commissioner states that the Welsh Government's M4 Team has provided the Inquiry with an "*incorrect interpretation of the Act*" but also that this incorrect interpretation *"could set a damaging precedent which could undermine the spirit and intention of the legislation".*

Regarding Welsh Government assessment that short term traffic needs out-weight long term environmental harm, Sophie Howe states *"This is clearly wrong as demonstrated by the letter of the law"* and that she *"would anticipate a decision which does not allow for this would be abandoned as not complying with the statutory duty".*

The scientific world now recognises that we have entered the Anthropocene epoch in which we are only today beginning to recognise the scale and permanence of the changes we have brought and, if unchecked, will continue to bring to our planet. Therefore, sustainable development, including acting on climate change and the protection of biodiversity, is the zeitgeist.

Anti-zeitgeist

We need to urgently change our actions and our mind-set if we are to address 21st Century challenges – biodiversity loss, climate change, social inequality, mental and physical health – many of which are intertwined. The new legislation identified earlier is required because 'business as usual', which could be termed unsustainable development or 'sustained development', created the crises we now face. This is why the Commissioner, in her recent letter to you stated "Business as usual is no longer an option".

Evidence from around the globe shows that building motorways to fight congestion doesn't work. Building a motorway to ease congestion has been likened to 'loosening your belt to fight obesity'. It may provide some short-term relief, but soon afterwards the extra road capacity generates more traffic than there was before. In the long term motorways just allow congestion to grow further: they don't reduce it. The evidence for this can be seen on every road journey, the M25, the M5 and M6, and closer to Newport on the M32. Every project has led to significant increases in road use and pollution. All projects have come unstuck when accidents occur creating gridlock for miles around and the increased levels of traffic encouraged by the projects are forced to find alternative routes.

The problems around Newport are not unique, and neither is the Welsh Government's proposed solution. The proposed solution is neither 'innovative' nor 'low carbon', both of which are required under the Well-being of Future Generations Act definition of a 'Prosperous Wales'.

However, regardless of the above and despite the major cultural shift that is required to avert these crises, the Welsh Government think that a motorway which tarmacs approximately 16kms of green fields, 10kms of which is nationally important wildlife sites, and has a huge carbon footprint, is a good idea.

We have listened to Welsh Government consultants advocate the necessity for new road schemes to relieve old road schemes with a logic that would tarmac the world - no matter what the consequences are for the landscape, biodiversity, climate change or the opportunity costs for the rest of society. The Welsh Government arguments are, in many cases, based on flimsy, non-existent or in some cases contradictory evidence. For example,

- Building more motorways leads to less congestion –
  - building a motorway to bypass a motorway ignores empirical evidence from the UK and around the world that proves building new roads actually creates more traffic.
  - the scheme is self-defeating because it attempts to address the symptoms of

a network traffic problem (congestion), not the cause (volume of traffic). You are not stuck in traffic – you are traffic. - it is not, as the Natural Resource Policy[8](page 28) states "promoting a more sustainable road transport network and a modal shift away from roads for people and freight"

• Building more motorways lead to jobs and inward investment – this degraded and simplistic assumption hides the deep-rooted causes of economic stagnation. This is highlighted not only by our witnesses but also in Welsh Government's National Development Framework – Integrated SA Scoping Report [9](Table 4-1 Key Sustainability Issues and Opportunities), which include the following as key reasons for Wales' relatively poor economic performance

- "Relatively low skills level and poor educational attainment levels (although improving), particularly in the more deprived parts of the country.
- The largely rural nature of the country resulting in relatively small urban areas which would otherwise be more strongly associated with agglomeration effects.
- The relatively high proportion of older people who are retirement age."

But it does not include Transport

There are far better ways of spending such a colossal amount of money to develop the economy of south-east Wales if that is the goal, as highlighted by the Federation of Small Businesses and the Future Generations Commissioner and our own expert witness, Professor Terry Marsden and Professor Calvin Jones.

Much of the benefits the Welsh Government associate with this new road rely on assumed time savings for drivers. Such time savings are often not statistically significant, and are not experienced as actual savings by real people and are also most susceptible to the impact of induced traffic.

There is little or no evidence to show economic gains that result from additions to the existing network in areas already well-served by good infrastructure such as the UK including south Wales.

• It is stated that the M4 relief motorway will 'maintain and enhance' biodiversity (section 86 of John Davies proof of evidence states "the Welsh Government has sought to maintain and enhance biodiversity") – building this 6 lane motorway over approximately 10kms of nationally important ecological wetlands will have a significant and long lasting impact on the SSSIs which cannot adequately be mitigated. Along with the direct loss of habitat beneath the concrete footprint of the motorway, one of the largest losses of SSSI land anywhere in the UK, the M4 bypass would rupture the essential cohesion of the place, acting as an impermeable barrier to all flightless wildlife, isolating wild animal populations on either side of the divide. However,

- Dr Keith Jones states "it is accepted, in spite of the comprehensive mitigation measures proposed, that it is not possible to entirely mitigate for the loss of complexity of the habitats of the SSSIs. Thus Chapter 10 Ecology and Nature Conservation of the March 2016 ES (Document 2.3.2) recognises that there would be a significant adverse long term impact on the Gwent Levels SSSIs as a result of the land take for the Scheme".

- John Davies, para 240, *"the Scheme… would conflict with planning policies in respect of cultural heritage, landscape, ecology and nature conservation. Consequently it would fail to meet the fourth part of the planning policy definition of the sustainable development principle in PPW* {Planning Policy Wales}, *respect for environmental limits"*

- As the Welsh Government document highlights, *"NRW considers the scale of permanent loss of SSSI in the Gwent Levels under the scheme is unprecedented and would not be in accordance with the statutory duties with respect to SSSIs under Section 28G of the 1981 Act and / or with respect to biodiversity and ecosystem resilience under Section 6 of the 2016 Act, and would be contrary to national planning policy*[10]*.*

• Building a motorway over 10kms of the Gwent Levels SSSIs will avoid "key environmental assets" is advanced by Matt Jones Evidence (section 17.5) and Ben Sibert. However, if they wanted to avoid the SSSIs then they should have avoided them by not putting the motorway across the Gwent Levels.

• Building a motorway will reduce greenhouse gas emissions is advanced by Welsh Government. However, spending either

- over half a million (Tim Chapmans - WG figures– section 4.3.13) with a potential and highly hypothetical date of 2072 – which could drift further out
- to 1m tonnes (Prof John Whitelegg – section 21) of carbon constructing the motorway, which may never be repaid,

will not help Welsh Government reduce greenhouse emissions by 80% by 2050.

John Davies MBE's evidence that this proposal is, of itself, not intended to reduce greenhouse gas emissions exposes the 'business as usual' approach of the Welsh Government to this issue. It is an admission that this issue, while being investigated by the Welsh Government, has effectively then been ignored by them so far as their requirement to address sustainability that is a requirement of law - Section 3(1) of the Well-being of Future Generations Act stating 'Each public body must carry out sustainable development.'.

• Building a motorway will benefit the well-being of Wales is advanced

- Welsh Government documents[11] (Page xi) admit that during its consultation process it received more comments against this motorway proposal than for it, however, it dismisses them without a trace of irony as possibly being "the result of interest groups' initiatives" while simultaneously championing the support they've received from corporate business and their 'consultation' exercises.

- Sophie Howe, the Future Generations Commissioner, Professor Terry Marsden, Professor Calvin Jones and Professor John Whitelegg amongst others believe that the motorway will not benefit the well-being of Wales.

- One of the 'ways of working' from the Well-being of Future Generations Act is 'preventative action' i.e. not to make things worse. However, in almost every conceivable way this scheme will make things worse, including climate change, ecology and transport.

The M4 Scheme is the continuation of 'business as usual', not only in the face of the historic failures of such projects to prevent the problems that they claim to solve, but now also set against the well-recognised harm to our planet that this course has contributed towards.

The Scheme is right out of the 1960s play book. We need to stop doing the same things over and over again and expecting different results - definition of insanity or – anti-zeitgeist if you will.

Our evidence

There are occasions when a campaign perfectly captures the zeitgeist. Our evidence has drawn attention to the fact that this scheme is not just unsustainable but hopelessly out of touch and in contradiction with,

• new legislation (Environment Act and Well-being of Future Generations Act), policies and commitments (National Resources Policy, Nature Recovery Plan, Paris Climate Change Agreement)
• the Well-being of Future Generations Commissioner's evidence
• even their own witnesses – with John Davies, the Welsh Government's 'sustainable development' 'expert' witness, saying it should go ahead even though the scheme doesn't 'respect environment limits' which is the very definition of unsustainability.

This non-conformity with Welsh Government sustainability policies and legislation is a significant departure from legislative intention and is a serious matter. It represents a deliberate decision that is contrary to legislation, made in the full knowledge that there are many low carbon, zero car-

bon, and less ecologically damaging alternatives to the most damaging option.

Together with partners we have brought in expert witnesses from the top of their disciplines to counter the case for a new road. Most of whom, like our barristers, acted unpaid, in a pro bono capacity such were their concerns.

From the ecological and landscape perspective, the following expert witnesses either appeared or submitted written evidence –

- Professor Sir John Lawton – Habitat Fragmentation
- Professor John Altringham - Bats
- Professor Neil Ward – Water Quality
- Lindi Rich – Gwent Wildlife Trust – Water Quality
- David Boyce – Invertebrates
- Geoff Liles – Otters
- Richard Bakere – Gwent Wildlife Trusts, Reserve Manager for Magor Marsh Nature Reserve which includes Barecroft Common.
- Mike Webb – from Gwent Wildlife Trust - Cumulative impact
- Richard Barnes – from the Woodland Trust – Ancient Woodland
- James Byrne – Wildlife Trusts Wales - Mitigation and Sustainable Development
- Peter Ogden, Director of the Campaign for the Protection of Rural Wales

From a climate change perspective – due to the significant greenhouse gas emissions that the construction of the motorway alone would create - we called

- Professor Kevin Anderson
- Professor Lorraine Whitmarsh
- Professor John Whitelegg

From a traffic perspective - due to the weak case on traffic forecasting we called

- Professor John Whitelegg
- Gerald Kells – Friends of the Earth

From an economic perspective – due to the weak economic case for construction of the Motorway we had

- Professor Calvin Jones – who highlights the deep-rooted causes of economic stagnation in Wales, none of which is related to transport.
- Professor John Whitelegg

From a sustainable development perspective – due to the unsustainable nature of the scheme, and that it is at odds with the Well-being of Future Generations Act - we called

- Professor Terry Marsden - a Professor in sustainability who repeats that the proposed road is unsustainable, and that the blue route is a less damaging alternative
- All of the witnesses mentioned above contributed to the case against the motorway being a sustainable option.

