APPENDIX 3

Welsh Government

Demand Forecasting and Economic Appraisal Technical Note

December 2011

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Welsh Government

Valley Lines Electrification

Demand Forecasting and Economic Appraisal Technical Note

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1 Valley Lines Electrification

1.1 Background

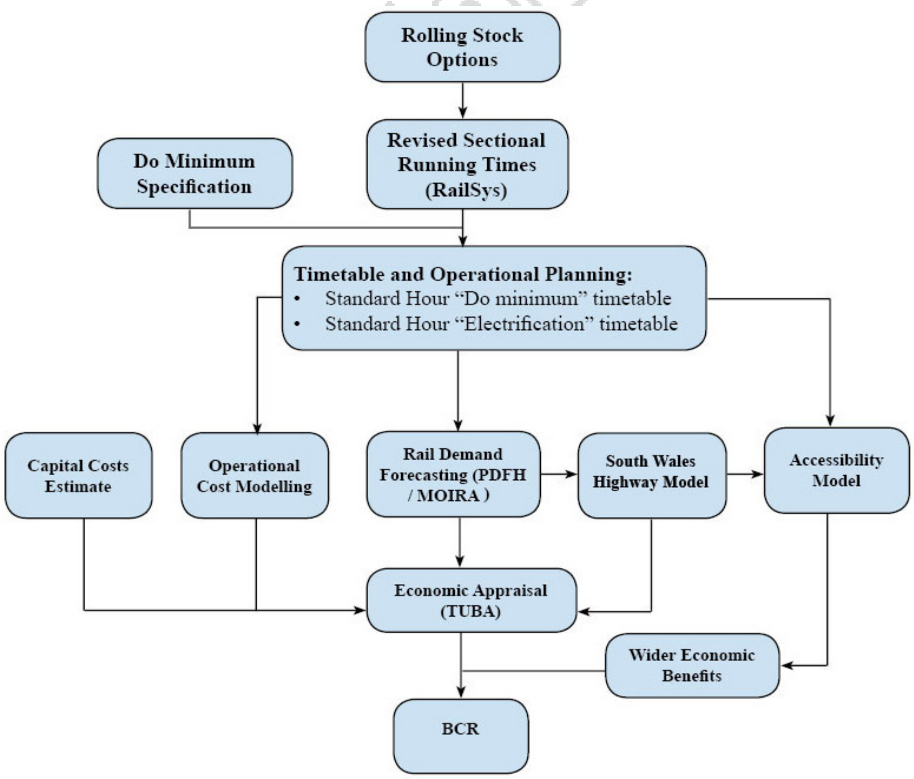
Welsh Government is taking forward a business case for the electrification of the Valley Lines rail network for consideration by the Department for Transport for inclusion in its High Level Output Specification (HLOS2) for Control Period 5.

The development of the business case is being undertaken in accordance with the Five Case Model adopted by DfT and, in turn, in line with WebTAG and WelTAG guidance. The business case is being taken forward on a collaborative basis with DfT and Network Rail. An outline of our proposed approach presented to these parties in advance of the completion of the Outline Business Case.

1.2 Overview

The economic appraisal has been undertaken in line with WebTAG 3.12[1] guidance which further satisfies Welsh Government appraisal requirements (WelTAG[2]). The key aspects of the approach to the economic case are shown in Figure 1.1 and described below.

Figure 1.1 – VLE Modelling and Economic Appraisal Framework



[1] Web-based Transport Appraisal Guidance: Guidance on Rail Appraisal
[2] Welsh Transport Appraisal Guidance

Demand Forecasting and Economic Benefits

The demand forecasting methodology and assessment of project benefits is built on the following:

- existing demand and revenue based on data provided by Arriva Trains Wales;
- modelling of demand responses due to changes in journey times and timetabling through application of the MOIRA model provided by Arriva Trains Wales;
- baseline demand forecasts linked to changes in exogenous factors (GDP, population, fuel prices etc) based on Welsh and UK Government forecasts and WebTAG guidance;
- an overall demand and revenue forecast model built by Arup based on the guidance and elasticity parameters (for both endogenous and exogenous factors) provided in the Passenger Demand Forecasting Handbook (PDFH);
- the application of a crowding model, based on guidance in PDFH, to establish the level of suppressed demand and crowding benefits for existing passengers, when new rolling stock and timetable scenarios are delivered;
- benefits of reduced car use assessed in line with WebTAG 3.9.5;
- estimation of transport user benefits consistent with TUBA method and based on values of time and vehicle operating costs provided in WebTAG 3.5.6;
- an approach to assessing Wider Economic Impacts in line with WebTAG 3.5.14C though the application of a multi-modal accessibility model to provide the inputs for calculation of agglomeration effects and impacts on the labour market.

Accessibility Model

To facilitate distributional and socio-economic analyses, impacts on accessibility and wider impacts, the South East Wales accessibility model has been used to analyse and illustrate:

- effects on access to employment opportunity for residents and access to a workforce for businesses;
- changes in labour market catchments for businesses;
- distributional impacts – by combining census data with transport data to separate benefits into deprived and non-deprived community categories, for example, and;
- changes in accessibility to feed into the calculation of wider economic impacts.

Capital and Operating Costs

Investment and ongoing subsidy costs have been estimated through use of data from the following sources:

- infrastructure cost estimates from the GRIP Stage 2 study currently being undertaken by Network Rail;
- existing operating costs provided by Arriva Trains Wales' current operation;

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- rolling stock costs based on up to data provided by rolling stock leasing companies, and;
- track access charges and energy costs based on data and guidance provided by Network Rail.

Economic Appraisal

An economic appraisal of discounted costs and benefits was undertaken in line with WebTAG guidance.

The outputs of the economic appraisal are summarised in a Transport Economic Efficient (TEE) table and a public accounts table.

Appraisal Summary Tables (ASTs) are provided for each option clearly showing the assessment of the options against each of the cases in the five case model.

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2 Appraisal Options

2.1 Options

The three options detailed in the Strategic Outline Case were taken forward for detailed economic appraisal following the application of the EAST (Early Assessment Sifting Tool).

The options have been structured to ensure like-for-like comparison of an electrified network with new trains against the phased replacement of the diesel fleet. The lower cost option assumes the electric rolling stock is 'cascaded' from other lines in the electrified network.

The options are as follows:

Do Minimum: A network based on post CASR conditions. This is a continuation of the current timetable across Valley Lines routes, plus the schemes committed under the National Transport Plan (NTP) , namely peak time turnback services between Cardiff Central and Pontypridd and Caerphilly and increased frequency on the Vale of Glamorgan and Maesteg lines to two trains per hour. The do minimum case assumes continued use of the existing fleet of vehicles until the end of their useful life, followed by replacement with new Class 172 DMUs, or similar.

Option 1: Electrification and new EMUs – All Valleys lines[3] are electrified and the diesel fleet is replaced by Class 378 EMUs, or similar. The timetable assumed is the same as under the Do-Minimum case, other than where improved performance of the rolling stock permits timetable enhancement without increasing overall fleet size.

Option 2: Electrification and Cascaded EMUs – All Valleys lines are electrified and the diesel fleet is replaced Class 315 units (or similar) cascaded from other parts of the UK electrified network. The timetable assumed is the same as under the Do-Minimum case, other than where improved performance of the rolling stock permits timetable enhancement without increasing overall fleet size. This is a lower cost option because the lease costs of the partially life-expired cascade EMUs are lower than the lease costs of new EMUs.

