THE BARTLETT SCHOOL OF PLANNING

# Incorporating Principles of Sustainable Development within the Design and Delivery of Major Projects: An international study with particular reference to Mega Urban Transport Projects

for

the Institution of Civil Engineers

and the Actuarial Profession

Working Paper 3

# The Perspective of the Civil Engineer

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Omega centre

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# 1. Introduction

This working paper has been prepared by Mark Hirst, Director of Development, Transport and the Environment at Capita Symonds. It provides a Civil Engineer's perspective of the treatment of Social and Environmental concerns in project appraisal with respect to Mega Urban Transport Projects.

## 1.1. Personal Background

Mark Hirst is a Chartered Engineer, a Member of the Institution of Civil Engineers and a Member of the Chartered Institute of Water and Environmental Management. Mark has been involved in the Development Industry in the United Kingdom since 1985. He has more than twenty years experience of the relationship between built development (residential, commercial, industrial and retail); infrastructure provision and the environmental and latterly, social impacts.

The working paper is written from a consulting engineer's perspective. The views of civil engineers in government / policy making organisations, contractors or operational organisations have not been sought as this project seeks to deal specifically with the design and delivery stages of projects.

## 1.2. Working Paper Structure

To be in a position to consider the Civil Engineer's perspective of the treatment of social and environmental issues the working paper needs first to establish the role of Civil Engineer in society and in the project delivery team. Use is then made of a number of case studies of transport studies to investigate social and environmental considerations which are drawn out in further individual sections.

Subsequent Sections of this working paper therefore address:

- The Role of the Civil Engineer in Society.
- The Role of the Civil Engineer in the Design and Delivery of Mega Urban Transport Projects.
- Case Studies.
- Environmental Concerns.
- Social Concerns.
- Conclusions and Recommendations for further appraisal.

## 1.3. Others Consulted

A number of fellow professional civil engineers and others within Capita Symonds have been consulted in the preparation of this working paper. These individuals have had specific responsibility for Capita Symonds work on the projects described in the case studies.

1.3.1. Jon Baber BEng MICE CEng

Jonathan Baber is one of Capita Symonds most experienced project managers and tunnel engineers and has worked on many prestigious international projects. He has extensive experience of designing for contractors on Design & Build projects and DBFO concession schemes for road and railway infrastructure. He is experienced in managing large multidisciplinary teams in fast track environments.

1.3.2. Richard Lunniss BSc MSc FICE CEng

Richard has extensive experience of managing major highway and rail infrastructure projects worldwide. Through his long career with Capita Symonds, Richard has built his reputation on the successful delivery of design and build contracts, from planning to implementation, with an emphasis on client focus. He has particular expertise in immersed tunnels and is one of the UK's leading specialists in this field. His expertise covers all aspects from the initial concept, through feasibility studies and procurement strategies, to detailed design, supervision of construction, and operation and maintenance.

1.3.3. Martin Beckett BSc MICE CEng

Martin Beckett is a highly experienced engineer with significant expertise in managing the design of major infrastructures projects. Through working with both engineering and contracting organisations he has developed an in-depth understanding of achieving the successful integration of design and construction. In addition, his work on a range of PFI deals gives him a strong appreciation of the development and key drivers for PFI projects

1.3.4. Jim Goodbrand BSc MICE FCIWEM CEng

Jim Goodbrand (BSc Civil Engineering) has over 40 years experience in different aspects of Civil Engineering, both in the UK and overseas. He has worked on numerous major projects in the ‘clean’ and ‘dirty’ sides of provision of water services, along with other aspects of civil engineering from conception (including masterplanning) through to construction of numerous residential, commercial and industrial areas, including holiday villages and a number of hospitals.

1.3.6 Roger Cooper MA(Hons) MALD CMLI

Roger Cooper is a qualified landscape architect who has increasingly focussed on the integration of environmental aspects in major development and infrastructure projects over his 30 years of experience.

# 2. The Role of the Civil Engineer in Society

## 2.1. Civil Engineering in 2009

The Institution of Civil Engineers strap line in 2009 is most revealing in understanding where the profession currently sees itself:

> ***"Civil Engineers at the heart of society, delivering sustainable development through knowledge, skills and professional expertise"***

The ICE website home page carries the following description of Civil Engineering

> Civil Engineering is all about **creating**, **improving** and **protecting the environment** in which we live. It provides the facilities for day-to-day life and for transport and industry to go about its work.
>
> Civil engineers **design and build** bridges, roads, railways and tunnels. They also design and build tall buildings and large structures, like Wembley Stadium, so that they can last for hundreds of years and can withstand all weather conditions.
>
> Like the Romans, Egyptians and Mayans who built great civilisations before us, our civilisation relies more than ever on teams of **inventive people** to design, build and maintain the sophisticated environment that surrounds us.
>
> Without civil engineers we wouldn´t have a constant supply of clean water, roads or trains to get to work in the morning, or sustainable energy to help us save our planet.

Pulling some key phrases out of these brief statements it is clear that the professional body seemingly acknowledges at a high level that civil engineers are:

- at the heart of society;
- part of teams of inventive people who design, build and maintain the facilities for day to day life.

It is interesting to note the restriction of the civil engineer's role to "design, build and maintain" and the absence of the words **"promote"**, **"plan"** and **"manage"**. The role of the Civil Engineer is therefore presently one, very much, as part of a team of professionals supporting the delivery of projects. This issue is discussed further in Section 3.

Whilst the Romans, Egyptians and Minoans were undoubtedly at the forefront of creating great civilisations, civil engineering truly came to the fore in the UK as a profession in the late 18th and 19th Century.

## 2.2. Isambard Kingdom Brunel and the Engineering Entrepreneurs

The Institution of Civil Engineers was founded in London in 1818, and in 1820 the eminent engineer Thomas Telford became its first president. The Institution received a Royal Charter in 1828, formally recognising civil engineering as a profession. Its charter defined civil engineering as:

> "...the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and application of machinery, and in the drainage of cities and towns."

Comparing this with the current description of the profession, the notable difference is the use of the term “directing” in the original charter.

Telford and his contemporaries, Brunel and Bazzalgette were not only civil engineers, they

- promoted concepts and schemes
- influenced government and decision makers
- raised finance,
- directed projects through planning, design and construction,

In the truest sense of the word they were Entrepreneurs.