Ecology

Here follows a summary of the Gwent Wildlife Trust evidence presented on ecology – as well as points on cross examination. It is worth highlighting that Dr Keith Jones – who was the main ecological consultant for Welsh Government could not be cross examined by Gwent Wildlife Trust and therefore we invite the Inspectors to give his evidence the appropriate level of weight. Mr Jonathan Davies, by his own admission a generalist ecologist, stepped in to assume some of Dr Jones evidence.

Before delving into the evidence on ecology it is worth highlighting the important context to our evidence;

WWF Living Planet Index (2016)

This report states that global biodiversity is declining at an alarming rate, putting the survival of other species and our own future at risk. The Living Planet Index[12] reveals that:

- global populations of fish, birds, mammals, amphibians and reptiles declined by 58 per cent between 1970 and 2012.
- We could witness a two-thirds decline in the half-century from 1970 to 2020 – unless we act now to meet global commitments on addressing climate change, protecting biodiversity and supporting sustainable development. That is the world seeing two thirds of the species that have evolved over millions of years

finding that they are no longer able to survive on this planet.

Biological annihilation

A peer reviewed, scientific study published in the journal Proceedings of the National Academy of Sciences by Ceballos et al[13] (July 2017), states that:

- "biological annihilation", caused by habitat destruction, toxic pollution and climate change, of wildlife in recent decades means a sixth mass extinction in Earth's history is under way and is more severe than previously feared. This is further strengthened by strong wording in the paper, highlighting that this represents a "frightening assault on the foundations of human civilisation".
- They analysed both common and rare species and found billions of regional or local populations have been lost
- They conclude: "The resulting biological annihilation obviously will have serious ecological, economic and social consequences. Humanity will eventually pay a very high price for the decimation of the only assemblage of life that we know of in the universe."

State of Nature

The State of Nature 2016[14] Report (which echoed the State of Nature 2013[15]), written by a coalition of more than 50 leading wildlife charities and research organisations, including The Wildlife Trusts, assesses the status of wildlife in the UK at land and sea. It shows, more clearly than ever before, that nature is in serious decline across the UK. Over the last 50 years,

- 56% of species have declined, while 15% are at risk of disappearing from our shores altogether.
- 57% of vascular plant species declined in Wales
- 60% of butterfly species declined in Wales
- 40% of birds have decline in Wales
- 53% of freshwater and wetland species declined over the long term
- 13% of freshwater and wetland species are threatened with extinction from Great Britain.
- In a global measure of the degradation of natural ecosystems – Wales is in the 'top' quarter (49th) for biodiversity loss of the 218 countries assessed

State of Natural Resources Report

The State of Natural Resources Wales[16] report, by NRW, the first statutory product from the Environment (Wales) Act states that:

- Ecosystem resilience in Wales…Overall, diversity is declining, which is shown by loss of habitats and species. The 'extent' of some habitats has also declined significantly…. 'connectivity' has greatly reduced. All ecosystems have problems with one or more attributes of resilience. This means that their capacity to provide ecosystem services and benefits may be at risk. No ecosystem, on the basis of our assessment, can be said to have all the features needed for resilience
- 63% of all freshwater water bodies defined by the Water Framework Directive were not achieving good or better overall status
- only one out of six freshwater habitat types are in Favourable Conservation Status

The Natural Resources Policy

The second statutory product from the Environment (Wales) Act is the Natural Resources Policy[17]. This policy states the following:

- Page 10 - To build resilience into our ecosystems we need to:
  Proactively develop resilient ecological networks to maintain and enhance the wider resilience of Wales' ecosystems. *The evidence shows that diversity is declining and that land and sea use change, including urbanisation, is leading to fragmentation and loss of habitats and species, and soil sealing. Building on the protected sites Wales, our aim is to improve resilience and reverse the decline of biodiversity in Wales. Reversing this trend, by better managing existing areas and creating new ones will also provide important wider benefits for society.*

This aligns with the Welsh Governments Nature Recovery Plan.

• Page 28 – Transport -
Through the Wales National Transport Strategy and Finance Plan we are promoting a more sustainable road transport network and a modal shift away from roads for people and freight. This will reduce emissions and the impacts that transport has on our environment and our health…. taking this action forward we will: take action on our transport network that enhances the resilience of our ecosystems and reverses the decline of biodiversity. We will also explore opportunities for wider ecosystem service delivery, such as carbon, water and flood management

Biodiversity and Resilience Ecosystem Duty

The Environment (Wales) Act introduced 2 new requirements on public bodies:

• Section 6 - Biodiversity and resilience of ecosystems duty – a duty on public authorities to 'seek to maintain and enhance biodiversity' so far as it is consistent with the proper exercise of those functions. In so doing, public authorities must also seek to 'promote the resilience of ecosystems'.
• Section 7 - Biodiversity lists and duty to take steps to maintain and enhance biodiversity - The Welsh Ministers must also take all reasonable steps to maintain and enhance the living organisms and types of habitat included in any list published under this section, and encourage others to take such steps.

Gwent Levels

It is easy to forget due to the vast amounts of reports and technical detail at this inquiry, just how special the Gwent Levels are – both for people and wildlife. Therefore, before we dive into a summary of the above witnesses and concessions from Welsh Government, we must highlight what the Gwent Levels are and what they mean to people.

The Gwent Levels is one of the jewels in the crown of Wales, with immense cultural and historic significance. They are a unique, low-lying area wedged between the river estuary and the hills that rise to the north and are a designated cultural monument in Wales, a Landscape of Outstanding Historic Interest. They are an ancient, hand-crafted mosaic of fields, villages and grazing marsh, riddled by narrow waterways, which has been reclaimed from tidal saltmarsh since Roman times. Most of the present-day reens are medieval in origin, some of them the work of monks who lived and worshipped on the Levels.

The Gwent Levels reflect the long and evolving relationship between coastal people and the sea and highlight the uniqueness of the historic, human-shaped landscape. They include an evocative line of majestic old sallow trees that are believed to have sprouted from the willow mats laid down by monks attached to Tintern Abbey when crossing a particularly wet field to reach their grange farm near Magor Marsh.

The Gwent Levels have been studied by archaeologists who have painstakingly sifted through alluvial silt to reveal boats from the Roman period buried miles inland or the astonishingly preserved Mesolithic footprints of the intertidal zone, the 7,500 year-old steps of adults and children[18] off the coast, as well as those of various wild animals, including the common crane.

Reens, from the Welsh rhewyn, is the local word for the watery ditches that criss-cross the landscape like arteries These are the primary feature of a complex drainage system, dug over many centuries, and which included a subtle variety of components, from parallel field depressions known as ridge and furrow to shallow surface grooves called grips. On a map of the region the reens appear in bewildering blue numbers, like a dense grid of city streets, carrying water from the uplands and local springs safely out to sea in order to protect the reclaimed land from flooding. It is these earthen-banked ducts that set the Gwent Levels apart, making them both culturally and ecologically unique.

The rare and complex wetland habitat is nationally important for its wildlife and is protected by national designations that encompass very rare water beetles and other aquatic bugs and wetland plants that live in and around the area's network of ditches and reens.

The list of species that live here - plants, fish, invertebrates, mammals and birds – is impressive. The Gwent Levels is a landscape that has been fizzing with a density of life comparable with the rainforests for hundreds, if not thousands of years. Each reen is subtly different. There are fast ones, slow ones, shaded ones, not so shaded ones, providing a massive variety of reens which suit a wide variety of invertebrates.

Each reen is wholly unique, supporting a singular cast of aquatic organisms according to the reen's physical characteristics, as if each waterway were a stage for a different play. They contain an extraordinary ecological diversity and vitality of the Gwent Levels, home to an enviable range of species from the totemic otter to the rootless duckweed, Wolffia arrhizal, the world's smallest flowering plant that's found nowhere else in Wales, so tiny that you could hold thousands of them in your cupped hands.

In recognition of the remarkable ecological richness, the Gwent Levels are listed as a suite of eight adjoining Sites of Special Scientific Interest, encompassing most of this beautiful and ancient place.

The Gwent Levels is also home to a variety of other important creatures such as otters, dormice, bats, common cranes (that are anything but common - a bird that until quite recently had been extinct as a breeding species in Britain for over 400 years) and water voles. Water voles occupy an unenviable position in modern Britain; it's the nation's fastest declining wild mammal, its population having nose-dived by as much as 90% since the 1970s. For a period of nine whole years it had gone unseen on the Gwent Levels until a successful reintroduction scheme returned the mammal to its native home in 2012. From those small beginnings at Magor Marsh the water vole has spread over miles on its own, journeying outwards across its former habitat by reen, like the ripples from a stone dropped suddenly into still water.

Legal note - effectiveness of proposed mitigation measures

It is worth highlighting here the legal note submitted by Gwent Wildlife Trust regarding the effectiveness of measures proposed by the Welsh Government. In summary, it states that, *the Welsh Government cannot rely upon proposed mitigation measures to grant consent unless it is confident that those measures will succeed. Confidence requires 'no reasonable scientific doubt' regarding the effectiveness* of the mitigation measures.

In the alterative, if there is a sliding scale of confidence, Welsh Government cannot be confident that mitigation measures will be effective in the absence of some scientific evidence demonstrating their effectiveness. The lower the degree of confidence in the mitigation measures proposed, the less likely the scheme should be approved.

It is the considered and expert opinion of Gwent Wildlife Trust and their independent, expert witnesses such as Professor Sir John Lawton, that much of the ecological mitigation measures for the species, habitats, SSSIs and ancient woodlands have no grounding in empirical evidence. It is also our considered and expert opinion that the mitigation measures will not 'maintain and enhance' the SSSIs and the biodiversity of the Gwent Levels.

This view is shared by the witnesses from the Welsh Government:

- Mr Green stated that he only had 25% confidence in some of his mitigation measures.
- Mr Jonathan Davies stated that the mitigation was not going to be 100% effective and the reens after mitigation 'won't be SSSI quality'.
- Dr Keith Jones stated that "it is accepted, in spite of the comprehensive mitigation measures proposed, that it is not possible to entirely mitigate for the loss of complexity of the habitats of the SSSIs. (Section 7.6.44 of Dr Jones proof)
- Mr John Davies (Sustainable Development) who stated in cross examination that it was self-evident that if you concrete over the Gwent Levels you cannot maintain them.