Option 3: New Diesel Rolling Stock – Deployment of modern diesel multiple unit (DMU) rolling stock. The timetable assumed is the same as under the Do-Minimum case, other than where improved performance of the rolling stock permits timetable enhancement without increasing overall fleet size.

All changes in rolling stock and timetables are assumed to commence in April 2018 to coincide with the start of the next franchise period.

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[3] All valley lines is defined as follows: Maesteg, Vale of Glamorgan, Treherbert, Aberdare, Merthyr, Rhymney, Penarth, Barry Island, Coryton, Ebbw Vale An additional case has been run including the subset of lines specified by the Secretary of State in his March 2011 statement: Treherbert, Aberdare, Merthyr, Rhymney, Penarth, Barry Island, Coryton.

2.1.1 Timetables

The do minimum option and each of the option cases is based on the current service pattern, enhanced by the 3 extra trains per hour through Cardiff Queen Street and one extra train per hour from Maesteg, all of which are prioritised by the Welsh Government and enabled by the Cardiff Area Signalling Renewal (CASR)[4]. The basic service pattern is the same in each scenario, including the Do minimum.

The extra services are as follows:

- Bridgend to Pontypridd service via Rhoose and Cathays (one per hour);
- Caerphilly to Pontypridd via the City Line (two per hour);
- Maesteg to Cardiff (one per hour)

These services fulfil the National Transport Plan priority for turnback services to Pontypridd and Caerphilly and a doubling of frequency on the Vale of Glamorgan and Maesteg lines. The inclusion of these services increases the number of Valley Lines trains passing between Cardiff Central and Cardiff Queen Street from 12 trains per hour to 15 trains per hour[5]. Services to and from Ebbw Vale remain at one train per hour[6].

2.1.2 Rolling Stock

Rolling stock scenarios have been developed in consultation with rolling stock leasing companies. No change in rolling stock is assumed to take place in the current franchise period, ending April 2018. Rolling stock availability in 2018 cannot be confirmed at present, therefore 'proxy' rolling stock types have been defined, for each option, as shown in the table below.

Table 2.1 - Proxy Rolling Stock Types

Time periods	Do Minimum	Option 1	Option 2	Option 3
2018 – 2025	Refurbished Existing Fleet *(Class 14X, Class 15X)*	New Electric Units – *(Class 378 or equivalent)*	Cascaded Electric Units - *(Class 315 or equivalent)*	New Diesel Units – *(Class Class 172 or equivalent)*
2025 – 2033	Diesel Replacement *(Class 172 or equivalent)*		Further Cascaded Electric Units	
2033 – 2045			New Electric Replacement	
2045 – 2078				

There is more certainty regarding the availability of new or cascaded rolling stock in the initial period (2018 to 2033) than for later periods, therefore existing stock types have been chosen which broadly reflect likely future availability.

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[4] A sensitivity test has been undertaken with retention of the current timetable i.e. a maximum of 12 trains per hour through Cardiff Queen St, as per the pre-CASR timetable.
[5] CASR provides for increased capacity which would allow for 16 trains per hour in the peak.
[6] The introduction of services from Ebbw Vale to Newport is also under consideration by Welsh Government but is not included in any of the cases in this study.

The existing rolling stock (Class 14x and 15x DMUs) are reaching the end of their usable life. However we consider that refurbishment in 2018 could potentially extend their life until 2025. The future availability of diesel rolling stock is expected to be highly constrained, although for the purposes of the appraisal it is assumed that Class 172 units could be used after 2025.

Under the electrification options, rolling stock types have been assumed which are suitable for the network and/or which are likely to become available following stock replacement on other parts of the electrified network.

Further details on timetable designs and rolling stock are provided in a Technical Note on Timetables and Diagrams.

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3 Demand Forecasting Approach

3.1 Overview

An overview of the approach to forecasting demand is illustrated in Figure 3.1.

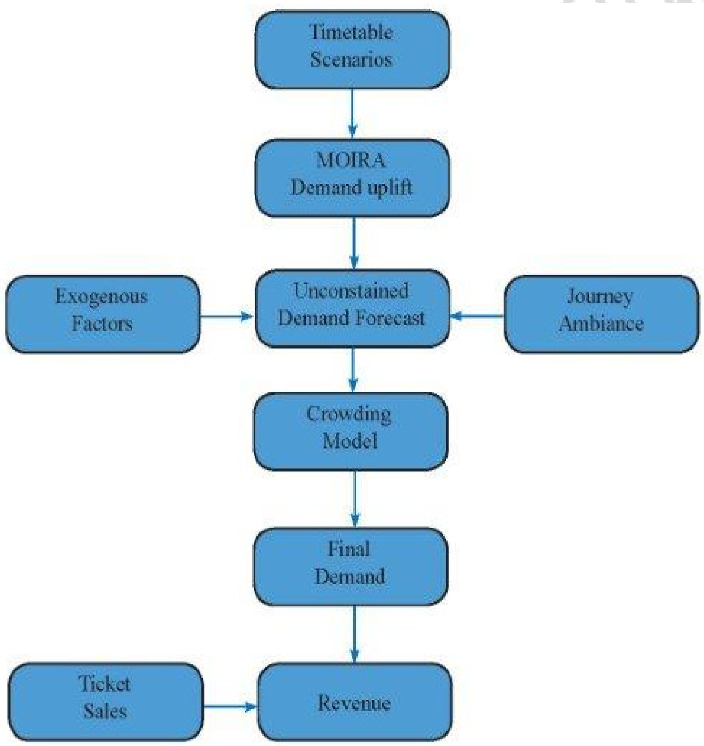
A baseline forecast has been produced based on current demand expanded to take account of growth in 'exogenous factors' such as new jobs, residents and growth in GDP.

The MOIRA model was used to predict the changes in demand arising from changes in the timetable.

Where trains are replaced or refurbished, resulting in improved journey ambience, uplifts to demand have been applied, in line with PDFH advice.

The unconstrained demand forecast is fed into a crowding model which adjusts demand where it exceeds capacity or where crowding is a deterrent to travel.

Figure 3.1 –Demand Modelling Framework



3.2 Baseline Forecast

3.2.1 Recent Trends

The Valley Lines, as a self-contained rail network, is very well placed to provide a high level of service and to compete with road transport. The linear settlement pattern and the dense rail network, a legacy of the industrial era, is such that the Valley Lines service the main population centres in South East Wales.

Total patronage on the Valley Lines has grown an average of 6.9% per annum since 1998.