Thomas Telford’s most influential projects included:

- The bridge carrying the London to Holyhead road over the river Severn at Montford,
- The Ellesmere Canal linking the ironworks and collieries of Wrexham with the Chester and including the Pontcysyllte Aqueduct over the River Dee.
- The masterplan for the improvements of communications in Scotland including the Caledonian Canal and the Crinan Canal and some 920 miles of new roads
- The reconstruction of large sections of the London to Holyhead road.

As well as being perhaps the most famous Civil Engineer of all times, Isambard Kingdom Brunel was also an innovative provider of solutions to long-standing problems both as a maritime and mechanical engineer. Brunel's notable Civil Engineering achievements included:

- The Thames Tunnel – originally a pedestrian tunnel from Rotherhithe to Wapping, then part of the East London Underground line and currently being refurbished to form part of the London Overground system.
- The Clifton Suspension Bridge linking Bristol to North Somerset
- The Royal Albert Bridge providing the rail connection over the River Tamar
- The Great Western Railway from London to Bristol, including the Box Tunnel and Paddington Station.

Sir Joseph Bazalgette began his career working on railway projects but is most famous for the creation of the central London Sewer Network, thereby beginning the clean up of the River Thames and proving a solution to the Great Stink of 1858.

All of these projects had huge social and environmental consequences and it was the civil engineers who provided the vision and leadership to see them from inception to completion.

In the 21st Century, the Civil Engineering profession is seeking to re-establish its pre-eminence in society as the leading profession in creating the infrastructure for a sustainable society. Tom Foulkes, Director General of the Institution of Civil Engineers raised this issue in a recent article in the Proceedings of the Institution of Civil Engineers – Civil Engineering 2009, 162, No. CE2.

*"Infrastructure is in the news. It seems that hardly a day goes by without a new civil engineering topic igniting emotional fires all over the UK. Heathrow expansion, congestion charging, flood prevention, power generation – all theses and more are hitting the headlines and sparking debates that rage through parliament and society at large. ……*

*It is clear that members want the profession's image to be built to a level where it has genuine influence on politicians and decision makers. ….*

*The Institution will contribute nothing by offering superficial platitudes or refusing to come off the fence. To achieve genuine influence, ICE must draw on its professional expertise and adopt a viable public position that it believes to be right and justify it when questioned. ….*

*Civil Engineers rightly want to be recognised at the heart of society, influencing government policy and ensuring sustainable growth in the UK and all around the world. To achieve this ICE must make its voice heard on the key issues of the day."*

# 3. The Role of the Civil Engineer in the Design and Delivery of Mega Urban Transport Projects

## 3.1. The UK System for planning and delivery of new infrastructure

The system for delivery of major infrastructure projects in the UK is currently going through a major review and update with the establishment of the Infrastructure Planning Commission. Government proposes to update the planning system specifically to speed up the decision making process.

The need for major infrastructure will be identified and promoted by government through National Policy Statements where, to date this has been achieved through Green and White papers. One recent example was the production of “The Future of Air Transport” which, through a process of lengthy consultation identified the Government’s proposals for the provision of runway, and hence airport capacity across Scotland, Wales, Northern Ireland and England.

As an example of the complexity and time consuming process required for taking forward a major transportation project under the existing system it is worth looking at the background to the Crossrail project.

The Central London Rail Study of 1989, commissioned by Government, proposed three projects, East-West Crossrail (now Crossrail Line 1), a new Underground line to link Wimbledon and Hackney (now Crossrail Line 2) and an extension of the Jubilee line. Work was started by London Transport and British Rail to develop these schemes. In 1991, a Bill was submitted to Parliament for the East-West scheme. Unfortunately, in 1994 the bill was rejected as the then recession temporarily depressed passenger journeys into and through the capital. Despite the decision not to proceed, the government issued Safeguarding Directions to protect the alignments of the lines through Central London, to ensure that no developments would be built which would prevent the schemes from being built.

In 2000, with both the Underground and National Rail networks now suffering record levels of congestion and a resulting decline in service reliability, the Government asked the Strategic Rail Authority (SRA) to study the requirements for extra passenger capacity to and through London. The London East West Study, prepared in response to that request, sets out the issues such as network capacity, congestion, growth and regeneration. It identifies a programme consisting of complementary and incremental projects that will create a railway network appropriate to London’s status as a World City.

The Study recommended that both the East-West and Hackney-SouthWest routes be resurrected and schemes developed to construct them. To achieve this aim a unique 50/50 Joint Venture company was formed in 2001 which is now owned by Transport for London and the Department for Transport. This company was tasked with defining the routes, as well as developing and promoting these two new railway routes.

In July 2008 the Crossrail Act received Royal assent giving the powers to construct the Crossrail Line One railway. The route of Line Two or the Chelsea-Hackney Line remains safeguarded. Crossrail is discussed further in Section 4 of this Working Paper.

Lesser, but none-the-less still significant, schemes tend to be promoted by Government Departments such as the Highways Agency. The need for the scheme tends to be determined by Transport Planners, their viability appraised by economists or financial consultants and their feasibility assessed from a construction and cost perspective by civil engineers. Such schemes are still subject to stakeholder consultation and approval through the planning process. A typical example of sucha project is the M25 Holmesdale Tunnel improvement works which is discussed in Section 4.

Civil Engineers are clearly involved in the promotion of these major infrastructure projects through the process of Consultation – along with other professions from business/industry, environmental groups, economists, finance.

3.2. How and When Civil Engineers get involved

Infrastructure delivery can therefore be seen from the above to be subject to a classic approach based on:

- Plan,
- Design,
- Construct,
- Operate/Maintain

At the **Planning** stage, Civil Engineers are principally involved in the process as stakeholders/advisers.

During the **Design** stage, (and following planning approval) Civil Engineers tend to lead the process.

**Construction, Operation and Maintenance** also tend to be civil engineering lead processes.

Civil Engineering can therefore be seen to be a “back-ended” profession – compared to its roots in “leading” and “directing” through its Victorian pioneers.

3.3. A typical Design / Construct project team

In the 21st century, an infrastructure project team will consist of a range of professions and advisers:

- Client
- Project Manager
- Civil Engineer (Structural Engineer)
- Environmental Consultant
- Safety Consultant
- Cost Consultant

- Project Finance
- Consultation / Communications
- Socio-economics

This is in marked contrast to the projects led by Telford, Bazalgette and Brunel where the civil engineer typically fulfilled all of these roles.