Therefore, as the mitigation is highly unlikely to have the desired effect to considerably reduce the impact of the scheme, we believe that the scheme will have a substantially greater impact on the Gwent Levels than the already grave assessment that is stated within the Environmental Statement "a significant adverse long term impact on the Gwent Levels SSSIs as a result of the land take for the Scheme."

It is worth noting that, Welsh Government have summarised NRW position as believing the Scheme "would not be in accordance with the statutory duties with respect to SSSIs statutory duties with respect to SSSIs under Section 28G of the 1981 Act and / or with respect to biodiversity and ecosystem resilience under Section 6 of the 2016 Act, and would be contrary to national planning policy" (Extent of loss 2.3.2 ID/061 : National Designated Sites Statement of Common Ground)[19].

In addition, based on the evidence and the effectiveness of the mitigation offered, if there was a risk that a derogation licence for European Protected Species would not be granted then, the Inspectors should not recommend the Scheme is taken forward.

Professor Sir John Lawton – Ecology

Professor Sir John Lawton is a fellow of the Royal Society, and was knighted in 2005 for his contributions to ecological science and he is one of the world's leading ecologists and scientists.

In his evidence, he discusses the well-established ecological principles that underline conservation science "which strongly support the view that if the proposed M4 extension across the Gwent Levels goes ahead, it will severely damage one of Wales's (indeed the UK's and Europe's) most important wildlife sites, and that the damage is very unlikely to be prevented by proposed mitigation measures… The measures proposed to mitigate the effect of the proposed M4 extension are unlikely to be effective. They are scientifically unproven and in some cases appear impossible". These 'well-established ecological principles' include:

- direct habitat loss and
- fragmentation of habitats.

This was a common theme with many of our ecological witnesses. Professor Sir John Lawton also stated that the effect of the proposed M4 extension:

- will be to destroy and fragment large areas of designated SSSI habitat
- will significantly damage populations of vulnerable species, including European Protected Species. Making those populations more vulnerable to local extinction as a result of inevitable shocks.
- Will lead to fragmentation, reducing or eliminating the potential for dispersal and re-colonisation, 'devaluing' remaining habitat and ultimately resulting in a greater risk of the regional extinction of some species.

He also made reference to his seminal DEFRA Lawton Report[20] 'Making Space for Nature' which made a number of recommendations. In simple, headline terms what is needed is more protected sites; bigger sites; better managed sites; and sites that are connected either by corridors or 'stepping stones' of suitable habitat. This DEFRA paper and the 'more, bigger, better and more connected' mantra has been used, quoted and has influenced Welsh Governments policy and legislation, such as the Nature Recovery Plan[21], Natural Resources Policy's and the Environment (Wales) Act[22]. However, Professor Sir John Lawton stated that the M4 would make the Gwent Levels "less, smaller, worse and fragmented". This is an extraordinarily cavalier approach to recognised SSSI areas.

Professor Sir John Lawton's evidence was put to the Welsh Governments ecological consultants.

Extinction

When questioned over Professor Sir Lawton's evidence, all the Welsh Government ecological consultants agreed with Professor Sir John Lawton's assessments of impact. For example, Mr Jonathan Davies agreed that "Smaller populations are less able to withstand inevitable 'shocks' (a hard winter, or a fire, for example), and as a result are more likely to die out, even in surviving fragments of suitable habi-

tat. Fragmentation and isolation of habitat patches means that many species are also unable to disperse naturally across hostile environments (arable fields, a motorway, urban areas etc.) to recolonise suitable habitat patches, reducing the long-term viability of so called "meta-populations", which can lead, eventually, to regional extinction, even if suitable habitat still survives".

Ecological Mitigation

The Welsh Government consultants initially disagreed with Professor Sir John Lawton that the mitigation they proposed was unlikely to be effective, even though they could not present actual scientific, peer reviewed evidence, to state that it was likely to be effective. For example,

• Mr Jonathan Davies, had scant regard for scientific peer reviewed evidence, which proved that creating new habitats to offset or mitigate for habitat loss resulted in a biodiversity deficit and a deficit of ecological functions. For example, he dismissed Moreno-Mateos et al (2017)[23] (highlighted in Iolo William's evidence) which showed that, compared with reference levels, recovering ecosystems run annual deficits of
- 46–51% for organism abundance
- 27–33% for species diversity.

Moreno-Mateos et al stated that these "results are consistent across biomes" (which includes aquatic, grassland and forest) and that even if complete recovery is reached, an interim recovery debt will accumulate (due to time lag before species and vegetation recover). This scientific, peer reviewed paper was only one of a number of papers showing that mitigation for habitat loss and fragmentation leads to a significant biodiversity deficit. Another paper included in Mr James Byrne evidence, Curran et al (2014) Is there any empirical support for biodiversity offset policy?[24], stated that active restoration has inherently large time lags, uncertainty, and risk of restoration failure. This requires offset ratios that far exceed what is currently applied in practice – such as the 1:1 ratio of the reen mitigation.

• Mr Davies, stated that he had 95% confident that the creation of new reens, to compensate for the loss of over 10kms of SSSIs reens and ditches, would be successful – even at a 1:1 ratio proposed. However, he contradicted himself by stating
- "not claiming it will happen immediately"
- "it is a possibility that it won't be SSSI quality…"
- "its only an aspiration to be SSSI quality…"
- "you can't replicate what is there"
- "it is difficult to replicate the complex drainage system with its niche habitats, even at a small scale"
- The mitigation was "in essence a salvage process"
- He cannot guarantee how long it would take to develop into an appropriate ecosystem.

He also stated, regarding the mitigation ratio of 1:1
- "was not what we planned …we wanted significantly more…"
- "The harder it is to establish…the more replacement you need…."
- The "Constraint {to getting significantly more than 1:1 reen mitigation} is hydrological not ecological'" and they were "stymied and hamstrung" by the hydrological requirements and as such could not provide a more appropriate mitigation package.
- "1:1 ratio will not create no net loss"

He agreed that 1:1 ratio was inappropriate due to the
- high risk of failure of the mitigation measures
- significant time lag before the 'successful' measures create suitable conditions for the appropriate SSSI species – even if some survive the shock of being transferred via 'seeding' (scoping up buckets of reen water containing SSSI species from the ancient reens that would be lost and placing them in the newly created reens). Mr Davies, acknowledged, after a helpful intervention by the Inspector, that 'seeding' would likely kill a lot of the SSSI invertebrate species.

• In order to compensate for not getting 'significantly more' than 1:1, Mr

Davies said that Welsh Government will 'enhance' some ditches. However, enhancement means make some ditches that already have some wildlife value a little bit better- it is not compensation for the complete loss of over 10kms of SSSI reens and ditches and the failure to provide adequate ecological compensation.

• In a moment of naivety, Mr Jonathan Davies said "He hopes GWT to take over migration areas…".

The risks of creating new habitats to replicate habitats which are to be lost to development (through, for example, failure of mitigation measures or time-lag before new habitats appropriately mature) apply to all other habitat types, such as grassland and woodland (please refer to Richard Barnes (Woodland Trust) evidence on ancient woodlands).

It is worth pointing out again, that Dr Keith Jones states "it is accepted, in spite of the comprehensive mitigation measures proposed, that it is not possible to entirely mitigate for the loss of complexity of the habitats of the SSSIs. Thus Chapter 10 Ecology and Nature Conservation of the March 2016 ES (Document 2.3.2) recognises that there would be a significant adverse long term impact on the Gwent Levels SSSIs as a result of the land take for the Scheme.". However, based on Professor Sir John Lawton's comments, he would likely want to slightly amend the above by removing 'entirely' so it reads "it is not possible to mitigate for the loss of complexity of the habitats of the SSSIs". We agree that the mitigation measures are comprehensive (wide ranging), just not based on evidence and will not be effective.

This accords with the Statement within ID/061: National Designated Sites Statement of Common Ground (Section 2.3.2) that NRW believe that the Scheme "would not be in accordance with the statutory duties with respect to SSSIs under Section 28G of the 1981 Act and / or with respect to biodiversity and ecosystem resilience under Section 6 of the 2016 Act, and would be contrary to national planning policy".

Therefore, even the most optimistic assessment of the scheme from the Welsh Government's own ecological consultants state they cannot 'entirely' mitigate the impact of the loss of the SSSI's. Therefore, it is logical and self-evident that the Welsh Government cannot

- "maintain and enhance biodiversity" or
- "promote the resilience of ecosystems"

as per Section 6 of the Environment (Wales) Act – or as per a Resilient Wales in the Well-being of Future Generations Act.

It is also worth noting that Mr John Davies (Sustainable Development), at least in part agrees with NRW, as he said;

• John Davies, para 240, "the Scheme… would conflict with planning policies in respect of cultural heritage, landscape, ecology and nature conservation. Consequently it would fail to meet the fourth part of the planning policy definition of the sustainable development principle in PPW, respect for environmental limits"

If the scheme doesn't respect environmental limits it is, by definition, unsustainable.

Species Mitigation

Mr Jonathan Davies was also questioned on the proposals to mitigate the significant adverse impacts of fragmentation of the SSSIs on many vulnerable species including dormice, otters, shrill carder bee and water voles.

Water Voles

Mr Davies sought to ignore current guidance and/or any basic animal ecology to state that water voles[25] could use culverts under the motorway which have a minimum length of 70 metres (up to several hundred metres). However the Water Vole Mitigation Guidance (2016) states that water voles will use culverts of up to 35m[26]. In fact, the entire scheme, ran contrary to the Water Vole Mitigation Guidance of "avoiding/minimising effects –considerations at the design stage" for example not 'retaining watercourses/wetland habitats in their current locations as part of a development' and 'avoiding the need to culvert watercourses'.

Dormice

Mr Jonathan Davies stated that he had very little, if any, confidence in some of their mitigation methods, such as dormouse bridges and tunnels, to reduce the impact of fragmentation on dormice which he said were undergoing a 'catastrophic decline'. He stated that tunnels/pipes and bridges were 'not tried and tested' and 'hasn't be proven to work in situ'.

However, he was happy with one of his main proposals to reduce the impact of fragmentation - capturing dormice, taking them to England, and allowing their offspring to return once the replacement habitat was suitably mature. Capturing and translocating any species, and taking them into captivity for an unknown or indefinite amount of time, is highly traumatic especially for small mammals – and this risky mitigation measure especially for this European Protected Species that is undergoing 'catastrophic decline'.