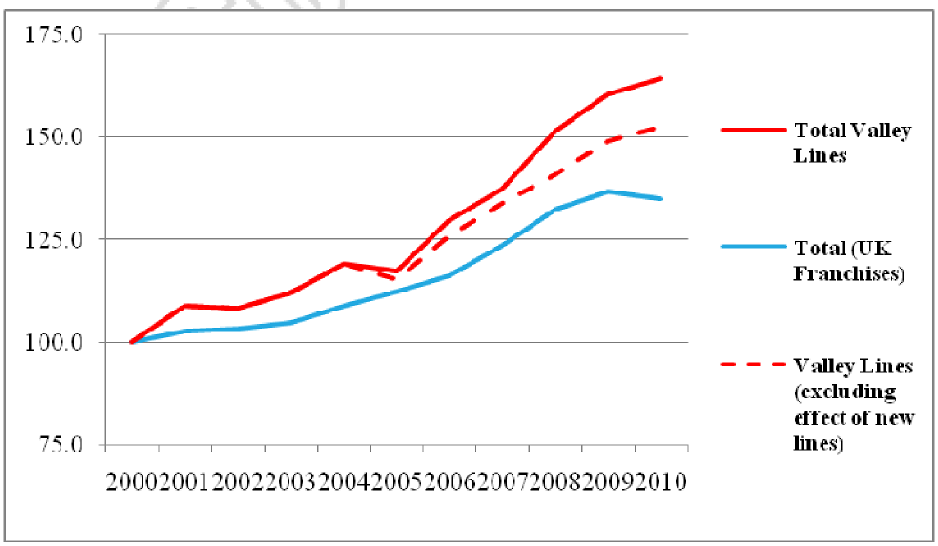
Taking out the effect of new lines (Vale of Glamorgan line and Ebbw Vale line), average growth was 4.3% a year between 2000 and 2010, and 5.8% a year between 2005 and 2010. All Valley Lines have experienced strong growth. In particular, rapid and sustained growth has been experienced on lines to Cardiff Bay following a significant frequency enhancement, the lines through Pontypridd and the City Line. This is linked to a shift from primary and manufacturing sector jobs located in the valleys to service sector employment located in Cardiff.

A number of high level drivers of growth have been identified:

- The development of Cardiff as the 'regional' centre for business and administration functions, reinforced by regeneration in the city centre and in Cardiff Bay;
- The main roads into Cardiff, particularly the A470, are heavily congested and there are constraints on increasing the capacity on such routes due to topography, environmental acceptability and cost;
- Relatively low fares
- Incremental improvements to the Valley Lines service.

The Wales Rail Utilisation Strategy *(Network Rail, 2008)*, based on analysis undertaken in 2007, contains 'Wales wide' forecasts of 23% growth from 2007/8 to 2018/19 (1.9% per annum) and 34% from 2007/8 to 2025/26 (1.2% per annum). Commuting flows to and from Cardiff were forecast to grow by 7-8% in 2007/8 per annum, steadily falling to 1.5% per annum by 2014. The forecasts in the RUS were developed on relatively conservative assumptions. Demand growth has exceeded these expectations, as shown in Figure 3.2.

Figure 3.2 – Historical Demand Growth



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UK Regional Rail Demand (MVA / ATOC)

In 2010, ATOC commissioned research to explain high levels of demand growth on regional rail services in the UK. One of the case studies was Cardiff. The key conclusions of the study with respect to Cardiff were as follows:

- *'Devolution has created an increased focus on Cardiff as a hub for administration, business and leisure within Wales. This has stimulated increased demand for interurban travel with Cardiff increasingly central to these movements. Regeneration has been focused on central locations; but there has also been a conscious decision to focus developments as close to the city centre as possible.'*
- *'Cardiff is now a much greater centre for employment opportunities, but residential locations have not changed in the same quantum to match this shift. Resulting longer travel-to-work distances favour rail and Cardiff is comparatively well served by a regional rail network that is competitive to road travel. The demand for rail has also been enhanced by a historical policy of low fares to support employment amongst communities who have suffered most from declines in heavy industries.'*
- *'In Cardiff, car parking and traffic controls have increased, but changes are still behind other comparable UK cities. The main factor driving any mode shift from the car has therefore been increasing congestion on the roads, and the resulting variability in journey times.'*

The study finds that the elasticities defined in PDFH 4.0 have under predicted growth in regional rail demand. Econometric analysis suggests that, for a range of journey types, elasticities would need to be significantly higher to fit with recent experience.

An alternative set of elasticities with respect to GDP were proposed ranging from 0.4 to 3.48, in comparison to PDFH recommended elasticities of between 0.85 and 1.5. These higher elasticities are based on an assumption that future economic growth is matched by continued structural change in the economy (shifts from manufacturing to service employment) and further increases in the costs of car travel and parking.

The study notes that for the UK as a whole, the shift in employment from manufacturing to services may begin to bottom out. However, in the case of South Wales, manufacturing employment makes up a much higher proportion of total employment and therefore there is good reason to believe that current trends will continue.

Further detailed analysis of recent trends in patronage as well as current and future drivers of growth is provided in the Market Analysis report.

3.2.2 Approach Adopted

Passenger journeys on the Valley Lines network are dominated by internal movements within south east Wales within the self contained Valley Lines network, with relatively few trips outside the network. As a result, local exogenous factors in south east Wales will have a strong influence on demand and the impact of changes in neighbouring regions will be relatively slight.

A baseline forecast, independent of any changes to rolling stock or timetables, has been constructed based on forecast levels of GDP, population, employment and changes in the cost/speed of competing modes.

The MVA analysis shown in Section 3.2.1 provides evidence that the standard rail PDFH demand modelling guidance has failed to predict the growth on the Valley Lines (and other regional rail services) in recent years. For this reason, we define two growth scenarios: a ***'constrained growth'*** scenario using standard DfT and PDFH assumptions, and a ***'continued growth'*** scenario to provide a better fit with recent growth trends and making use of recent research into the drivers of regional rail demand.

Under the ‘continued growth’ scenario, it is assumed that structural change in the economy of South Wales and growing congestion on the road network will continue to drive mode shift to rail. This scenario adopts Welsh Government forecasts of employment and population growth. The assumptions behind each of these assumptions are described further below.

Demand Forecasting Framework

The baseline forecast applies the standard PDFH forecasting framework set out below:

$$I_E = \left(\frac{GDPPercapita_{new}}{GDPpercapita_{base}}\right)^g \times \left(\frac{EMP_{new}}{EMP_{base}}\right)^e \times \left(\frac{POP_{new}}{POP_{base}}\right)^p \times \exp\left(n \times \left(NC_{new} - NC_{base}\right)\right) \times \left(\frac{RAILFARE_{new}}{RAILFARE_{base}}\right)^r \times$$

$$\left(\frac{FUELCOST_{new}}{FUELCOST_{base}}\right)^f \times \left(\frac{CARTIME_{new}}{CARTIME_{base}}\right)^c \times \left(\frac{BUSCOST_{new}}{BUSCOST_{base}}\right)^b \times \left(\frac{BUSTIME_{new}}{BUSTIME_{base}}\right)^t \times \left(\frac{BUSHEAD_{new}}{BUSHEAD_{base}}\right)^b$$

$$\times \left(\frac{PARKINGCOST_{new}}{PARKINGCOST_{base}}\right)^k$$

Where:

- I_E is the external factors index for the change in volume between the base period and the future period.
- The parameters are all elasticities with the exception of n, which determines car-ownership.

Current rail demand was extracted from MOIRA on a station to station basis. Trip origins and destinations were assigned to ‘zones’ in the demand model. In south east Wales, these are local authority areas. Outside this area, the zoning system is coarser, typically at regional (NUTS 1) levels.

Each of the above demand drivers has been forecast and applied within this zoning system. Some growth drivers are linked to the origin end of the trip (e.g. population growth) whilst others are linked to the destination (e.g. employment growth). Switches within the model allow the origin or destination to be determined for each station to station pair.

In some cases, different elasticity values apply to seasons and other ticket types. These ticket types are mapped to journey purposes (business, commuting and other) for demand forecasting.

Demand Drivers

The data sources and assumptions behind the exogenous inputs are set out in table 3.1 for constrained and continued growth scenarios.