The expansion of the team reflects the expanding legislative framework, regulatory and policy context, and changing standards, expectations and perceptions amongst regulatory authorities, developers, owners, funders, users, and those (and/or on behalf of those) receptors that are impacted. Whilst often the champion of sustainability and coordinator of environmental issues may well be the Environmental Consultant, the interdependency of decisions and effects means that an integrated approach must be followed with and common ownership of goals accepted to achieve not only compliant and acceptable environmental performance, but also deliver the improvements that are expected by today's society. Some selected key context for the incorporation of sustainable development within the design of major projects, particularly MUTP's, has been set by the development of Highways Agency appraisal methodologies, the introduction of the CEEQUAL awards scheme, the development by the financial sector of the Equator Principles (in respect of funding for major projects) and Council of Europe guidance on landscape and biodiversity considerations in the transport sector, as discussed below.

*Appraisal Background*

Systematic analysis and modelling of urban transport systems has its origins in the US some 50 years ago, spreading to Europe within a decade. By comparison, however, similarly sophisticated systems for the identification of environmental and social effects of lagged behind. Impact studies originally developed in national law (in the United States and France), but international law has been seeking to generalize these obligations until later in the 20th Century. When the UK Government's then Department of Transport's "Manual of Environmental Assessment" (MEA) published in 1982, it was in the forefront of such guidance for roads, or indeed any particular project type. A structured appraisal and detailed approach to the environmental assessment process has been consistently used as a decision making tool in the promotion of trunk road schemes in the UK since the publication of the MEA. The EC 1985 Directive on Environmental Assessment along with other changes to environmental protection legislation set a context for improved guidance and the MEA was superseded by Volume 11 Design Manual for Roads (DMRB) - originally published a decade later in 1993. Further to placing environment firmly alongside a suite of standards in the (currently) 15 volume manual and refining and extending the methodological basis of environmental assessment, the DMRB importantly introduced the standardization of the scale/depth of appraisal effort according to the stage of the scheme in the promotion process. Whilst specifically developed for use as a guide for the promotion, design and impact assessment of roads, in respect of environmental appraisal methodology it set standards that were recognised as being applicable to other types of projects also, with widespread use by engineers and consultants as an important reference, particularly for linear infrastructure developments.

A further step forward in transport project appraisal came in 1998, with the introduction of the New Approach to Appraisal (NATA), which was introduced as part of the 1998 Integrated Transport White Paper as a multi-criteria decision analysis based tool that built on the earlier environmental assessment and cost benefit analysis techniques. Within the NATA framework, the impacts of transport projects are categorised in terms of five high level criteria aligned with HM Government's overarching objectives for transport (viz: economy, safety, environment, accessibility and integration), each of which is further divided into a number of sub-criteria. The impacts of a proposal are assessed against each of these sub-criteria, variously expressed in monetary terms, quantitative measures or some just in qualitative terms and presented in a 1 page Appraisal Summary Table (AST) and supported by backing work sheets to collate the range of cost-benefit and environmental data.

Supporting analyses recommended by WebTAG cover three additional groups of issues that do not easily fit within the Appraisal Summary Table. These issues are:

- distribution and equity which aims to show the distribution (spatially, across modes, etc.) of the impacts of the solution, thus enabling an assessment to be made about the fairness of impacts on those affected;
- affordability and financial sustainability which aims to outline the financial performance of the solution, identifying public and private sector input; and
- practicality and public acceptability which follows a checklist that includes such measures as feasibility, area of interest, complexity, time scale, phasing, and political nature of solution.

WegTAG at least partially covered social considerations but perhaps, as the NATA Refresh consultation (see below) suggested, it maybe does not go far enough.

Following its introduction, various parts of the appraisal guidance (including particular DMRB topic assessment methodologies) have been updated from time to time. The introduction of, the now subsumed, Guidance on the Methodology for Multi-Modal Studies (GOMMMS DETR March 2000) being significant, providing an methodological approach to appraise more multimodal strategies and proposals and including additional qualitative objectives.

The framework contains a number of tools, chiefly WEBTAG, which is the actual tool for appraisal, whilst the NATA framework acts as guidance for completion of the WEBTAG/AST process and informs the emphasis and coverage of it. The Department for Transport initiated this website in 2003 to provide detailed Transport Analysis Guidance (TAG) on the appraisal of transport projects and wider advice on scoping and carrying out transport studies, restructuring GOMMMS and the associated guidance into a family of web-based TAG Units. The guidance is seen as a requirement for all projects/studies that require government approval, including road, rail and other modes. For projects/studies that do not require government approval, it is recommended that TAG should serve as a best practice guide.

Whilst as noted above the site originally brought together the Department's existing documents, The Guidance on the Methodology for Multi-Modal Studies (GOMMMS) and associated supplements and errata, Applying the Multi-Modal Approach to Appraisal to Highway Schemes (The Bridging Document) and Major Scheme Appraisal in Local Transport Plans, the material on the WebTAG site now supersedes these documents.

The guidance includes or provides links to advice on how to:

- set objectives and identify problems;
- develop potential solutions;
- create a transport model for the appraisal of the alternative solutions; and
- how to conduct an appraisal which meets the Department's requirements.

Another more recent change saw the basis of the DMRB assessment approach shifting to a consequential, rather than sequential one.

NATA remains the actual analytical framework used to appraise economic, environmental and social impacts of all transport proposals that require Department for Transport funding or approval. Hence, the process is geared principally toward decision making in the funding process rather than a system for identifying routes themselves. It is used, however, to inform option selection. NATA generates options and can have road vs rail and other choices. The question is whether or not this process is robust, adequate and defensible (the NATA Refresh consultation responses suggested maybe not). WebTAG advises on options for solutions (1.6 Step 5): Options for Solutions.

In response to recommendations made by Sir Rod Eddington and Sir Nicholas Stern in their recent Reviews in 2006 and to issues emerging after a decade of use and also to adapt NATA to the new Delivering Sustainable Transport System (DaSTS), however, a more fundamental and overall review has been carried out – NATA Refresh.

*NATA Refresh*

Following a period of consultation on better capturing of impacts and issues around five principal themes:

- transport policies and schemes on productivity and competitiveness
- environmental impacts, particularly valuing carbon emissions, landscape impacts and changes in air quality;
- equality issues;
- greater comparability across modes and different types of intervention; and

- reflecting uncertainties (in forecasting and understanding of valuations and behaviours),

the Refresh programme aimed to:

- ensure the appraisal system would closely reflect the goals and challenges faced by our transport system;
- strive to create a system that would better discriminate between more and less effective options and secure better value from spending ; and
- reduce the overall burden of effort associated with appraisal.