While acknowledging that fragmentation of habitat was a significant issue for dormice, Mr Jonathan Davies thought that on this scheme it would not be significant because in 10-20 years the compensatory planting, much adjacent to the motorway, would be sufficiently mature to provide suitable habitat. However, he did acknowledge that he was working in a 'world of uncertainty and best guesses'. GWT argue that potentially 10-20 years before the habitat is mature enough to maintain a population of dormice is unacceptable.

Bats

We will explore the evidence on bats below, but it is worth noting again that Mr Green, the Welsh Government's bat witness, had only 25% confidence in some of the methods that he proposed to combat fragmentation of bat habitat. Professor John Altringham, one of the UKs, if not the world's leading expert on bats, especially in the context of infrastructure developments impact on bats, highlighted that the majority of Mr Greens mitigation measures where are not based on empirical evidence and were highly unlikely to work.

Otters

We will explore the evidence on otters below but it is worth noting in this section that the otter surveys fail to provide even the most basic ecological information on otters due to serious failings in each step of the process. Therefore, if the information to show how the otters are using the Gwent Levels is lacking, the mitigation proposals are likely to be inappropriate too.

Shrill Carder Bee

The shrill carder bee is one of the rarest insects in the UK and a feature of 6 of the Gwent Level SSSIs. The Welsh Government propose to mitigate for the loss of SSSI habitat for this species by providing wildflower provision on the embankments of the new section of motorway. When asked, Mr Jonathan Davies, did agree that there was no evidential basis for the proposed mitigation but 'some mitigation was better than nothing'. He also agreed that due to the location, shrill carder bees will likely be killed by traffic, but then incorrectly stated that Buglife think that the mitigation was a good idea. This was strongly refuted by Buglife who wrote to the Inspector to highlight Mr Davies false statement.

Professor John Altringham – Bats

Professor Altringham is one of the UKs, if not world's leading scientists on bat ecology and has a long and impressive list of scientific, peer reviewed publications. Of particular relevance to this case is his interest in the effects of transport infrastructure on bats (and other animals), so much so that he is extensively quoted, and misrepresented, in the Environmental Statement and in Mr Green's Proof of Evidence.

Professor Altringham published research has demonstrated that major roads reduce bat activity and species diversity. This includes a major DEFRA-commissioned report[27] which summarises the current knowledge in the field of road ecology related to bats, and provides detailed best practice guidance on survey, monitoring and mitigation for bats on transport infrastructure. The report shows a decline in bats 1-1.6 km either side of the road, with the 'missing' bats having died or been displaced – and displacement probably also leads to population decline, since displaced bats will be in competition for resources with other bats. It also shows that the current mitigation practice is largely ineffective.

It's worth noting that this effect is not only related to bats, there is a significant body of research in the UK and globally that highlights the impact of roads on wildlife such as:

- Benitez-Lopes et al (2010)[28] highlighted that "mammal and bird populations decline with their proximity to infrastructure. The effect of infrastructure on bird populations extended over distances of over 1km and for mammals up to 5km".
- Ware et al (2015)[29] highlighted that "traffic noise is an invisible source of habitat degradation".

Professor Altringham highlighted that the Environmental Statement shows that the footprint of the motorway covers part of an important bat habitat along most of its route. He highlights that the loss and fragmentation of habitat included, but was not limited to, the loss of:

- ancient woodlands,
- 10kms of reens and ditches
- 36km of hedgerow

He also highlighted that it will take many years for the replacement woodland to mature and become useful to bats. In that time, populations could crash and local extinctions could occur. There is also a high likelihood of cars colliding with bats. Given the low population densities and barriers, these species may never recover.

Professor Altringham highlighted that the Environmental Statement concerns itself almost entirely with impact during construction and makes insufficient reference to the long-term, landscape-scale impact of the operational phase of the road - this issue is a major part of his DEFRA report. The Environmental Statement also fails to take account of the many basic ecological principles, such as bat displacement, and assumes that there is lots of empty habitat waiting for these displaced bats to move into. There is not, it is already occupied.

Professor Altringham highlights that:

- the mitigation offered in the Environmental Statement and Bat Mitigation Strategy is at best high-risk and largely ineffective and, at worst, completely ineffective.
- Mr Green's evidence for mitigation was not based on empirical scientific evidence - in fact many of the mitigation measures ignore the scientific evidence regarding their lack of effectiveness. In part, this is because Mr Green equated occasional use with effectiveness – almost all of Mr Green's mitigation is based on the exception not the rule. For example, there is limited evidence to suggest that bats will actively use artificial corridors, with the only study available suggesting they are only used by 10% of the bats[30].

In fact, Mr Green stated that in some of the mitigation measures proposed to reduce fragmentation, he had 25% or less confidence.

Mr Green also proposed other mitigation measures where the "value of new ponds and reedbeds is expected to reach full potential as bat foraging habitat within ten years, whilst planted woodland would provide some foraging habitat within ten to twenty years". This significant time lag (and ignorance of the likely failure rate) means that he is suggesting he believes that 20 years of 'moderate adverse impact' is acceptable based on the assumption that all the mitigation will be 100% effective.

David Boyce – Invertebrates

David Boyce is an ecologist with over 30 years specialising in invertebrate ecology and conservation and has undertaken many extensive invertebrate surveys of wetland sites throughout Wales, including the Gwent Levels for the Countryside Council for Wales (NRW's predecessor).

It is worth noting that aquatic and terrestrial invertebrates are the main designated features of the Gwent Levels SSSIs.

Mr Boyce highlighted significant inadequacies in the invertebrate survey techniques, which means that the results of the surveys are very likely to significantly underestimate the invertebrate interest on the Gwent Levels SSSI. Therefore, any assessment of adverse impact is likely to be an under-estimate.

He highlighted that a 6 lane motorway, built of tarmac, concrete and steel, designed to facilitate vehicles that will emit pollution

(copper, zinc, cadmium, oil, etc.) across nearly 10kms of SSSI designated for their invertebrate interest, will be catastrophic. It will significantly weaken and fragment invertebrate populations through both direct mortality and behavioural avoidance. In his oral evidence he highlighted several studies, including Moreno-Mateos et al (2017), which showed, compared with reference levels, recovering ecosystems run annual deficits of:

- 46–51% for organism abundance,
- 27–33% for species diversity.

As stated above Mr Jonathan Davies gave scant regard for available scientific evidence, preferring his own experience, none of which was on the Gwent Levels or recreating SSSI quality reens.

Mr Boyce highlighted that, among other impacts, pollutants in water treatment area outfalls from the Motorway scheme would be detrimental to the aquatic invertebrate fauna. Mr Jonathan Davies did admit that rare invertebrates such as the SSSI invertebrates require rare habitats. However, Mr Davies in cross examination, said that the water treatment works, designed to prevent pollution entering the reens:

- "wouldn't be 100% effective… are vulnerable to failure",
- and would "kick out pollution into the reens".

However, Mr Davis did not know:

- what level of pollution 'kicked out' into the reens would cause the SSSI invertebrates to die off and the reens to become uninhabitable for these rare invertebrates.
- what the sensitivities of the rare SSSI invertebrates to various pollutants such as cadmium, copper, zinc and chlorine are.

Therefore, once again they had no empirical evidence so they cannot have any degree of confidence that pollution from the motorway which runs along nearly 10kms of SSSI habitats will not have an impact on the rare SSSI invertebrates.

Geoff Liles – Otters

Geoff Liles is one of the UK's leading otter ecologist and conservationist and has been working in this field for over 35 years, including setting up and developing the otter conservation initiative for Wales. He is now an ecological consultant specialising in otter conservation and research. Of particular relevance to this inquiry is his work on otter road deaths in Wales to identify the scale, trends and factors involved in otter road mortalities.

Geoff Liles highlighted that the otter surveys for the new M4 failed to provide even the most basic ecological information due to serious failings in each step of the process:

- Desk study – there were many reports which provided details of potential breeding sites and resting sites that were not looked at by the Welsh Government consultants. If these reports were analysed, it would have led to a significantly more comprehensive investigation being undertaken.
- Survey methodology – the otter methodologies within DMRB were not followed, for example they undertook one survey not four throughout a year (four are required because otters use different parts of their home range at different times of the year). The consultants also combined surveys for otters and water voles which use different survey methodologies and therefore should not have been combined.

Mr Liles stated that the survey should have:

- located and described protected sites (breeding and resting sites) and feeding sites;
- identified actual and potential otter travel routes (including 'short-cuts' across open land);
- provided an understanding of how otters utilise water habitats throughout the year;
- identified potential mitigation measures throughout the route;
- presented all the above data in a clear, detailed manner using maps

The Arup reports did not appropriately address any of the above.

• Survey results - failed to provide even the most elementary baseline ecological information on otters. Of the 1,442 water bodies apparently surveyed in their 'one-off' survey, otter signs were found at only 18 sites, a result that tells us nothing about otter use of the watercourses throughout the year.
• Conclusions drawn - The Arup/RPS surveys have added nothing to an understanding of otter use of the Levels and the potential impacts of the scheme on the species.

Mr Liles highlighted the choice of preferred route by Welsh Government appears to have been made without any understanding of the likely significant impact on otters. For example, he highlights DMRB 81/99 states "Otter populations with low densities will be most at risk through road casualties." The scheme creates a barrier to otters therefore the scheme is contra to DMRB 81/99 which states "It is also important not to create barriers to the re -colonisation of habitat by otter populations".

Mr Liles also submitted a Cardiff University Report entitled 'Evidence of Eurasian Otter (Lutra lutra) population connectivity across the M4 Corridor around Newport Proposed Motorway'. The report was based on Cardiff University DNA studies of otters which had been subject to road traffic accidents. The reports conclusion was that:

• Individual otters regularly disperse and mate across the Gwent Levels and River Usk (i.e. across the proposed M4 motorway route).
• The populations of otters on either side of the river (and in the river itself) and above and below the proposed route should therefore be treated as a single demographic unit.
• Construction of a road, such as proposed for the M4 motorway, across this area will impede dispersal, fragment both otter habitat and this population, reducing connectivity and thus gene flow.