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Table 3.1 – Key Inputs to exogenous growth model

Growth Driver	Continued Growth Scenario	Constrained Growth Scenario	Applied to	Data Sources
GDP per capita	Office of Budget Responsibility Forecast		Non-commuter trips, zone of destination	Office of Budget Responsibility
Employment	Welsh Government Forecast	Welsh Government forecast constrained to TEMPRO forecast for South East Wales	Commuter trips, zone of destination	Welsh Government Department for Transport
Population	Welsh Government Forecast	Welsh Government forecast constrained to TEMPRO forecast for South East Wales	All ticket types, zone of origin	
Car Ownership	TEMPRO car ownership projections		All ticket types, zone of origin	
Rail Fares	RPI + 1% growth per annum		All ticket types	Welsh Government
Car Travel Times	South Wales Strategic Highway Model travel time forecast		All ticket types, zone of origin & destination	Arup / Welsh Government
Motoring Costs	WebTAG fuel costs		All ticket types, zone of origin & destination	WebTAG
Bus fares, travel times and headways	Assumed to grow at the same rate as rail fares. Bus travel times are assumed change at the same rate as car travel times. Bus headways are assumed to remain constant.		All ticket types	As above

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Elasticities

Under the constrained growth scenario, the elasticities with respect to each of the above drivers were taken from PDFH version 4.0, with the exception of the fares elasticity, as agreed with DfT.

Given the fact that PDFH version 4.0 elasticities would have under predicted growth in demand on the Valley Lines over the last decade, we have applied a higher elasticity of rail demand with respect to GDP for the continued growth scenario (an elasticity of 1.88 rather than 0.7[7]). This is based on an econometric estimation for regional rail demand undertaken by MVA for ATOC in 2010[8]. For conservatism and to reflect uncertainty in the longer term, this higher elasticity is applied only for the first five years of the forecast to 2016.

Table 3.2 - Elasticities

Elasticity	Continued Growth Scenario	Constrained Growth Scenario
GDP per capita	1.88 (MVA 2010) to 2021 0.7 (PDFH 4) after 2021	0.7 (PDFH 4)
Employment	1.0 (PDFH 4)	
Population	1.0 (PDFH 4)	
Car Ownership	0.63 (PDFH 4)	
Rail Fares	Commuters – -0.7, Other – -1.0 (PDFH 5.0)	
Car Travel Times	0.3 (PDFH 4)	
Motoring Costs	0.2 (PDFH 4)	
Bus fares and travel times	0.13 (PDFH 4)	

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Demand capping

Current DfT guidance was followed on capping demand in 2026 for the constrained growth scenario. For the continued growth scenario, the demand cap is applied in 2031, which we consider appropriate given the timescale for the intervention[9].

Baseline forecast

The baseline forecasts are shown given in Figure 3.3. Under the continued growth scenario, growth rates are broadly consistent with recent trends with an annual average growth rate of just over 4% until 2016.

Over the same period, the growth rate under the ‘constrained growth’ scenario is 2% per annum. Over the whole period from 2011 to 2031 the average growth rates for the two scenarios are as follows:

- Continued growth: 2.7%
- Constrained growth: 1.7%

For comparison, the Wales RUS assumption was 1.5% annually through the same period.

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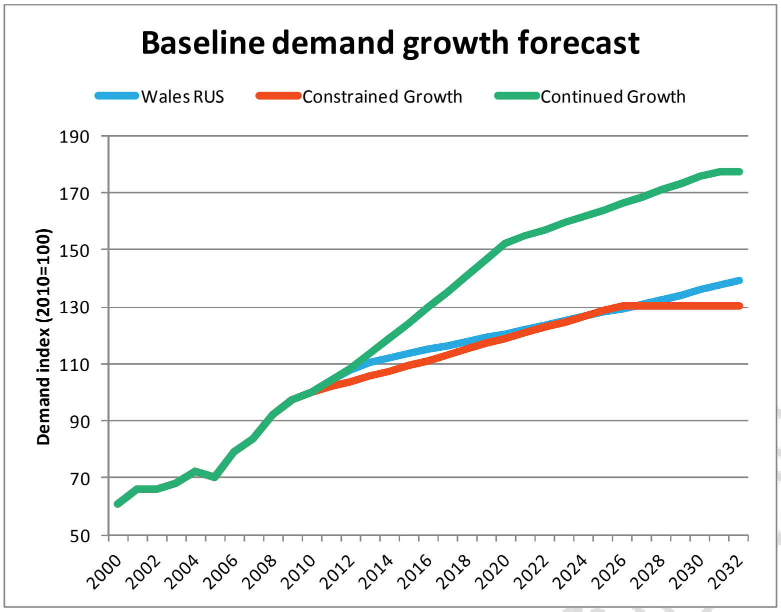
[7] Non-season tickets under 20 miles

[8] MVA estimated elasticities of rail demand with respect to GDP between 0.4 and 3.48. The relevant category for most Valley Lines journeys is ‘to core cities from others’ for which the elasticity is 1.88 for journeys of less than 20 miles.

[9] The DfTs recent economic appraisal of the case for electrifying the Great Western Main Line capped growth at 2033 (www.parliament.uk/deposits/depositedpapers/2011/DEP2011-0587.doc)

Figure 3.3 - Baseline growth forecast



3.3 Impacts of Service Improvement

3.3.1 Improved Timetable

The forecasting approach is compliant with advice in WebTAG unit 3.15.4 (Rail Passenger Demand Forecasting). The PDFH approach of applying elasticities to the percentage difference in generalised journey times was followed. The Arriva Trains Wales (ATW) version of the MOIRA model was used, validated against passenger count data provided by ATW.

3.3.2 Rolling Stock Quality

An assessment was made of the passenger experience and consequent demand boost of upgrading existing rolling stock through refurbishment or replacement with new or cascaded vehicles. Elsewhere, electrification has been credited for encouraging an step change in demand, sometimes referred to as the 'sparks effect'. The 'sparks effect' is likely to encapsulate a range of influences including the quality of the train interior, the ride quality, reduced noise, as well as passenger concerns about environmental damage.

Representing these influences requires some judgement. For example, there are no established 'willingness to pay' values specifically relating to reduced noise. Therefore, the approach taken to reflect rolling stock quality (or journey ambiance) is to construct quality factors from empirical data in PDFH 5.0 which provides a reasonable and conservative estimate of the overall effect of rolling stock improvements or a switch from old diesel to newer electric rolling stock. The quality factors we have applied are provided in Table 3.3.

Given the age and quality of the existing rolling stock (14x, 15x DMUs) there is justification for applying value of time multipliers to in-vehicle time for rolling stock quality. It should be noted that the diesel rolling stock will undergo

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refurbishment in the do-minimum, delivering an improvement in quality under the 'do minimum' case. Electric rolling stock would be expected to offer some further benefits to passengers, for example, in terms of ride quality.

Upgrading the existing fleet through refurbishment or replacement with a refurbished cascaded unit leads to an uplift in the value of in-vehicle time of between 1.8% and 2% (train condition).

Replacement with a new unit is assumed to provide a uplift against the current situation worth between 2.8% and 3.1% (train condition).

Refurbishment or new replacement is further assumed to improve ride quality with a factor of between 2.4% and 2.6% (ride quality).