The DfT reported on the Refresh programme very recently (*NATA Refresh: Appraisal for a Sustainable Transport System* Department for Transport April 2009). The Refresh programme is ongoing, but one of the aspects it is looking at is greater inclusion of social and distributional impacts of new and upgraded transport infrastructure. A key finding of a recent study has within this area was that the environmental effects of transport schemes often affect different social groups to varying degrees. This is as a result of the locational distribution of different socio-economic groupings in relation to transport corridors and the associated spatial parameters of the impacts and hence exposure to them (such as noise; air quality; accessibility; severance; affordability or financial impacts; distribution of user benefits; personal and road safety). These will be eventually reflected more within WEBTAG once all the usual consultation etc has gone on.

*CEEQUAL* (www.ceequal.com)

The ICE's Environment and Sustainability Board's mission to promote the application of sustainable development principals into all areas of the Institution's activities resulted in it leading the cross industry team (including BRE, CIRIA, CECA and ACE) that developed the CEEQUAL scheme (Civil Engineering Environmental Quality Assessment and Awards Scheme), which was launched in September 2003. Gaining a CEEQUAL Award celebrates the achievement of the whole delivery team as an organisation that measures and compares standards of performance, respects people and the society in which it operates, seeks to undertake its work in an ethical and sustainable manner, acts in a socially and environmentally responsible way and also protects and enhances the environment.

By 2008, the value of projects being assessed under CEEQUAL had reached some £6 billion and the importance of the initiative in promoting the design agenda for civil engineering and infrastructure projects was identified by HM Government in their Strategy for Sustainable Construction (June 2008) . Its prime objective encourages the attainment of environmental excellence in civil engineering projects which go beyond the legal and environmental minima to achieve distinctive environmental standards of performance. It thus delivers improved environmental performance in project specification, design and construction through evidence based achievement of performance indicators in 12 topic areas standards. The most recent version (November 2008) provides a significant update through the inclusion of new questions that address climate change issues through identifying carbon emissions

and whole-life-cycle carbon analysis. This encouragement of higher standards is particularly, and importantly practically, beneficial in driving forward the sustainability, social and environmental credentials of civil engineering projects.

*Equator Principles* (www.equator-principles.com)

In 2002, elements of the financial sector recognised the need to develop a method for checking that the projects that they were going to support had been assessed against an appropriate set of environmental and social standards, enabling them to form opinions on those projects' social and environmental risks. This was formalised in 2003 as a set of performance standards on these issues, adopted as a voluntary commitment by (initially 10, but by 2008 over 60) international banks and other financial institutions. These standards were modelled on the social policies of the International Finance Corporation (IFC) and the environmental standards of the World Bank, and became known as the Equator Principles (EPs). They were to be applied globally to all new project funding, and set out the need for social and environmental assessment, performance management and community engagement. The EPs were reviewed and revised in 2006.

For emerging markets, where project evaluation and the development and application of regulatory frameworks are often not as mature, they were relatively more demanding, particularly in relation to labour and working conditions; pollution prevention; community health ; land acquisition and resettlement; biodiversity conservation and sustainable resource management; indigenous peoples; and cultural heritage. The EPs set out 10 main Principles, which may be summarised as:

- Principle 1: Review and categorisation of projects
- Principle 2: Social and environmental assessment
- Principle 3: Applicable social and environmental standards
- Principle 4: Action plan and management system
- Principle 5: Consultation and disclosure
- Principle 6: Grievance mechanisms
- Principle 7: Independent review
- Principle 8: Covenants
- Principles 9 and 10: Independent monitoring and EPs reporting

Whilst not itself a methodology, the importance of attracting funding for the implementation of major projects can exert significant influence on their design parameters and construction methodologies such that the Principles, if applied with rigour, could become an important driver in shaping projects and in particular their environmental and social performance. In practice, however, against a background of perhaps even greater political and public awareness on social change and consultation processes, and especially on factors influencing climate change since

the update, there is a danger that this potentially positive influence becomes merely a 'tick-box' exercise.

*Council of Europe*

The Committee for the Activities of the Council of Europe in the field of Biological and Landscape Diversity commissioned studies which informed the preparation of a pan European Code of Practice for the Introduction of Biological and Landscape Diversity Considerations into the Transport Sector (Council of Europe 2003, Nature and Environment Paper no. 131). The Code relates to linear transport systems (roads, railways and inland navigation) and provides '*a practical instrument that will help national governments and others involved in the linear transport sector to consider and implement measures relating to the maintenance and enhancement of biological and landscape diversity.'* Whilst recognising that there are differences between the modes, there are also key commonalities across the sector that enabled the Code to develop a series of practice pointers that are characterised under four headings, viz:

- Procedures effecting decision makers, including conservation and enhancement
- Knowledge and understanding
- Project development and management
- Assessment, review and research

In assisting the understanding issues and developing solutions that support the sustainable development of transport systems, the Code is thus a useful tool for decision makers, practitioners and nature conservation bodies (as well as elected representatives) at all stages of the scheme identification and promotion process.

# 4. Case Studies

## 4.1. Introduction / Background

To obtain a civil engineer's perspective on the social and environmental concerns associated with the design and delivery of mega urban transport projects, a limited number of recent schemes have been identified in which Capita Symonds have had direct involvement. These are:

- Crossrail
- The Øresund Crossing
- The Ebbw Valley Railway
- M25 Holmesdale Tunnel Improvement Works
- Fastrack at Ingress Park

This section provides a brief description of these projects in order that their context can be appreciated.

## 4.2. Crossrail

Efficient transport systems are the key to reducing travel congestion and disruption. Crossrail represents probably the most important infrastructure development for London and the UK as a whole.

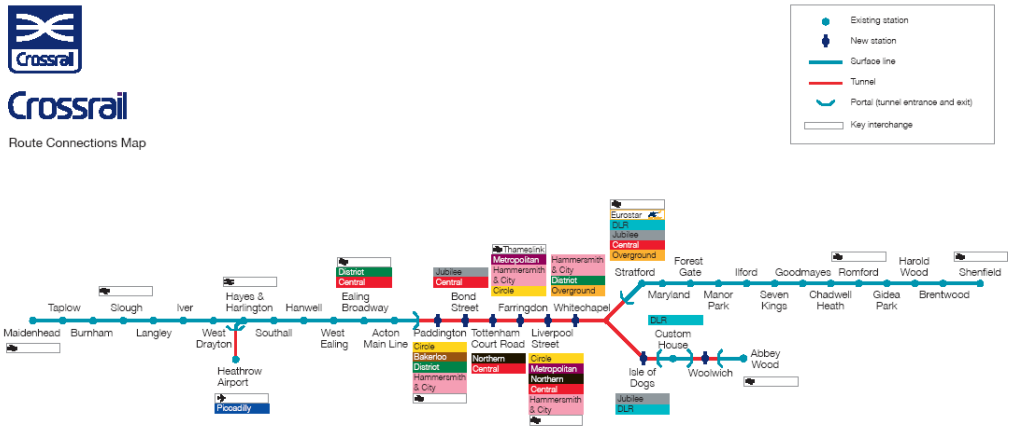
There are serious implications in not building Crossrail. Congestion on an already overcrowded system will worsen and conditions for passengers will suffer. There is also the possibility that, faced with a transport infrastructure not meeting the dynamic needs of an expanding city, international business will relocate to Europe, away from the UK altogether.