As otters are a European Protected Species (similar to bats and dormice) and a designated feature of the River Usk Special Area for Conservation (SAC) - all of the above has implications for:

- Obtaining an otter derogation licence (a licence to disturb otters or their breeding or resting places) from NRW.
- The validity of the Statement to Inform the Appropriate Assessment for the River Usk SAC

Mr Liles highlighted that the failure to assess the otter impacts with any degree of adequacy also impacts on the ability of the scheme to meet other legislative commitments and requirements, including the Wildlife and Countryside Act 1981 (as amended) and the Environment (Wales) Act 2016.

Richard Bakere – Magor Marsh Nature Reserve
Mr Bakere is a Senior Reserves Officer for Gwent Wildlife Trust and has been responsible for many of Gwent Wildlife Trust's nature reserves since 2006, and the Magor Marsh nature reserve since 2010, which includes Barecroft Common.

Magor Marsh is the oldest, most visited and potentially the most cherished of all of Gwent Wildlife Trusts Nature Reserves. Each year:
• 3,000 visits are made to the education centre on the reserve by school children
• 10,000 people visit the nature reserve
• GWT undertakes events on Barecroft Common such as guided walks, volunteer work parties that help manage the reserve, University Group visits and species recording activities for bees, butterflies, water voles, harvest mice, etc.

Mr Bakere discussed how the Gwent Levels has evolved in parallel with people over millennia. Consistency in agriculture and management of the drainage structures produced a stable environment where wildlife and farming flourished. The two fields on Barecroft Common, part of the Magor Marsh Nature Reserve, are also part of Redwick and Llandevenny SSSI. Mr Bakere, stated that this area is special because of the peat rich ground, high water table and history of sympathetic management without agricultural 'improvement', such as the addition of artificial fertilizers and pesticides, ploughing, etc. These fields and reens are home to rare habitats and plants (both rare on the Gwent Levels and rare in the UK), rare inverte-

brates such as the great silver beetle (Hydrophilus piceus), as well as otters, water voles and harvest mice.

Mr Bakere also highlighted that the impact of the motorway on the wildlife in the reens, ditches and fields would be severe and long-lasting on Magor Marsh Nature Reserve, namely:

- it risks the very essence of the Nature Reserve at Magor Marsh as it threatens the water that creates the wetland habitat in the reserve.
- the scheme physically builds an embankment on the top of Magor Marsh Nature Reserve. This will cause direct habitat loss of Barecroft Common which would obviously be a significant impact upon Magor Marsh Nature Reserve and Redwick and Llandevenny SSSI.
- the wildlife on the northern side of the motorway would be isolated from the habitats to the south of the motorway and would like cause death of important species such as bats and otters as they try to cross the 6 lane carriageway.
- reduced water levels and reduced water quality (through the addition of pollutants) would lead to a loss of biodiversity and localised extinctions of sensitive species across the whole reserve (over 800 invertebrate species recorded).

The M4 embankment planned to replace part of Barecroft Common is over 5m in height, therefore piling will be used. This has the potential to impact spring flows into Barecroft Common and the rest of Magor Marsh Nature Reserve. The complexity of the water systems on the Gwent Levels as a whole, and in particular at Magor Marsh, is staggering. This is in part shown by the Welsh Government incorrectly stating that the Mill reen feeds Magor Marsh – the Welsh Government consultants did not correctly identify the source of the water that feeds the reserve or the complexity of the water flows.

In addition, given the size and location of the scheme Mr Bakere, like other witnesses, has little confidence in the pollution control measures to protect the reens especially during the construction phase as he has personally witnessed simpler control mechanisms fail on the A465. Pollution control measures are never 100% effective.

- noise from the motorway would be carried from the elevated level on the prevailing wind over the nature reserve, adversely affecting both people and any wildlife that relies on calls, whether for establishing territories (such as cuckoos) or for warning of the approach of predators (water voles).

Mr Bakere emphasized that Magor Marsh does not function in isolation. It is only with resilient habitat in the wider context that these areas can support viable long-term meta-populations (in essence a group of individual populations made robust by mutual support from adjacent populations). Mr Bakere highlighted his significant concerns regarding the inadequacy of the proposed reen and ditch mitigation. In particular,:

- the timescales for equivalent habitat to become established on new watercourses.
- the mitigation ratio of 1:1.
- the sites of proposed mitigation within existing SSSIs.

Mr Bakere drew attention to the fact that Magor Marsh, Barecroft Common and the Gwent Levels SSSI is not a simple habitat system that can be recreated by digging a ditch. As one of the last fragments of unimproved peatland on the Gwent Levels, any loss of this ground is irreplaceable. This is clearly expressed in the lowland peatland survey of 2009 conducted by the Countryside Council for Wales "The Barecroft Common area has, along with Magor Marsh, escaped the large scale habitat loss that has affected the Gwent Levels".

Richard Barnes – Ancient Woodland
Richard Barnes is employed by the Woodland Trust as a Senior Conservation Advisor and has worked in the nature conservation sector for over 25 years. His evidence regards ancient woodland, mitigation and compensation proposals and national policy.

He highlights that ancient woodland is defined as an irreplaceable natural resource that has remained constantly wooded

since AD1600. Ancient woodland is one of the UK's richest habitats for wildlife, supporting 256 priority species. The length of time which ancient woodland takes to develop and evolve (centuries, even millennia), and co-evolve with plants, animals and the soil, only accentuate its irreplaceable status.

Mr Barnes states that the loss and damage of these amazing habitats is against planning policy. For example, Planning Policy Wales (PPW) makes explicit reference to the consideration of ancient woodland in paragraph 5.2.9: "Ancient and semi-natural woodlands are irreplaceable habitats of high biodiversity value which should be protected from development that would result in significant damage". Welsh Government's Strategy for Woodlands and Trees, 'Woodlands for Wales' also recognises ancient woodland's irreplaceability. However, this scheme would completely destroy or damage ancient woodland (and the associated species that utilise them) at:

- Berryhill Farm
- Pwll Diwaelod
- Roggiett Brake
- Pye Corner

Mr Barnes stated that the mitigation/compensation offered to offset the damage and loss of ancient woodland was utterly insufficient. Planting new trees does not mitigate for the loss of ancient woodland, at least 100 years are needed before a newly planted wood starts to resemble the ecological complexity of mature woodland. Ancient woodland, by definition, is irreplaceable. Mr John Davies, in cross examination, agreed that ancient woodland are irreplaceable and therefore mitigation cannot replicate them leading to a net loss in biodiversity.

Attempts to salvage ancient woodlands by translocations of soil or trees is not based on any empirical scientific evidence.

Mr Barnes highlighted the Joint Nature Conservancy Council (JNCC is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation) information which shows that it is not possible to move assemblages of species together without substantial changes taking place in the structure of the habitat and in its species composition, thus rendering the translocation unsuccessful with respect to sustaining the original flora and fauna.

Since loss of ancient woodland cannot be mitigated, the question of adequate compensation arises. New planting at a ratio of 2:1 is woefully inadequate compensation for the loss of ancient woodland. Mr Barnes, in his evidence has stated that, if such a high value habitat is to be destroyed, then the compensation ratio of newly created habitat should be a minimum of 30:1.

Part of the loss of woodland from the scheme includes compensation woodland planted as part of the original construction of the M4. Therefore, Mr Barnes wondered how can any mitigation or compensation measures can be expected to deliver long term benefits if these areas of new planting are then subjected to damage and loss in later years from further harmful development.

Peter Ogden - Landscape
Peter is the Director of the Campaign for the Protection of Rural Wales (CPRW). He is a member of the International Union for the Conservation of Nature (IUCN) World Commission on Protected Areas and one of its Technical Advisors on World Heritage matters. He has 40 years' experience in environmental and landscape planning.

Mr Odgen highlighted that the Welsh Government's Environmental Statement which states that the motorway will cause major long term impacts to the character and heritage value of certain Local Landscape Character Areas of the Gwent Levels and the Gwent Levels Historic Landscape. However, in Mr Odgen's expert opinion the motorways impact will be more significant than the Wel:

- a prominent feature,
- very noticeable and
- significantly out of character with the Gwent Levels' landscapes, not only because of its physical appearance, but also the constant flow of traffic day and night, emitting additional noise and light.

These additional effects would be significant compared to the comparatively undisturbed circumstances which currently characterise the Gwent Levels and its surroundings. These effects will affect the crucial landscape value of this area (its tranquillity / undisturbed character) and increase clutter resulting from its construction.

Climate Change

Before we begin this section, it is worth highlighting the reason climate change is so important.

The Intergovernmental Panel on Climate Change (IPCC), which is a scientific and intergovernmental body under the auspices of the United Nations, has predicted that by 2100, assuming that current trends in burning fossil fuels continue, the surface of the Earth will warm on average by as much as 6 degrees Celsius (around 11 degrees Fahrenheit) or more. Whilst it is not possible to predict how most species, including our own, and how most ecosystems, will respond to such extreme warming, the effects are likely to be catastrophic.

To put an average surface warming of 6 degrees Celsius into context, consider the following: all the changes we have seen to date that have been ascribed to global warming have occurred with an average warming of the Earth's surface since the late 19th Century, when this warming (and the Industrial Revolution) began, of less than 1 degree Celsius. These changes include:

- the melting of glaciers, sea ice, and permafrost;
- the bleaching and dying of coral reefs;
- extreme storms and flooding, droughts, and heat waves (droughts and desertification are already recognised by the UN as significant drivers of armed conflict and refugee movements); and
- major shifts in the ranges of organisms and in the timing of their biological cycle.

A new WWF report[31], 'Developing and piloting a UK Natural Capital Stress Test', shows the cost of inaction by 2050, and highlights why environmental decline must be considered in governmental and business decisions. It states that if we don't take action, extreme weather could have a significant impact on our jobs and economy. For example, without action to protect UK water supplies, a future drought could reduce UK GDP by around £35bn and 354,000 jobs may be lost.

It is also worth pointing out that acting on climate change is an essential component in three of the Well-being goals of the Well-being of Future Generations Act, namely:

- A Prosperous Wales – An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change); and which develops a skilled and well-educated population in an economy which generates wealth and provides employment opportunities, allowing people to take advantage of the wealth generated through securing decent work.
- A Resilient Wales – A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).
- A Globally Responsible Wales - A nation which, when doing anything to improve the economic, social, environmental and cultural well-being of Wales, takes account of whether doing such a thing may make a positive contribution to global well-being[32].

We have shown that, and John Davies MBE in his evidence admitted that, the scheme does not address climate change. As such, we submit that the scheme is contrary to the

- Well-being of Future Generations Act Wellbeing
- the Environment (Wales) Act which requires Welsh Government to reduce greenhouse gas emissions by at least 80% by 2050.