Table 3.3 - Rolling Stock Quality Factors by Train Type

Train Type	Ride Quality	Value of Time Multiplier	Train Condition	Value of Time Multiplier
Existing Class 14X / 15X	Train with an extremely bumpy ride	NA	Train in poor condition – with damaged fixtures and seating	NA
Refurbished Class 14X / 15X	Train with a lot of movement – it is difficult to read whilst standing	0.026 (business) 0.024 (commuters)	Train in excellent condition – slightly damaged areas	0.020 (business / leisure) 0.018 (commuters)
Cascaded Refurbished EMU	Train with a lot of movement – it is difficult to read whilst standing	0.026 (business) 0.024 (commuters)	Train in excellent condition – everything looks new	0.031 (business / leisure) 0.028 (commuters)
New DMU	Train with a lot of movement – it is difficult to read whilst standing	0.026 (business) 0.024 (commuters)	Train in excellent condition – everything looks new	0.031 (business / leisure) 0.028 (commuters)
New EMU	Train with a lot of movement – it is difficult to read whilst standing	0.026 (business) 0.024 (commuters)	Train in excellent condition – everything looks new	0.031 (business / leisure) 0.028 (commuters)

3.3.3 Crowding

Customer satisfaction surveys have shown that passengers place crowding high on their list of concerns. If passengers are forced to stand, many will be dissuaded from travelling again; this may be an immediate reaction ('next time I will go by car'), or longer term ('I will change job or move house'). The PDFH also suggests a small disbenefit associated with sitting in crowded conditions.

Electrification involves changes in train quality and capacity which will impact on journey ambiance and could drive further demand growth. There is currently overcrowding on Valley Lines services during peak periods to the south of

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Caerphilly and Pontypridd. The Network Rail RUS highlights expected future capacity constraints as demand grows on the network.

Mitigating this, are the service frequency enhancements prioritised by the Welsh Government and enabled by CASR to reduce crowding in all scenarios including the do minimum.

Approach

Following discussions with DfT, it was agreed that MOIRA 1 would be used to calculate the impact of timetable changes. This version of MOIRA does not consider crowding influences on demand. Therefore we have modelled crowding through application of a spreadsheet model, with PDFH 4.1 crowding parameters.

Passengers experience travelling in crowded conditions, or having to stand, as a disbenefit which can be translated into monetary terms. The PDFH gives guidance on the values that can be used for this, derived from market research.

In summary, crowded conditions and lack of seats constrain demand.

Equilibrium Crowding Model

The approach taken in the Equilibrium Crowding Model is to model the overall change in crowding disbenefit across the whole of the network and use this to estimate the degree of crowding off.

As demand for travel increases:

- the total cost of crowding (i.e. the total passenger disbenefit) will increase at a rate which depends on the particular timetable and rolling stock allocation to that timetable, as well as the pattern of passenger loadings; and
- as the cost of crowding increases, demand will be “priced off” – this modelled as an equivalent increase in fare.

The first response can be described mathematically by a “cost curve” relating cost to load factor, and the second by a “demand curve” relating demand to cost.

The modelling of crowding requires iteration: as demand is crowded off, the costs and load factor fall, which in turn cause demand to increase again, increasing costs again. Following iteration, an equilibrium solution is arrived at, which is mathematically described as the point where the demand and cost curves cross.

The crowding model operates using curves derived using a simulation spreadsheet which estimates the slope of the cost curve for each timetable and rolling stock combination. The slope of the demand curve is a function of the elasticity to fare and, given these two pieces of information, the point of equilibrium can be calculated and crowding off estimated. The model provides separate suppression factors for each ticket types (full, reduced, season tickets).

The aim of the approach is to estimate the proportion of passengers who have to stand, based on the existing distribution of train loadings, and then to calculate the degree of demand suppressed. It is assumed that passengers in excess of that limit will be “crowded off”. The calculations are applied at an aggregate level rather than on a train-by-train basis, which means implicitly that that there will be redistribution of passengers between trains, whilst the overall “shape” of the way loadings are distributed will stay the same.

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The approach does not directly use the crowding factors in PDFH, but analysis on other comparable studies has shown it to yield similar results.

The modelling is based around average loads over the year. Thus applying a cap at 100% of capacity still allows for individual trains to carry loads in excess of this.

Inputs and assumptions

Unconstrained passenger demand is extracted from MOIRA under each scenario. This is controlled to observed load factors from count data provided by Arriva Trains Wales. Count data for all services was made available for April 2011.

Seating and standing capacities for each proxy stock type were estimated based on information provided by rolling stock leasing companies. It is assumed that each rolling stock type is refurbished with a DDA compliant toilet. A consistent assumption of 2 standing passengers per m^2 has been used.

3.4 Revenue Forecasts

The demand growth drivers outlined in Sections 3.2 and 3.3 are applied through a revenue model which has been built to a best practice specification, conforming to current DfT and PDFH guidance on rail demand forecasting. It has been applied previously for franchise bids.

The revenue model applies growth rates from exogenous demand drivers and from timetable enhancement (from MOIRA) to baseline LENNON ticket sales data obtained by Arriva Trains Wales.

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4 Economic Appraisal

4.1 Monetised Benefits

4.1.1 User Benefits

The economic appraisal has been undertaken using consistent values applied in the demand forecasting model and in line with recommended values of time in WebTAG unit 3.5.6. A summary of the approach taken to quantifying benefits is given in Table 4.1.

Table 4.1 - Appraisal Parameters - Benefits

Parameter	Approach	Source Data / Guidance
User Benefits		
Demand forecast	Growth scenario – 2.7% per annum, growth capped at 2031	Passenger Demand Forecasting Handbook Welsh Government Population and Employment projections MVA/ATOC: Regional Rail Demand Study
	Growth scenario – 1.7% per annum, growth capped at 2026	PDFH, TEMPRO
Time savings (existing passengers)	Application of MOIRA software employing WebTAG Values of Time	WebTAG 3.5.6
Time savings (new passengers)	As above employing the ‘rule of half’	WebTAG 3.5.6
Crowding benefits	Load factors based on MOIRA demand forecast adjusted to reflect recent count data. Adjustments to generalised journey times based on PDFH values.	Arriva Trains Wales Passenger Demand Forecasting Handbook
Journey Ambiance	Journey time adjustment factors based on empirical data for: • Refurbishment • New Rolling Stock • Electric Rolling Stock (noise / ride quality)	Passenger Demand Forecasting Handbook
Non-User Benefits		
Mode shift	National Diversion Factor for Rail Demand (-0.26%)	WebTAG 3.13
Reduced car use	Pence per kilometre values dues reduction in car use for decongestion, accidents and carbon emissions.	WebTAG 3.13
Rail Sector Carbon emissions	Emissions per litre of diesel fuel based on ATOC estimate. Emissions per KWH of electricity based on DECC carbon intensity factors.	ATOC Department for Energy and Climate Change (DECC) DECC Spreadsheet Tool
Indirect taxation	VAT and excise duty on rebated oils.	HM Revenue and Customs

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4.1.2 Benefits of Reduced Car Use

The improvement in train service quality and capacity following electrification will drive up rail demand. A proportion of the increase in rail trips will be a result of mode switch from car to rail.

Mode switching effects have been controlled to the ‘national average diversion factor’ of -26% given in WebTAG unit 3.13.2, with further analysis of the magnitude and locations of diversion from road to rail given in the Wider Economic Benefits and Social Impacts technical note. In compliance with WebTAG guidance, average (per km) values for decongestion benefits, accidents and emissions have been applied.