However, business has also said that it does support Crossrail and is prepared to meet some of the cost.

Crossrail will:

- Establish a brand new network of services linking areas across London and beyond.
- Allow existing suburban rail services to run through London.
- Reduce overcrowding on Underground lines as well as reducing congestion at a number of busy National Rail stations.
- Provide a major boost to the development of London's integrated transport network.
- Ensure that features such as full access for people with restricted mobility are included as an integrated part of the design.

By bringing about these improvements, Crossrail will make a significant contribution to tackling the problems facing the infrastructure of the South East.




**The overall objectives of Crossrail are**

- to support the continuing development of London as a World City, and its role as the key financial centre of the UK and Europe
- to support its economic growth and its regeneration areas by tackling the lack of capacity and congestion on the existing network
- to improve rail access into and within London.

Specifically Crossrail needs to:

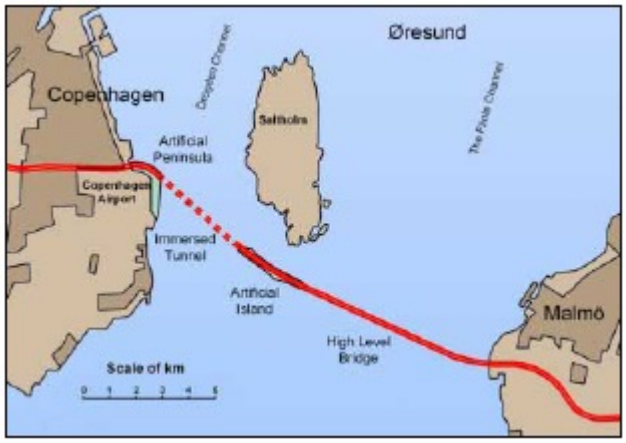
- Support the wider transport, planning, social and environmental objectives of the Government's current transport strategies, the Mayor for London's Strategies for London, and Regional Planning Guidance
- Relieve congestion and overcrowding on the existing National Rail and Underground networks and support the development of a network of strategic interchanges
- Facilitate the continued development of London's primary finance and business service activities, which are now located in both the City and Docklands
- Facilitate the improvement of London's international links, including Heathrow
- Facilitate the regeneration of priority areas, such as the Thames Gateway and the Lea Valley
- Provide improved east-west rail access into and across London from the East and South East regions
- To meet these objectives Crossrail needs to be feasible from both operational and engineering points of view, environmentally acceptable and value for money.

## 4.3. The Øresund Crossing

Proposals for a fixed link between Denmark and Sweden go back as far as the mid-nineteenth century, but it was not until the 1950's that momentum toward a

technically and politically feasible solution really gathered. This culminated in the two governments signing an agreement in 1973. Again political and economic issues intervened until the 1980's, when the proposals in their current form came together, but this at a time when environmental regulation and awareness were also shaping projects.

In 1991, the Danish and Swedish governments signed an agreement to establish a fixed link across the Øresund. The agreement was ratified by the two countries' parliaments in August of the same year. Øresundskonsortiet, a joint venture between A/S Øresund and Svensk-Danska Broförbindelsen SVEDAB AB, constructed the permanent link between Sweden and Denmark. The project cost more than DKK12 billion and forms a 10-mile link between Copenhagen and Malmö consisting of a tunnel, a bridge and an artificial island.




Through the agreement, the two governments each hold a 50% stake in Øresundskonsortiet. The project was officially started when The Danish Ministry of Transport approved the general design, alignment and environmental conditions for the Øresund Link on Danish territory. Once completed in March 2000, the bridge was handed over to the client Øresundsbro Konsortiet by the contractor Sundlink. In April, the tunnel and the artificial island Peberholm were handed over to the client Øresundsbro Konsortiet by the contractors ØTC and ÖMJV. The Øresund Bridge was inaugurated in July 2000.

The whole project consisted of the construction of a bridge, a tunnel and an artificial island between the two countries that stretched 16.4km. The tunnel construction contract had a value of DKK3.98 billion. The contract for the artificial island had a value of DKK1.4 billion and the contract for the construction of the high bridge and the two, two-level approach bridges with the motorway on the upper level and the railway on the lower level had a value of DKK6.3 billion.

In May 2003 the Øresund Bridge won the IABSE Outstanding Structure Award. The judges commended the project for its innovative planning, design and construction management as well as its compliance with the time schedule, budget and tough environmental requirements.

The western part of the Øresund Link is a 4km-long tunnel between the artificial island of Peberholm and the artificial peninsula at Kastrup. The tunnel is the longest immersed tube tunnel for both road and rail traffic in the world. It consists of 20 tunnel elements.

The artificial island of Peberholm was built in order to transfer the traffic from the immersed tunnel up onto the approach bridge. Peberholm is approx. 4km long and mainly made up of dredged material from the Øresund seabed. A total of 1.6 million m³ of stone and 7.5 million m³ of sand and dredged material were required for its completion.

The artificial peninsula at Kastrup, which accommodates the portal of the Øresund tunnel, was constructed by Øresund Marine Joint Venture (ØMJV). It covers 0.9km² and is made up of dredged material from the Øresund seabed.

Capita Symonds was designer to ØTC, a joint venture of NCC, Laing, Dumez GTM, Pihl and Boskalis for the £450m design and build contract. We worked closely with ØTC during pre-tender and tender stages to develop a design that took full advantage of the economies of scale possible with such a large scheme.

The 4km tunnel crosses under the Drodgen navigation channel from a new artificial peninsula adjacent to Kastrup Airport to a new 4km long artificial island where the route transfers to a bridge for the remainder of the crossing. The tunnel lies in a trench dredged into the Copenhagen limestone beneath the sea bed. It carries a dual carriageway road and a high speed railway.