Professor Kevin Anderson and Professor John Whitelegg

Kevin Anderson is Professor of Energy and Climate Change in the School of Mechanical, Aero space and Civil Engineering at the University of Manchester and is the

Zennströmm Professor of Climate Change Leadership at the University of Uppsala, Sweden. He is Deputy Director of the Tyndall Centre for Climate Change Research, the UK's leading academic climate change centre. He is generally regarded as one of the UK's, if not the world's leading climate change experts.

Professor John Whitelegg is a visiting Professor in the School of the Built Environment at Liverpool John Moores University and a transport consultant. His PhD was in industrial location theory and change over time in the opening, closing, decline and growth of the firm. He has worked on transport projects for over 40 years, written 10 books on transport and now edits the journal "World Transport Policy and Practice". His projects include ex-post evaluation of job creation and inward investment following new highway and motorway investments, the impact of new highways on air quality and greenhouse gases and the performance of non-highway building measures on reducing congestion and pollution and stimulating local economic performance.

Both Professors highlighted that the M4 scheme will lead to an increase in carbon emissions. Professor Whitelegg challenged the Welsh Government assessment that motorway construction would create just over 500,000 tonnes of carbon. Mr Tim Chapman admitted that the scheme would be somewhat carbon neutral by 2072 but this figure could drift further out. However, Professor Whitelegg estimated, based on research from Leeds University, the motorway would, at a minimum, likely create nearly 1,000,000 tonnes of carbon.

Even putting aside Professor Whitelegg's carbon figure, both Professors believed that this Scheme was an avoidable and unacceptable move in the wrong direction and will make the task of Welsh Government meeting the 80% reduction in greenhouse gases by 2050 required by Environment (Wales) Act 2016 much more difficult than it need be. It is also directly contrary to the intentions, aspirations and objectives of the Paris Agreement, which the Welsh Government is signed up to, which recently significantly tightened the ambition of the international community to take action to limit global temperature rises associated with climate change to "well below 2^{o}C" and to work towards limiting warming to 1.5^{o} C.

For there to be any reasonable chance of limiting temperature rises to 2^{o}C or below, emissions from nations such as Wales need to be falling by well over 10% per annum – a hugely challenging task. Professors Anderson and Whitelegg believe that it is essential that the scale of the challenge is not made even more significant by policy decisions that have a high potential to increase emissions, both in the short-term and by creating a lock-in to carbon intensive activities and infrastructure in the medium and longer term. Consequently, considerations of climate change have to be central to the decision-making process.

Professor Anderson highlights that the Climate Strategy for Wales (2010) and now the Environment Act underline the need for the Welsh Government and wider public sector to lead by example. However, he pointed out that is evident that insufficiently rigorous analysis has been presented by the Welsh Government to appropriately address the implications of the M4 proposal for the total level of greenhouse gas emissions. In fact, if one was to take climate change seriously, one would have undertaken a carbon assessment to inform whether the proposal was sound in the initial options or scoping phase, rather than doing it to inform the Draft Orders / Public Inquiry.

If Wales is not to renege on the Paris 1.5°C commitment, then the timeframe and scale of action is very demanding. In light of this, the question that needs to underpin all proposals is: how can this potential development be reconciled with the Welsh Government's commitments enshrined in the Paris Agreement? The answer is, it can't.

Professor Anderson states that the M4 scheme is emblematic of a failure to acknowledge the challenges enshrined in the Paris Agreement. If it proceeds it will illustrate the Welsh Government's disregard for its climate change commitments, and the impacts of unchecked emissions on future generations of Welsh citizens and

those poorer and climatically vulnerable communities elsewhere in the world today (this directly impacts our ability to create a Globally Responsible Wales).

Professor Anderson, states that if tackling climate change is a priority, and the 80% greenhouse gas emissions reduction by 2050 and the Paris 1.5oC and 2°C targets are to be taken seriously, then Welsh Government should not facilitate, or even permit, schemes that result in higher (or even static) greenhouse gases emissions and which lock travellers into high carbon lifestyles.

In fact this proposal simply repeats past failed road developments and does nothing to address the damaging underlying transport issues that give rise to the supposed need for the road.

Professor Lorraine Whitmarsh

Professor Lorraine Whitmarsh is a Professor of Environmental Psychology at Cardiff University. She is the Cardiff University partner coordinator for the Tyndall Centre for Climate Change Research. Her research examines environmental perceptions, communication and behaviour. She is involved in several research projects on travel behaviours (including modal choice, vehicle choice, car use and driving style), attitudes to transport technologies (e.g. electric vehicles) and policies (e.g. congestion charging). Between 2011 and 2016, she sat on the Climate Change Commission for Wales, providing expertise in transport and behaviour.

She highlighted that there were various barriers to changing lifestyles that prevent awareness of transport problems manifesting in behaviour change. Institutions and infrastructures serve to lock in carbon-intensive lifestyles, including car dependency. She stated that travel behaviour is often habitual, and as such difficult to change, however infrastructure is critical to shaping and constraining travel choices, Furthermore, changes in infrastructure can play a critical role in breaking travel habits and creating modal shift.

She stated that building a motorway does not create a modal shift to more sustainable forms of transport and cannot be considered an integrated transport system. She was challenged on this by Welsh Government who stated that, as they were building a park and ride, surely that was creating an integrated transport system and facilitating modal shift. However, Professor Whitmarsh highlighted that while a park and ride system was indeed helpful it was still enabling cars usage and thus locking in carbon intensive lifestyles. She also highlighted that a motorway, or a park and ride, cannot be considered an integrated transport system.

A successful integrated transport system should result in higher demand for public transport, with a knock-on reduction in congestion and pollution. Transport integration means that whatever modes or types of transport are involved they all operate as one 'seamless' entity - for the benefit of the fare paying customer. For example, where electric street transports (trams and buses) and electric mainline railways are knitted together by an integrated multi-modal ticketing system, people are positively encouraged to make extensive use of the transports, perhaps running out of nodal points where several services are working together, sharing a terminus that was designed to make interchange as easy as possible. To minimize interchange waiting time the various services shown here are co-ordinated to arrive within a few minutes of each other.

Professor Terry Marsden agrees with Professor Whitmarsh and states that much of the evidence and policy direction in Europe is now pointing in the direction of reinvesting in more integrated public transport systems, to encourage modal shifts both in commuter and commercial traffic, and the shifts in car use to more electric vehicles.

The review of the UK Government's Sustainable Travel Towns policy similarly concluded that the implementation of 'soft measures' (e.g. marketing, travel plans) to change travel behaviours had been limited due to failure to implement complementary measures to discourage car use. Policies to encourage sustainable mobility thus require both making car use less attractive ('push' measures) and making the alternatives more attractive ('pull' meas-

ures). She also highlighted that while it is acknowledged that creating new roads induces traffic, the converse is also evident, and reducing road capacity reduces demand.

Professor Whitmarsh was part of the Climate Change Commission for Wales (CCCW) and conducted a detailed review of transport policy and climate change in Wales for the CCCW. It concluded that road building would negatively impact climate change targets, as well as other sustainability goals (now embodied in the Well-being of Future Generations Act). For example, road building is socially divisive for communities and negatively impacts on biodiversity. She argued that implementing the transport hierarchy is key to:

- avoid using transport (by video conferencing etc.),
- shift (to more sustainable forms of transport – walk, bike, train),
- improve (electric vehicles over conventional)

Transport and Economics

Mr Gerald Kells
Mr Gerald Kells is an Independent Policy and Campaigns Advisor, with a background in transport, planning and environmental issues. He gave evidence on behalf of Friends of the Earth. He has 25 years' experience in the sustainable transport and policy sector, previously working for the Campaign to Protect Rural England (CRPE). Amongst other roles, Mr Kells was a member of the Regional Planning Executive of the West Midlands Regional Assembly as well as Vice-Chair of the West Midlands Regional Transport Partnership. He sat on the steering group of two Multi-Modal Studies, and gave evidence to a number of Parliamentary Committees.

Mr Kells argued that the problem is network wide, not just on the motorway, and needs network solutions. Traffic currently passes through the system without significant delay most of the time. The wider problem that exists on the Network, put simply, is that there has been inadequate investment in alternatives and little management at peak times. He argued that modest measures to control traffic upstream of the Brynglas tunnels should be able to smooth the flow and create an acceptable level of service for an urban motorway, (while also reducing emissions and noise impacts).

Friends of the Earth Cyrmu argued that a combination of alternative measures, both public transport and demand management, could resolve the problems.

Friends of the Earth Cymru likened this approach to a jigsaw where you needed to see the whole picture to understand the overall impact on traffic levels on the motorway and surrounding network. While the Welsh Government pointed the Inquiry to the high level package assessment of M4 CEM, these simply do not provide the traffic figures needed for such a comparison. What was clear from the rebuttal of their evidence was that public transport investment on its own could provide a 6% reduction in traffic on the M4, bringing almost all sections within the Motorway's Capacity Limits. Separately, the simple measure of closure of the Eastbound slips at Jn 26 would reduce traffic at the key pinch-point of the Brynglas tunnel by 5%. This should give confidence that a wider package of demand management and public transport ought to be able to address both the symptoms and the underlying problems of car dependency on the Newport Network.

Moreover, the approach Friends of the Earth Cymru advocates compliments the Welsh Government's admirable and essential policy goal of reducing car travel and promoting alternative modes. Unlike the motorway proposal it does not require a convoluted explanation to try to prove it will have knock on benefits for public transport.

Professor John Whitelegg
Professor John Whitelegg highlights that the most common justification for road-building was that more road capacity would reduce congestion. However, old and new research shows the opposite. New road building generates new traffic or "induced traffic" and adds to congestion problems in and near urban areas and city regions. He cited:

- extensively his own experience and

studies from the UK and around the world

• from the UKs leading expert Professor Phil Goodwin including the gold standard Standing Advisory Committee on Trunk Road Assessment (SACTRA).

• Professor Phil Goodwin 2006 review of a major report "Beyond Transport infrastructure"

• CPRE commissioned report 'The Impact of Road Projects in England' by consultants Transport for Quality of Life Community Interest Company which drew upon evidence of short-term impacts from over 80 road schemes via Post-Opening Project Evaluation (POPE) process. This was supplemented by long-term evidence from four road schemes that were completed between 13 and 20 years ago. It showed that:

- All road schemes, bar one, saw traffic growing significantly faster than background trends for other regional roads. This suggests that the new schemes were inducing traffic. In the remaining scheme, the traffic growth was the same as the background trend.
- The longer these roads schemes have been in place, the more traffic they have attracted. Schemes completed 8-20 years ago showed a 47% increase in traffic compared with a 7% increase of those completed 3-7 years ago.