4.1.3 Wider Impacts

Given the potential impact on the South Wales travel to work area, wider impacts are an important element of scheme justification. These benefits amount to between 5 and 10% of regular transport benefits, which is similar to other regional rail upgrades studies elsewhere. There are three sources of wider benefits: agglomeration, increased output and labour supply. These benefits are described and estimated in the Wider Economic Benefits and Social Impacts technical note.

The Outline Business Case shows the results of the economic appraisal both excluding these wider impacts.

4.1.4 Distribution of Benefits

Much of the region served by the Valley Lines exhibits relatively high levels of unemployment and depressed economic activity. The distribution of areas (LSOAs – Lower Super Output Areas) ranked amongst the most deprived in Wales illustrates this point in Figure 4.1.

Deprivation is severe towards the northern end of the South Wales valleys. The study area incorporates the Heads of the Valleys Strategic Regeneration Area which is the subject of a 15 year programme of regeneration.

In this context, the implications of improving accessibility and the distribution of benefits is considered to be a very material part of this business case. The SE Wales accessibility model has been used to disaggregate user benefits in line with the guidance in WebTAG unit 3.5.3 as well as to illustrate the effect of the preferred option on access to employment opportunities, or other socio-economic metrics. The results of this analysis are provided in the Wider Economic Benefits and Social Impacts technical note.

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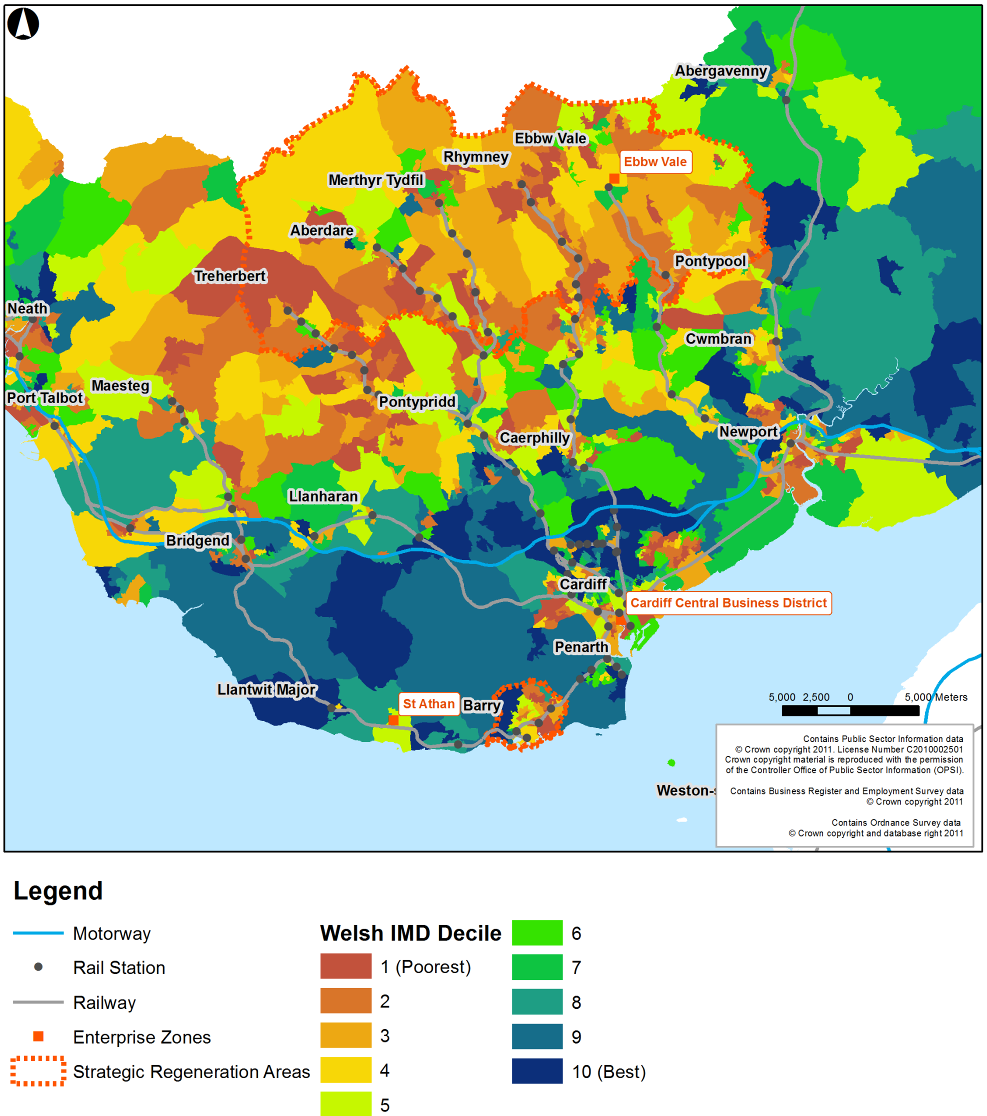
Figure 4.1 - Welsh Index of Multiple Deprivation (Employment Domain)



Source: Statistics Wales

4.1.5 Rail Sector Emissions Benefits

Carbon dioxide emissions from diesel rolling stock and from electricity generation have been valued in accordance with WebTAG guidance and using the carbon reduction toolkit provided by the Department of Energy and Climate change (DECC) with the October 2011 guidance.

4.2 Project Costs

4.2.1 Capital Costs - Risk and Optimism Bias

Capital cost estimates for electrification have been provided by Network Rail for the GRIP 2 (Pre-feasibility) stage[10]. Additional capital cost of converting Cardiff Canton depot from diesel to electric has been included in electrification scenarios. Optimism bias has been applied in accordance with WebTAG guidelines and in consultation with the GRIP 2 study team. All investment costs are assumed to be financed through Regulatory Asset Base (RAB) payments over 30 years.

4.2.2 Operating and Maintenance Costs

An operating cost model has been constructed to captures staff costs, diesel fuel costs, electric current for traction, rolling stock lease or purchase costs (including refurbishment or upgrade costs), rolling stock heavy and running maintenance costs, fixed track access charge; and variable track access charges.

Operating cost estimates have been informed by network rail, Arriva Trains Wales and data provided by rolling stock leasing companies. Key assumptions are outlined in Table 4.1.

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Table 4.1 - Operating Cost Assumptions

Item	Assumption	Source
Staff costs	Staff costs as per existing rates for drivers and conductors	Arriva Trains Wales
Diesel fuel consumption	Average actual fuel consumption of diesel stock types	Arriva Trains Wales and other sources
Electricity consumption	Electricity consumption based on the train performance. Regenerative braking to provide a 20% saving	Network Rail
Diesel costs	Current cost per litre for existing franchise	Arriva Trains Wales
Electricity costs	Average EC4T pence per KWh rates paid by TOCs	Network Rail
Future energy costs	Electric traction rates to 2013 based on Network Rail expectations. Other fuel cost forecasts from DECC forecasts - central scenario.	Network Rail DECC / Department for Transport
Rolling stock costs	Lease charges, refurbishment or upgrade costs and maintenance costs	Rolling Stock leasing companies
Fixed track access charge	£4,800 per track mile	Network Rail
Variable track access charge	VTAC for proxy rolling stock types based on quoted vehicle mile costs in Control Period 4	Network Rail, CP4 Price List

[10] Version 1.4, received from Network Rail on 16th December 2011.