## 4.4. Ebbw Valley Railway

The Ebbw Valley Railway Project involves upgrading the existing Network Rail owned freight railway between Ebbw Vale and the South Wales Main Line. The old line, up through the valleys to Ebbw Vale, last carried passengers in 1962, after which it was turned into a freight line to service the Corus steelworks. When the plant closed in 2002, the freight line did too. The Ebbw Valley Rail Project was conceived to permit reinstatement of passenger services on the route.

The scheme is being managed on behalf of Blaenau Gwent County Borough Council with key stakeholders; Arriva Trains Wales, Caerphilly County Borough Council, Newport City Council, Strategic Rail Authority and Welsh Assembly. Blaenau Gwent are directly procuring the works under an asset protection agreement with Network Rail.

The project objectives include:

- Providing public transport services which meet the needs of people living in the Ebbw valley
- Providing access to work, education, training, health & leisure opportunities
- Providing a catalyst to stimulate economic regeneration in Blaenau Gwent and Caerphilly County Boroughs
- Providing environmentally sustainable alternatives to the car, particularly for travel to the M4 corridor and coastal plain
- Promoting social inclusion

Passenger services recently re-commenced with a direct hourly service between Ebbw Vale Parkway and Cardiff Central Station. Six new stations serve communities along the route and connecting bus services link Ebbw Vale to Ebbw Vale Parkway Station and Abertillery to Llanhilleth Station.

It is proposed to introduce an hourly service to Ebbw Vale Parkway – Newport in the future.

4.5. M25 – Holmesdale Tunnel Improvement Works

The M25 Junction 25 Improvement and Holmesdale Tunnel Refurbishment Scheme is a Highways Agency project to reduce congestion and refurbish the tunnel to address dilapidation and mitigate escalating maintenance and operational risks.

The Holmesdale Tunnel was constructed in 1983 as part of the M25 North Orbital Motorway. It is 650 metres long and of 'cut and cover' construction consisting of two parallel bores separated by a dividing wall. The bores share common portals and the tunnel is located in a semi urban location with overlooking residential areas, and a playing field and crossing side road on the roof above.

The scheme involves adding a short additional eastbound lane through the junction and extending it through the eastbound bore, together with a new ventilation system for pollution control during congested traffic conditions and smoke control in emergency (fire) incidents. The tunnel refurbishment works also include installation of fire protection and complete replacement of the mechanical, electrical, operational and communication systems.

The works were carried out as a Highways Agency Early Contractor Involvement (ECI) project with an overall scheme budget is £53m and Construction Costs estimated at £35m. The contract period commenced in August 2005 and construction started in early 2006. Construction works were carried out 24hrs per day, 7 days per week.

The Capita Symonds team has been working on the Project since August 2005 as Designers to the ECI Team. During that time the target construction cost has been reduced from approx £78m to £57m through a series of formal and informal value engineering exercises which focussed on the safe operation of the tunnel while removing any unnecessary work and work that could be completed at a later date without disruption to traffic.

In an innovative approach to inspection and surveillance of the site work, the Designer’s and Employer’s Supervisor’s site teams were merged to provide an Independent Quality Verification Team.

4.6. Fastrack at Ingress Park

Fastrack is Kent Thameside’s innovative and award winning Bus Rapid Transport system, with many of the advantages of a light railway system, but with all of theflexibility of a bus system, Fastrack will ultimately connect nearly all the major developments in the Dartford area.

There will be certain core express routes on which only Fastrack services will be allowed to run. Crest Nicholson (South East) Limited are committed, as part of their

development of the Ingress Park site, to provide a section of such a core route, from where it enters the Ingress Park site to where it joins the existing main spine road of the site.


Where the route enters the site, it is in a tunnel, enabling it to pass under an adjacent road. Then, when it emerges from the tunnel, it is in a considerable amount of cut, and, because of various constraints (amongst others, a listed structure and a distinct lack of available space), the sides of the excavation will be retained by contiguous piled walls. After the route passes out of the excavation, returning to existing ground level, it will be carried on piled raft slabs because of very poor ground conditions.

Beyond the piled raft section of roadway, there is a listed structure under the road, known as “The Cave of the Seven Heads” and the road is carried over this on what is, essentially, a bridge structure. At the other side of this bridge a hinged slab is to be installed to allow for possible differential settlement and Fastrack will then, again, because of poor ground conditions, run on a reinforced earth base until it joins the existing site spine road.

Capita Symonds has been involved in the Ingress park project since 1995. We have been retained to provide inputs to the planning process and engineering design and construction services, from concept through to commissioning. Numerous possibilities for the various sections of this highly complex project were investigated before the final design was arrived at. As this will be an adopted highway, under the appropriate acts, Capita Symonds consulted with the Highway Authority and obtained all the approvals that were required from them, to enable this adoption to take place.

# 5. Environmental Concerns

## 5.1. Introduction / Background

The projects that Brunel, Bazalgette and Telford took forward in the 18th and 19th centuries all had huge social and environmental consequences. At that time it was the civil engineers who:

- provided the vision and leadership to see them from inception to completion;
- provided all of the technical knowledge and capability necessary;
- acted as project sponsor; and,
- secured project finance.

Since the foundation of the Institution of Civil Engineers in 1818, and the receipt of its Royal Charter ten years later in 1828 many other professional bodies have been established including:

- The Chartered Institute of Water and Environmental Management (CIWEM) in 1987 (receiving its Royal Charter in 1995 (and its forerunner the Institute of Public Health Engineers )
- The Institute of Environmental Management and Assessment (IEMA) in 1998.
- The Royal Town Planning Institute (RTPI) in 1914 (receiving its Royal Charter in 1959)
- The Royal Institute of Chartered Surveyors (RICS) in 1868
- The Institute of Highways and Transportation (IHT) in 1930.
- The Landscape Institute (founded 1929, Royal Charter 1997)

This reflects the degree to which technical specialisation has increasingly developed in the provision of skills for projects and the marked shift in emphasis on these issues.

## 5.2. Environmental Awareness

Project teams for the design and delivery of Mega Urban Transport teams typically include specialist environmental consultants across the broad range of issues covered by this discipline from Air Quality, Archaeology, Ecology, Ground Conditions, Landscape and Visual Impact, Noise and Water Environment. Civil Engineering projects therefore rely heavily on these environmental technicians and Civil Engineers now work in an integrated manner with environmental specialists as part of integrated project teams. Civil Engineers are therefore generally aware of the issues and work with the environmental specialists to minimise the impact of schemes or to mitigate their impact both during the design and construction phases.