If built to reduce congestion, these road and motorway schemes backfired. The road schemes studied did not solve the problems that they were supposed to but ratcheted up traffic levels year on year in a self-perpetuating cycle, by unlocking car-dependent development. Not only did this mean that the new roads filled up quickly, the bypassed roads did too in many instances. Worse still, traffic increased on roads feeding into the new roads, creating new pinch-points in the medium-term.

The reality is that a motorway proposal like this is likely to generate significant amounts of additional traffic, both through changes in journey lengths and through more fundamental changes in where people choose to live, work, shop and enjoy leisure facilities. The road removes a constraint and releases capacity for commuting, leisure, retail and business journeys, extending the commuter belt to Cardiff dramatically.

Professor Whitelegg stated that induced traffic is very important because of the effects it has on traffic forecasts, time savings, Benefit: Cost Ratios (BCR) and Value for Money (VFM). A large amount of induced traffic will usually have the effect of cancelling out or minimising the travel time savings that have been predicted for a road scheme and then converted into a monetary estimate of benefits – here the Welsh Government predict time savings on average of between 3 and 9 minutes!

Professor Whitelegg stated that the Welsh Government report on traffic forecasting also ignores the reality of exaggerated and inaccurate forecasts made in the past. The traffic engineering and modelling world is well aware that forecasting is based on flawed assumptions and this has been expertly illustrated by Professor Phil Goodwin in his many writings and presentations presented by others at the Inquiry and through written submissions, notably from Friends of the Earth. This means that the arguments made in support of road building, as in the case of the M4 motorway, are based on unreliable traffic forecasts.

The Professor highlighted the successes of Reading buses, Brighton buses. Nottingham's Workplace Parking Levy combined with Nottingham's bus and tram projects are well documented and show that it is possible to reduce car travel and boost alternatives. However, these areas have not been fully explored by Welsh Government.

Professor Whitelegg, along with others, highlighted the two way road argument which shows that the new motorways are just as likely to drain jobs away from a local economy as it is to attract them. Roads don't equate to significant employment, as shown by the structural economic problems of areas very well served by motorways in the 21st Century such as Glasgow and Hull.

Professor Calvin Jones

Calvin Jones is a Professor of Economics at Cardiff Business School. He has 25 years experience examining issues related to the development of the South Wales economy and the broader Welsh economy. He is involved in numerous economic advisory

committees for the UK and Welsh Governments and sits on the Institute of Directors' Wales Policy Committee, and the Institute for Welsh Affairs Re-Energising Wales steering group. He is regarded as one of Wales leading economists.

He stated that he had seen zero substantiated evidence that a problem with road connectivity is a significant downward pressure on economic or employment growth in the region. There is little evidence that such a relationship is discernible anywhere in Europe, especially when reasonable provision already exists. He highlighted that Wales has in recent years enjoyed its best ever performance in inward investment, including investment in south Wales by car manufacturers, an activity that a priori would be more susceptible to connectivity issues.

Professor Jones highlighted that the main reasons behind the economic problems of South Wales are long-standing such as:

- lack of economic variety and headquartered firms;
- low levels of entrepreneurship
- limited aspirations and
- poor skills and qualifications

This list is similar to the Welsh Governments consultation on the National Development Framework Integrated Sustainability Assessment which highlighted the Key reasons for Wales's relatively poor economic performance. It highlighted relatively low skills levels and poor educational attainment levels but not transport infrastructure. Professor Jones stated that globalisation, reduced demand for lower-skilled workers and the fragmentation of work have, since 1991, exacerbated these issues. The new M4 motorway addresses none of these issues.

Professor Jones believes that building the motorway could even discourage companies from moving to Wales, as it is at odds with Welsh Government policies that seek to build a distinctive economic development narrative for Wales based on sustainable development i.e. A Prosperous Wales – An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change).

Investment in the M4 Scheme could also exacerbate Intra- regional and social disparities by allocating the bulk (or all) of Wales' borrowing ability on the M4. Across the region between 25- 30% of households do not own a car and car ownership correlated strongly with other poverty and income measures. Poorer people in the area would therefore rarely use the road themselves, which means the most direct benefits would be enjoyed by those regional residents who are already more affluent. Investments in public transport have a far greater impact on the poorer. The provision of a new motorway will generate very limited co–benefits – or 'bang for buck' – as required under the Well-being of Future Generations Act.

Professor Jones highlighted the study by Dr Mark Lang of Cardiff University's Sustainable Places Research Institute which stated that:

> *"Some of the key economic priorities that have emerged in Wales, notably the proposed construction of an M4 relief road around Newport, appear to offer little to the well-being of future generations. They also appear to offer very little to the people and town of Pontypool, who like other communities have not been engaged in the conversation around setting the economic policy agenda".*

Costs vs Benefits

Professor Jones also highlighted that the costs are likely to be far more than anticipated, and many of the benefits will largely 'leak' from Wales. For example, the benefits from procurement will likely leak in large part from the region as Wales has a paucity of large 'Tier 1' contractors who are able to bid for the largest construction or design jobs, with labour and machinery also likely to be sourced from across the border in England.

He stated that the Scheme is not a future-oriented investment and that human society, in the West at least, appears on the cusp of radical change in productive, distributive and consumption systems due

to the impact of digital technology, even leaving aside the key ecological and energy challenges that will change the way we live. Most relevant here are the huge strides being made in the development of connected and autonomous vehicles. Professor Jones went on to state that there is a substantive risk that capacity relevant to current trend-based projections will constitute a massive over- build in the light of autonomous passenger and freight travel. For example, the Department for Transport (DfT) stated that the average time spent delayed on city roads at rush hour will fall by 12.4% when 25% of vehicles are driverless[33]. But as more people adopted the technology and it became common place on the country's road network, the study found that congestion could be cut by 40%[34].

In addition, the perception of journey times might change also with autonomous vehicles. As cars become less of a status symbol, and as the popularity of shared ownership and subscription-based mobility rises, auto manufacturers are increasingly focusing on the comfort and amenities inside vehicles. Wi-Fi, sound systems, comfortable seating, easy access to social media, and anything else that makes being in the vehicle as comfortable as possible – or even desirable – is the goal. In this context, the whole experience of congestion might shift dramatically: instead of feeling enraged by traffic delay and the ensuing lack of productivity, you could simply use the Wi-Fi, continue working, make calls, or engage in social media, much as you would at the office or home. Congestion might not even be that much of a hassle if only because people won't experience it in the same way.

Professor Jones highlighted that the Welsh Government's Economic Appraisal Report (EAR) fails to include some significant costs or dis-benefits that are likely to make the scheme poor or low value for money. The UK Government specifications also state that following a basic Value for Money (VfM) assessment, non-monetised impacts are then considered to ascertain whether those impacts are great enough to shift a scheme into a different category. The final VfM category is then assigned. However, the significant ecological (and ecosystem services) impacts have not been considered in the Benefit:Cost Ratio (BCR), which could be large enough to shift it into a different category. As Mr Bussell stated in cross examination, an evaluation of ecosystem services was not undertaken, even though this is a requirement of the January 2016 CIEEM Guidelines for Ecological Impact Assessment (the industry guidelines for EIA). This is inconsistent with the Environment (Wales) Act 2016.

The BCR also didn't include VAT or construction inflation which Professor Cole during his evidence stated was 7%. Professor Jones also highlighted that much of the major assumed economic benefits will go to Bristol and South Gloucestershire, one of the South Wales biggest economic competitors – and yet it is Welsh taxpayers paying the bill for the scheme including the ongoing repayments back to the treasury.

Professor Whitelegg

Professor Whitelegg stated that the evidence nationally and internationally is very clear and new road building is just as likely to drain jobs away from a local economy as it is to attract them. He stated that there is a total lack of empirical evidence in support of the "roads=jobs" argument or that roads assist the economy. The clear evidence of these studies is that it would be perverse to proceed with a large transport infrastructure investment on the unsubstantiated assumption that such an investment will lead inexorably and unambiguously to job creation, especially in disadvantaged areas. He highlighted the inspector's report into the proposed M74 motorway in Glasgow as especially relevant to a discussion about the impact of additional highway capacity in South Wales. Most, if not all, the issues relevant to the debate around social exclusion, relative disadvantage, business growth, job creation and new transport infrastructure were dealt with in a thorough manner by the Inspector and have a direct transferability to the sub-region centred on Newport. The Inspector came down firmly against the M74 and accepted the case made by the objectors.

Professor Whitelegg stated that any objective assessment of the weight of evidence, both scientific evidence and public policy, would lead inevitably to the rejection of a proposal that claimed economic and social gains from a large item of transport infrastructure. It would further reject the assertion that such investments could maintain accessibility improvements over time as traffic levels rise and erode the temporary gains made in the few months following opening of a scheme.

Professor Whitelegg stated that the SACTRA report (1999) is central to the consideration of any claims made for the M4 Relief Road in terms of regeneration, job creation, inward investment and local economic gain. SACTRA concluded that "there is no convincing general evidence" in support of these desirable outcomes and that improved highway connectivity can also lead to the "2 - way road effect" where economic activity drains away from less prosperous regions to stronger regions.

Professor Whitelegg also cited that the principles of transport appraisal have not been followed and the adoption of a road-building option has not followed careful evaluation of all options, including the non-road building options. WebTag makes it very clear that there should be a sequential approach to dealing with transport problems followed by option listing and scoping and concluding with a clear and transparent comparison and evaluation of the options, leading to the selection of the best performer. This sequential approach has not been followed in the case of the M4 motorway. There is no evidence that "genuine, discrete options" have been identified and pursued and no evidence of the requirement to include "A range of solutions... across networks and modes." Professor Whitelegg stated that, for the avoidance of doubt, the WebTag requirements of "a range of solutions …across networks and modes" would include the "smarter" options, including the systematic application of workplace travel plans across the whole Cardiff-Newport corridor to reduce single occupant vehicle use and encourage modal shift to non-car alternatives.

He stated that there has been no detailed evaluation of the extent to which significant improvements in rail-based commuting opportunities could reduce vehicle numbers on this same corridor. The lack of robust and wide ranging option generation is a particularly serious defect in the case of the M4 relief road. He stated that it was very difficult indeed to avoid the conclusion that the M4 relief road, from the beginning, has been a "preferred modal solution" and a "solution in search of problems" as WebTag looks to avoid (para 2.8.3).