Further details on methodology and results are provided in the Operational Cost technical note.

4.3 Reporting

The appraisal has been undertaken over a 60 year period from 2018, with demand capped at 2016 level (constrained growth scenario) or 2031 level (continued growth scenario). All values are in 2002 market prices. Benefits and costs accruing over the appraisal period are discounted to 2002 using the social discount rate outline in the Green Book: 3.5% for the first 30 years of the appraisal period and 3.0% thereafter.

The results of the appraisal are summarised in the Transport Economic Efficiency (TEE) Table and DfT Public Accounts Table (PA). All impacts are calculated as the change relative to the do minimum.

The changes in timetables and rolling stock, for each scenario, take place from April 2018 at the start of the next franchise period. As such, all forecast changes in revenue and operating cost are realised by Government through changes in the overall subsidy requirement of the franchise.

The overall Benefit to Cost Ratio is the ratio of Present Value Benefits (consumer and business benefits and impacts on private sector operators) to Present Value Costs (the net cost to government taking into account the cost of investment and the impact on the subsidy requirement).

The outputs from the TEE table and Public Accounts table are included in an Appraisal Summary Table (AST) for each option, which details all monetised and non-monetised costs and benefits and shows the impact of the project against WebTAG sub-objectives under the five case business model.

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4.4 Results

4.4.1 Transport Economic Efficiency (TEE) Table

Results of the TEE table are summarised in Table 4.2. It presents the changes brought about by the options relative to the do minimum case in monetary terms for the ‘Continued Growth’ scenario. This scenario best reflects the current and expected demand trajectory on the Valley Lines.

Option 2 – electrification with cascaded EMUs – provides the best value for money of the three options. Operating cost savings and higher revenue are such that, over the whole 60 year appraisal period, including finance costs, the net present value of costs of Valley Lines electrification is £39.5m. Adding the benefits to passengers of faster journeys, improved journey ambiance and reduced crowding, and environmental benefits, results in a net present value (NPV) of £128m, and the benefit cost ratio is 4.2 to 1.

Under the new purchase option electric vehicle option, operating cost savings are lower due to higher lease costs than the capital costs of investment. With similar passenger benefits this option achieves an NPV of £59m and a benefit cost ratio of 1.5 to 1.

Table 4.2 - Economic Appraisal Summary: Continued Growth Scenario, All Valley Lines (2002 Values and Market Prices, £Ms)

	Option 1 **Electrification: New EMUs**	**Option 2** **Electrification: Cascaded EMUs**	**Option 3** **New Diesel Rolling Stock**
a. User Time Savings	77.7	74.9	74.8
b. Crowding Benefits	30.9	32.5	4.1
c. Rolling Stock Quality Factors	18.6	15.5	13.1
d. Benefits of Reduced Car Use	5.8	4.5	4.1
e. Rail Sector Carbon Emissions and Air Quality Benefits**	57.4	57.6	-1.3
f. Indirect Tax	-17.5	-17.4	+0.9
g. Present Value Benefits (a+b+c+d+e+f)	**173.0**	**167.6**	**95.7**
h. Revenue	53.7	47.8	45.8
i. Operating Costs	-127.2	-207.9	90.6
j. Capital Costs	295.1	295.1	0.0*
k. Present Value Costs (j+i-h)	**114.3**	**39.5**	**44.8***
Net Present Value (g-k)	**58.7**	**128.2**	**50.9***
Benefit Cost Ratio (g/k)	**1.5**	**4.2**	**2.1***

** Costs have been assumed to be zero for this option although infrastructure improvements would be required to cater for 23m vehicles as noted above.*
*** Based on DECC 14 October 2011 publication using the 'Toolkit for guidance on valuation of energy use"*

The diesel scenario (Option 3) would result in increased operating costs and no environmental benefits. User benefits are similar to the EMU options. The net present value is £51m and benefit cost ratio for this option is 2.1 to1, though this excludes the costs of adapting line clearances to modern 23m vehicles.

Table 4.3 summarises the benefits and costs of a sensitivity test employing the constrained growth demand forecasts. VLE continues to demonstrate strong value for money with a benefit cost ratio of 3.6 to 1.

Table 4.3 - Economic Appraisal Summary: Continued and constrained Growth Scenarios, All Valley Lines (2002 Values and Market Prices, £Ms)

Preferred Option **Electrification: Cascaded EMUs**	**Preferred Option Continued Growth**	**Preferred Option Constrained Growth**
a. User Time Savings	74.9	58.7
b. Crowding Benefits	32.5	32.4
c. Rolling Stock Quality Factors	15.5	15.4
d. Benefits of Reduced Car Use	4.5	3.7
e. Rail Sector Carbon Emissions and Air Quality Benefits	57.6	57.6
f. Indirect Tax	-17.4	-17.4
g. Present Value Benefits (a+b+c+d+e+f)	**167.6**	**150.4**

Preferred Option Electrification: Cascaded EMUs	Preferred Option Continued Growth	Preferred Option Constrained Growth
h. Revenue	47.8	45.6
i. Operating Costs	-207.9	-207.9
j. Capital Costs	295.1	295.1
k. Present Value Costs (j+i-h)	**39.5**	**41.7**
Net Present Value (g-k)	**128.2**	**108.8**
Benefit Cost Ratio (g/k)	**4.2**	**3.6**

Table 4.4 shows the results for just those lines included in the Secretary of State's (SoS) announcement. This excludes the Vale of Glamorgan (VoG) line, the Ebbw Vale line and Maesteg – Cardiff. This will result in dis-benefits for the operational efficiency of the Valley Lines. Such operational inefficiencies are complex and not fully reflected in the analysis in the table. Continued operation of these lines with diesel trains in an otherwise electrified network will require an additional three diagrams for the Valley Lines as a whole. An alternative arrangement would be to serve the Vale of Glamorgan using by a shuttle service between Bridgend and Barry, but this would require passengers travelling to interchange, which would be an undesirable and politically unacceptable outcome for passengers on the Vale of Glamorgan line.

In this scenario, PV of benefits exceeds PV of costs and therefore a benefit to cost ratio cannot be calculated. The NPV for the continued growth scenario is £160m.

Table 4.4 - Economic Appraisal Summary: Constrained and Continued Growth Scenario, Network as per Secretary of State's Announcement (2002 Values and Market Prices, £Ms)

Preferred Option Electrification: Cascaded EMUs	SoS announcement lines only Continued growth	SoS announcement lines only Constrained growth
a. User Time Savings	66.1	51.8
b. Crowding Benefits	25.0	25.0
c. Rolling Stock Quality Factors	12.8	12.8
d. Benefits of Reduced Car Use	3.6	2.9
e. Rail Sector Carbon Emissions and Air Quality Benefits	46.6	46.6
f. Indirect Tax	-14.0	-14.0
g. Present Value Benefits (a+b+c+d+e+f)	**140.1**	**125.1**
h. Revenue	30.2	28.8
i. Operating Costs	-174.5	-174.5
j. Capital Costs	184.9	184.9
k. Present Value Costs (j+i-h)	**-19.8**	**-18.4**
Net Present Value (g-k)	**159.9**	**143.6**
Benefit Cost Ratio (g/k)	**n/a**	**n/a**

Table 4.5 shows a sensitivity test based on the current pre-CASR timetable of 12 tph through Cardiff Queen Street station; the standard assumption is 15 tph.