## 5.3. Environmental Issues associated with the Case Study Projects

### 5.3.1. Crossrail

The "Crossrail concept has been around for more than twenty years, following the principles of the Thameslink north to south rail route. The route of the assented Crossrail scheme is therefore one which has been established in broad principle for some time. The majority of the surface route to the West and East of Central London uses existing surface rail routes. The majority of the route across Central London will be underground and this principle was generally established at the outset of the project.

With no logical alternative, the environmental impact of the scheme was therefore minimised at the planning stage, almost by default. Nevertheless, a optioneering process was undertaken in 2001 which included consideration of environmental effects. Crossrail's major impact will potentially be the reduction in emissions brought about by the use of "mass transit" (as opposed to the private car). It is the Transport planning profession that had the most technical influence in this outcome.

The Crossrail project was subjected to a full environmental impact assessment and submission of a formal Environmental Statement as part of its progress through the Hybrid Bill approval to Royal assent. Following assent, engineering development of the scheme continues to be subject to tight environmental controls through the Environmental Design Management (EDM) process. This tests the scheme at key stages against preset parameters contained in the Environmental Minimum Requirements. Further, from RIBA stage D onwards a bespoke CEEQUAL/BREEAM scheme will operate.

The principal area of involvement for Civil Engineers was in the evaluation of Construction Related Impacts which related to the use and re-use of materials, through a Waste Management Strategy. Given the need to construct several kms of tunnel, a key issue is the transport, disposal and recycling of fill material arising and the associated environmental effects. Hence, a key driver in the preparation of the works phasing was to programme sections, where possible, such that arisings from tunnel drives and shaft excavation could be 'exported' outside of central London using previously partly completed tunnels to minimise HGV movements. Further, locations for sorting/recycling and storing of bulk materials were subject to environmental screening to manage (down) their impact potential. The environmental impact will be minimised by the transport logistics (moving materials principally by rail) and the potential for the reuse of the arisings in land use either to provide capping material for the remediation of contaminated land sites or in land raising to counter flood risk.

### 5.3.2. The Øresund Crossing

As indicated above, the current proposals took shape in the context of increasing environmental regulation and awareness and the scheme's promotion was accompanied by significant environmental concern. The Environmental Impact Assessment, submitted in 1992, ran to some 40 reports. Some 4 years of procedural

determination followed, which included the resignation of the Swedish minister for the environment as a result of his concerns over its impact.

The Øresund link Use of the immersed tube tunnelling technique coupled with a bridge meant that one of the principal long term environmental impact of the The Øresund Crossing was the creation of the artificial Peberholm island, where the tunnel and bridge interface. At the early design stage, works were considered on the neighbouring existing natural island of Saltholmen, but this would have caused impact to natural habitat and associated bird life and seals. There were also potentially significant construction related environmental impacts associated with the project.

The potential impacts related to the hydrodynamics of the Øresund itself were of particular concern. The flow of salt and oxygen rich waters of the Kattegat into the Øresund Sound are vital to maintain both the marine environment and its ecosystem and support the cod stocks on which an important fishing industry was based. Design changes, including the shape of the artificial island, were introduced to minimise the effects on the complex currents and reduction in flows eliminated through further mitigation - dredging of the sea-bed. This in itself was not without its problems, however, since disturbed sediment could impact on marine life, notably mussel-banks and eel-grass and in turn fish and birds which feed on them. Dredging works were also required to create the trench for the tunnel elements, with potentially equal harmful effects to create turbidity in the marine waters which might have impacted on the marine flora and fauna and ultimately resulted in the deposition of silt.

The majority of these issues were addressed by specialists in hydrodynamic modelling (who would, for an equivalent UK project, be members of CIWEM) and marine ecologists working with civil engineers to minimise and mitigate the impact. This included a strict regime for the control and monitoring of suspended solids were therefore implemented Civil engineering inputs related to the size and shape requirements of the island and how its footprint could be minimised through the use of retaining walls and engineered slopes.

Use of materials was also a significant consideration with the creation of the trench for the tunnel resulting in a significant volume of material for disposal being balanced out by the use of this material in the creation of the artificial island. The project team therefore sought to create a materials mass balance, as far as was possible, during the planning and initial design of the scheme.

### 5.3.3. Ebbw Valley Railway

The Ebbw Valley railway project is a classic example of how a piece of transport infrastructure acts as a catalyst for wider regeneration. The project was promoted and brought forward through political influence arising from the socio-economic imperative to support the community of Ebbw Vale and other settlements along the route. The majority of the impacts associated with the project are socio-economic

rather than environmental and are therefore dealt with in the next section of this report.

As the project involved the re-opening of a disused railway there were no route selection issues that might have impacted on environmental considerations. The principal engineering related impact was the line runs beside a river and for part of the route, flood risk mitigation was an issue that needed to be overcome. This was addressed through hydraulic modelling of the river by specialists (principally members of the Institute of Hydrology and CIWEM) working with the civil engineers to design works which both protected the railway and meant that flood risk was not exacerbated by the scheme on landowners up and downstream. Other less significant issues related to noise associated with the reopening of the route and the use / re-use of materials in construction.

5.3.4. M25 Holmesdale Tunnel

The Holmesdale Tunnel project demonstrates the current policy in the UK for the provision of additional highway capacity through making better use of the existing infrastructure whilst using modern technology to ensure that safety is not compromised- a sustainable approach. The principal objectives of the scheme, provision of a new ventilation system and uprating the existing tunnel whilst providing additional capacity had to be achieved in the context of limited land availability (a 'no-land take' scheme) and the sensitivity of overlooking housing and open space use of the tunnel roof.. The civil engineering team were required to came up with a design which worked within these constraints, proposing new fan station constructed on portal extensions above the carriageways at both ends of the tunnel. The proposals were subject to the Highways Agency's environmental appraisal process.

Developing that scheme through the ECI stages, the major related issues for detail design development and construction were associated with the 24/7 working in a live motorway environment, requiring careful consideration of buildability, working methods and traffic management, in addition to negotiation of Section 61 consent with EHO. Further to construction noise and vibration, noise limits at identified nearby residential receptors were set for operation of the powerful fans in the new ventilation system, especially during emergency condition, which needed to be taken account of in the detail design of fan(s) -and their mountings - the intake louvres and building envelop. Dealing with asbestos, which was originally included in the original construction for fire protection purposes, also involved the engineering and environmental teams working together to arrive at a construction methodology which complied with health and safety requirements in this regard during its removal and final disposal.

The impacts identified in the environmental appraisal were used to benchmark detail scheme development and incorporated within an environmental management process that saw all disciplines working to the Designers Environmental Management Plan, prepared by the Environmental Coordinator, which was taken forward and further developed into the Construction Environmental Management Plan.