Professor Whitelegg stated that a reduction of peak hours traffic around Newport as a result of these non-road building measures by 21% is sufficient to deliver significant amounts of congestion relief without triggering the phenomenon known as "induced traffic" which has been proven by a remarkably robust and wide ranging body of evidence. He states that the M4 motorway proposal has not adopted a rigorous review of induced traffic and incorporated the findings from empirical evidence into the development of a road building option and the exclusion of non-road building options. The lack of attention to induced traffic means that congestion level is likely not to be reduced and a great deal of public money will be deployed in ways that cannot deliver the primary objectives of the project. It also means that VFM and BCR calculations are unsound and it cannot be right to proceed with a project based on flawed VFM and BCR calculations.

It is unacceptable that a major public investment of the scale contemplated by the matter before this Inquiry should proceed when there is an evidence base pointing to highly uncertain and contradictory outcomes that have not been addressed adequately by the promoters.

Sustainable Development

Professor Terry Marsden is the chair of Environmental Policy and Planning in the School of Geography and Planning at Cardiff University. He is the Director of the Sustainable Places Research Institute at Cardiff and was Co-Director of the UK Economic and Social Research Council's Research Centre for Business Relationships,

Accountability, Sustainability and Society (BRASS) at Cardiff University for 12 years. He has 25 years' experience working in the field of sustainability. He is one of Wales', if not the UKs, leading expert on sustainable development.

Professor Marsden has stated that Wales has a leading international position and reputation in developing environmental and sustainable development policy through the enactment of the Future Generations (Wales) Act 2015, the Environment Act 2016, and the climate emissions and change obligations associated with the Paris COP21 process.

Professor Marsden regards the proposed M4 scheme as a legacy proposal in the sense that it was conceived in earlier periods when carbonised solutions still held legitimacy both in the transport sector and in the wider economy. This is no longer the case. The proposal, in his view, is thus seriously out-of-date, and not commensurate with the obligations Wales is making to developing a post-carbonised transition for existing and future generations. Professor Marsden highlighted the urgency with which Governments around the world, including the Welsh Government, must take action to avoid dangerous climate change but this scheme does not do this.

He agreed that the 'blue route' proposal was a favourable alternative to the proposal.'
By contrast, John Davies MBE was to admit that he had no sustainability experience other than that incidental to decisions that he has had to make in the past. He maintained that on the most optimistic carbon emission increase of half a million tons of carbon from the project, that the break even date of 2072 meant that the project was sustainable. This of course flies in the face of the reality and timescales of global warming, and also the 80% reduction goals that the Welsh Government states elsewhere. Without any apparent basis he was to assert that so far as the Future Generations Commissioner interventions on sustainability were concerned, he was right and she was wrong. Sadly it highlights the Welsh Governments failure to address sustainability in any serious way. In truth it is a bolt-on afterthought to a historic project.

Mr Davies, in cross examination, stated that the scheme doesn't 'respect environmental limits'. However, if it does not respect environment limits then by definition, its unsustainable.

Conclusion

The M4 Scheme is the continuation of 'business as usual', not only in the face of the historic failures of such projects to prevent the problems that they claim to solve, but now also set against the well-recognised harm to our planet that this course has contributed towards.

The Scheme is right out of the 1960s play book. We need to stop doing the same things over and over again and expecting different results –

- building a motorway to bypass a motorway is like loosening your belt to fight obesity
- building a road will not create an economic boon

against all the weight of evidence from around the world and at home, including the CPRE report, road building is not the answer.

One of the 'ways of working' from the Well-being of Future Generations Act is 'preventative action' i.e. not to make things worse. However, in almost every conceivable way this scheme will make things worse, including climate change, ecology and transport. It is clear that the scheme:

- does not live up to the climate change measures / goals with the Environment (Wales) Act and the Well-being of Future Generations – as it will be carbon positive until at least 2072 – when, by 2050 we should have an 80% reduction.
- will lock us into carbon intensive futures and behaviours. It will not only create new generated traffic, but it will also hinder modal shift and legitimise non-sustainable behaviour.
- it will have little if any impact upon economic development in South Wales.
- will have a significant and long lasting damaging impact on many important habitats including the SSSIs wetlands and ancient woodlands, on vulnerable

and rare species. As such it does not comply with the Resilient Wales of the Well-being of Future Generations Act or the Environment Act.

This non-conformity with Welsh Government sustainability policies and legislation is a significant departure from legislative intention and is a serious matter. It represents a deliberate decision that is contrary to legislation, made in the full knowledge that there are many low carbon, zero carbon, and less ecologically damaging alternatives to the most damaging option.

This is the first test case of both the Environment (Wales) Act and the Well-being of Future Generations Act. We hope that a recommendation that the scheme is not progressed will send out a strong message, that Wales stands for sustainable development, not sustained development.

Notes:

1. https://blogs.wwf.org.uk/blog/green-sustainable-living/what-on-earth-are-sustainable-development-goals/

2. http://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm

3. http://unfccc.int/paris_agreement/items/9485.php

4. http://gov.wales/newsroom/environmentandcountryside/2015/150429-future-generations-act/?lang=en

5. https://naturalresources.wales/media/679409/chapter-8-summing-it-up-final-for-publication.pdf

6. Chapter 8 – Assessment of the sustainable management of natural resources

7. http://gov.wales/docs/desh/publications/170821-natural-resources-policy-en.PDF

8. http://gov.wales/docs/desh/publications/170821-natural-resources-policy-en.PDF

9. https://consultations.gov.wales/sites/default/files/consultation_doc_files/consultation_document.pdf

10. ID/061National Designated Sites Statement of Common Ground - Extent of loss 2.3.2

11. http://gov.wales/docs/det/consultation/140812-consultation-participation-report-en.pdf

12. http://wwf.panda.org/about_our_earth/all_publications/living_planet_index2/

13. See the scientific paper here http://www.pnas.org/content/114/30/E6089 or for the guardian article that highlights it https://www.theguardian.com/environment/2017/jul/10/earths-sixth-mass-extinction-event-already-underway-scientists-warn

14. https://www.wildlifetrusts.org/stateofnature16

15. https://www.wildlifetrusts.org/news/2013/05/22/state-nature-60-uk-species-decline-groundbreaking-study-finds

16. https://naturalresources.wales/evidence-and-data/research-and-reports/the-state-of-natural-resources-report-assessment-of-the-sustainable-management-of-natural-resources/?lang=en

17. http://gov.wales/docs/desh/publications/170821-natural-resources-policy-en.PDF

18. http://www.bbc.com/news/uk-wales-south-east-wales-20914482

19. http:\bailey.persona-pi.com\Public-Inquiries\M4-Newport\E - PI Documents\PID\ID061.pdf

20. http://webarchive.nationalarchives.gov.uk/20130402170324/http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf

21. http://gov.wales/topics/environmentcountryside/consmanagement/conservationbiodiversity/?lang=en

22. See the Explanatory Memorandum http://www.assembly.wales/laid%20documents/pri-ld10201-em/pri-ld10201-eme.pdf

23. https://research-information.bristol.ac.uk/en/publications/anthropogenic-ecosystem-disturbance-and-the-recovery-debt(1a216c25-fef4-4f52-95c8-18d6cc586875).html

24. http://onlinelibrary.wiley.com/doi/10.1890/13-0243.1/abstract

25. Since the 1970s, water vole numbers are thought to have declined by more than 90%.Water voles have declined by a fifth in the UK since 2011. http://www.bbc.co.uk/news/science-environment-23975749

26. Section 4.5.2. states "The following types/lengths of culverts are known to be effective in allowing the movement of water voles , based on the authors' personal observations: Over-sized box culverts up to 30–35m in length

27. Berthinussen A and Altringham JD (2015) Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure. Defra research report WC1060. http://sciencesearch.defra.gov.uk/Document.aspx?Document=12712_WC1060MAINReport.pdf

28. http://www.academia.edu/4558621/The_impacts_of_roads_and_other_infrastructure_on_mammal_and_bird_populations_A_meta-analysis

29. https://www.ncbi.nlm.nih.gov/pubmed/26324924

30. Britschgi A., Theiler A. & Bontadina F. (2004) Wirkungskontrolle von Verbindungsstrukturen. Teilbericht innerhalb der Sonderuntersuchung zur Wochenstube der Kleinen Hufeisennase in Friedrichswalde-Ottendorf / Sachsen. Unveröffentlichter Bericht, ausgeführt von BMS GbR, Erfurt & SWILD, Zürich im Auftrage der DEGES, Berlin.

31. https://www.wwf.org.uk/updates/extreme-weather-could-cost-our-economy-billions

32. Addressing climate change and biodiversity loss is a significant part of this goal. For example, Welsh Governments International climate change webpage states that an historic climate deal was agreed between nearly 200 countries at COP 21, the 2015 International Climate Conference. The agreement is the first to commit all countries to cut carbon emissions in order to limit the rise in global temperatures to less than 2ºC….and a clear pathway for decarbonisation… One of the seven goals of the Wellbeing of Future Generations (Wales) Act 2015 is to build a globally responsible Wales. See also http://gov.wales/docs/desh/publications/151125-infographic-a-globally-responsible-wales-en.pdf

33. http://www.bbc.co.uk/news/uk-38533517

34. Ibid

Plate 12: Northern edge of the Wentlooge Levels near Coedkernew

CALL FOR PAPERS

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The Healthy 10-Minute Neighborhood
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Complete streets
Vision Zero
Integrating public health and planning
How the built environment affects health
Health impact assessment
Health effects of nature
Health impact and mitigation of air pollution

Generating Neighborhood Community
Neighborhood plazas, sociable squares
Reclaiming streets for people
Child- and elder-friendly lifetime community
Form based coding for "Eyes on the Street"
Combatting loneliness, depression

The Ecologically Sustainable Neighborhood
Fighting climate change by urban design
Balanced transportation planning
Restructuring suburbia
Sustainability of vertical and horizontal sprawl
Green architecture, green urban design
Combatting food deserts, urban agriculture
Healthy green and blue urban ecosystems

The Equitable 10-Minute Neighborhood
Health equity planning
Inclusive and equitable communities
Mixed-income/affordable family housing
Stabilizing low-income home ownership
Community participation
Prioritizing accessibility in poor neighborhoods
Housing the homeless/preventing homelessness
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