### 5.3.5. Fastrack at Ingress Park

The principal environmental impacts associated with the Fastrack project relate to its route through the development. These are largely pre-determined by the masterplan layout of the development and in particular the need for Fastrack to follow the main spine road and the connections at either end of the spine road where Fastrack enters and leaves the development, mostly following the line of a previous works access.

The principal environmental issue, therefore, related to the safeguarding of the site of the Cave of the Seven Heads Scheduled Ancient Monument, which was also a roost for bats (a European protected species) . The Civil Engineering team worked with Archaeologists to come up with a solution involving the use of contiguous bored piled walls to support the cuttings and minimise the landtake prior to being carried over the Cave on what is, essentially, a bridge structure which ensures that the Cave is preserved. At the other side of this bridge a hinged slab is to be installed to allow for possible differential settlement and Fastrack will then, again, because of poor ground conditions, run on a reinforced earth base until it joins the existing site spine road.

# 6. Social Concerns

## 6.1. Introduction / Background

The Institution of Civil Engineers and its members recognise that civil engineering projects have potentially significant Social effects. This is borne from involvement in issues such as the provision of sanitation and the ability to travel, giving access to employment and leisure opportunities.

However, measuring and assessing social impacts and the issue of social sustainability seems to be less well understood or developed than environmental impacts and issues. Environmental Impact Assessment in the UK first "grew up" around the National Roads programme in the early 1990s and later developed consideration of socio-economic issues. Social Impact Assessment is still in its infancy when compared to EIA and whilst it is understood to have been adopted in the US and Europe, there is no recognised methodology for Social Impact Assessment in the UK.

Our awareness of Social impacts is undoubtedly improving but the whole issue of Social Sustainability seems a bit of a holy grail. Specialists in Social issues and Socio-economics are increasingly in evidence as members of project teams. Some of these specialists appear to have their background in planning and economics whilst others clearly have a direct background in social science with an increasing number of UK Universities now offering relevant courses.

## 6.2. Social Issues associated with the Case Study Projects

### 6.2.1. Observations common to all projects

The government has defined sustainable communities as *"places where people want to live and work, now and in the future. They meet the needs of existing and future residents, are sensitive to their environment, and contribute to a higher quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all."*

As the majority of the case study projects were planned some time ago, their social impact was not assessed in detail. However using the definition above as a basis for assessing the social issues associated with all of the case study projects it can be seen that they are generally similar and principally revolve around accessibility.

All of the case study projects improve accessibility to jobs, education and leisure activities either through a saving in time or cost. Measurement of accessibility is an issue which is presently assessed by Transport professionals (members of IHT) and Planners (members of RTPI).

The case study projects also improve the "attractiveness" of locations along the route or in their proximity. This is reflected in the degree to which inward investment is attracted to the area thereby potentially improving the quality of life for residents and the quality of the environment.

All of these social impacts are best demonstrated by the Ebbw Valley Railway project.

### 6.2.2. Ebbw Valley Railway

As part of a drive to regenerate Ebbw Vale following the demise of the steelworks – by far the biggest local employer – the Welsh Assembly Government invested some £30million in the Ebbw Valley Railway project to provide the community with a better link to jobs in Cardiff. The project also received European funding and support from the Corus Regeneration fund.

Prior to the reopening of the line the community had to endure either:

- a 90 minute bus ride to Cardiff; or,
- at least a 50 minute drive (longer during rush hour), and in a town which has one of the lowest car ownership rates in the UK, this was not open to a significant proportion of the community.

Travelling on the reopened line Operated by Network Rail, it takes 50 minutes by train to reach Cardiff, and a further link to Newport is planned. The line had a goal of carrying 400,000 passenger journeys a year by 2013. It is already on course to achieve the target for 2009, having averaged 44,000 trips a month over the last eight months.

With the first phase of the project now complete and the service up and running, the next phase of the plans call for legislation to extend the line by 1 km so that it reaches into the heart of Ebbw Vale and a station site at the heart of a regenerated town centre. The new rail station is not the only driver of regeneration: the Works Ebbw Vale project aims to provide 720 new homes, a learning campus, a hospital – now being built – and a business park. "*The rail line will enable both new and old residents of Blaenau Gwent to access opportunities they never thought possible,"* says Richard Crook, project director of the Ebbw Valley Railway.

The alternative to the project was to implement a series of road improvement measures to shorten road journey times but this "easy option" was discounted for the wider benefits that the rail scheme would bring. It was important that the rail journey time was quicker than the 50 minute minimum car journey time and for this reason it was necessary to limit the number of station stops on the route to six. Clearly this meant that some communities along the route miss out but the scheme needed to achieve the maximum impact. The scheme is also unusual for the UK in that it has been put in ahead of the development and regeneration projects in Ebbw Vale. Putting the line in first has shown the level of commitment to the regeneration of Ebbw Vale and to the community.

The line gives local people the realistic chance to travel to, and work in Cardiff, opening up new opportunities they otherwise would not have had. With the longer term addition of the link to Newport, the community in Ebbw Vale will only be around two and a half hours from London, thereby encouraging further inward investment.

## 7. Conclusions and Recommendations

The Civil Engineering profession no longer has the pre-eminence that it enjoyed during the 18th and 19th Centuries when it lead and promoted projects that shape our current society. Major civil engineering schemes such as the Great Western Railway, the canal network and the London to Hollyhead road clearly had significant environmental and social effects. At that time civil engineers were probably more conscious of the social impacts than the environmental effects. There is clearly a desire for the profession to raise its image and influence at the heart of society with the recent statements from Tom Foulkes. The position of Sir Michael Pitt (a civil engineer) as the Chair of the Infrastructure Planning Committee clearly gives the profession a clear role in reviewing which projects should come forward.

The development of specialist professions in fields such as planning, transportation, the environment (and all its facets), socio-economics and finance means that mega urban transport projects are now taken forward by teams of professionals. The civil engineer therefore works as part of the team relying on advice from others to maximise the benefits and to mitigate the negative impacts of projects. Civil engineers are now the enablers rather than taking responsibility for directing projects. The profession and its members are clearly aware of the social and environmental potential that civil engineering projects can have but are no longer solely influential in their promotion.

This working paper has taken views solely from a consultancy perspective. In order to complete picture it would be valuable to the seek views from other members of the profession within the following organisations

- Government (National and Local)
- Operators – such as Network Rail, The Highways Agency,
- Contractors

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