Table 4.5 - Economic Appraisal Summary: Current timetable (pre CASR), All Valley Lines Continued Growth Scenario, (2002 Values and Market Prices, £Ms)

Electrification: Cascaded EMUs	post CASR timetable	Current timetable (DM and option)
a. User Time Savings	74.9	75.5
b. Crowding Benefits	32.5	30.9
c. Rolling Stock Quality Factors	15.5	15.3
d. Benefits of Reduced Car Use	4.5	4.5
e. Rail Sector Carbon Emissions and Air Quality Benefits	57.6	49.8
f. Indirect Tax	-17.4	-14.9
g. Present Value Benefits (a+b+c+d+e+f)	**167.6**	**161.1**
h. Revenue	47.8	47.5
i. Operating Costs	-207.9	-193.1
j. Capital Costs	295.1	295.1
k. Present Value Costs (j+i-h)	**39.5**	**54.5**
Net Present Value (g-k)	**128.2**	**106.5**
Benefit Cost Ratio (g/k)	**4.2**	**3.0**

4.4.2 Public Accounts (PA) Table

Impact to the public account is described as the net costs incurred by central and local government. The PA table calculates the impact on Broad Transport Budget and on Wider Public Finances separately.

The appraisal has been undertaken assuming that costs are financed through the Regulatory Asset Base which allows Network Rail to borrow the necessary funds and for the Government to make regular payments to Network Rail to allow servicing of the debt. Therefore, both revenues and costs are summarised under the Government's Broad Transport Budget.

Change to indirect tax revenue is presented under the Wider Public Finances as it would benefit the Government as a whole but do not directly affect the Broad Transport Budget.

Results of the public accounts are summarised in Table 4.6 below. Option 2 – electrification with cascaded EMUs – provides the better value for money than the new electric vehicle option. It incurs a lower cost to the Broad Transport Budget and a lower dis-benefit to the Wider Public Finances.

Table 4.6 Public Account Table: Continued Growth Scenario, All Valley Lines (2002 Values and Market Prices, £Ms)

	Option 1 Electrification: New EMUs	Option 2 Electrification: Cascaded EMUs	Option 3 New Diesel Rolling Stock
a. Revenue	-53.7	-47.8	-45.8
b. Operating Costs	-127.2	-207.9	90.6
c. Capital Costs	295.6	295.6	0.0*
d. Central Government Broad Transport Budget (a+b+c)	**114.7**	**39.9**	**44.8**
e. Indirect Tax Revenues	17.5	17.4	-0.9
Wider Public Finance (e)	**17.5**	**17.4**	**-0.9**

** Costs have been assumed to be zero for this option although infrastructure improvements would be required to cater for 23m vehicles as noted above.*

4.4.3 Appraisal Summary Table

The Appraisal Summary Table (AST) gives a concise overview of impacts across the board. It records the degree to which the five Central Government objectives for Transport – environment, safety, economy, accessibility and integration – would be achieved and provides a summary of the impacts of each option.

AST results for the three options are shown in Tables 4.7 - 4.9.

Option 2 – electrification with cascaded EMUs – is the most favourable of the three options. The option has high potential in achieving environmental objectives, in terms of noise, local air quality and greenhouse gases emission. It also has high potential in achieving both economic objectives due to high operation cost saving and integration objectives for switching from the use of diesel to electricity.

Option 1 – electrification with new EMUs – is less favourable because of the lower operating cost saving than Option 2.

Option 3 – new diesel units – is not favourable because it has limited potential in achieving environmental, economic and integration objectives.

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Table 4.7 – Appraisal Summary Table for Option 1 New Electric Units

Option: 1		Description: New Electric Units – (Class 378 or equivalent)	Problems	Present Values (£m 2002)
OBJECTIVE	**SUB-OBJECTIVE**	**(a) QUALITATIVE IMPACTS**	**(b) QUANTITATIVE ASSESSMENT**	
ENVIRONMENT	**Noise**	Electric rolling stock would have significantly reduced noise emissions in comparison to diesel rolling stock. This would affect a significant population living in close proximity to the rail corridor.	+ + +	
	Local Air Quality	Electric rolling stock would have significantly reduced local emissions in comparison to diesel rolling stock, since there will now be no emissions from the rolling stock. This would affect a significant population living in close proximity to the rail corridor.	+ + +	£15.5m Benefits
	Greenhouse Gases	Electronic rolling stock would reduce carbon emissions by switching to a less carbon intensive source of energy whilst stimulating rail demand and encouraging reduced car use. The extent of emissions reduction provided will depend on the carbon intensity of the grid electricity. Further reductions in emissions would be expected to result from mode shift from car to rail. Deployment of new electric units across the network from 2018 would give a slightly lower benefit in the first 15 years than the cascaded electric units.	+ + +	£41.9m benefits
	Landscape	The introduction of overhead lines would have a visual impact however this would be confined to the existing railway corridors.	-	
	Townscape	There are no significant effects on the townscape of the routes since the railway corridors will not alter from the existing situation. The visual impact of overhead lines is considered to be reduced in an urban environment where there is typically a greater level of infrastructure.	0	
	Heritage of Historic Resources	Electrification will require additional headroom under structures to accommodate overhead power lines, in some cases this may necessitate the alteration of historic or listed bridge structures. (One listed structure currently identified as being affected.)	-	
	Biodiversity	During construction minor localised clearance of the surrounding areas is likely to be required. In operation the railway lines would be quieter and cleaner which may encourage increased local biodiversity.	0	
	Water Environment	This option is expected to have negligible effect on the local water environment.	0	
	Physical Fitness	Mode shift may lead to higher levels of active travel as new passengers travel to stations by walking and cycling.	+ +	
	Journey Ambience	Electrification is likely to significantly improve journey ambience. In-vehicle noise levels and extent of crowding are likely to reduce substantially in the long term. New rolling stock would also be likely to offer an improved standard of internal comfort and facilities for passengers.	+ +	£30.9m benefits on crowding
SAFETY	**Accidents**	This option is not expected to result in a significant difference from the existing situation on the rail network, however mode shift is expected to have associated accident benefits on the road network.	+	£0.18m benefits
	Security	Electrification may lead to an increase in railway related crime as a result of the value and danger of overhead cables. New rolling stock is likely to include security measures/design to include improved lighting and CCTV.	0	
ECONOMY	**Public Accounts**	Central government funding would need to be increased substantially as investment costs of electrification would significantly outweigh benefits from increased revenue and reduction in operating costs. In terms of wider public finances, reduction in indirect tax revenue would also moderately reduce central government funding.	- -	£114.2m costs to Central Government Budget - £17.5m change in Wider Public Finance
	Business Users & Providers	For Business users the network is likely to offer time savings and increased reliability. For the service operator the financial implications will be dependent on how the rolling stock is procured. The operator would however benefit from reduced maintenance and improved reliability.	+	£3.5m benefits to business users £127.2m operating costs savings to providers
	Consumer Users	The introduction of electrification with new rolling stock would have significant effect in decreasing journey times and improving reliability. It is also anticipated that the public response and hence mode shift would be highest with this option.	+ +	£74.2m benefits
	Reliability	It is anticipated that the introduction of electric rolling stock would result in a significant improvement in journey time reliability and overall reliability of the Valley Lines Network.	+ +	
	Wider Economic Impacts	Timetable enhancements are expected to result in a significant improvement in journey times and access to services and employment. A significant of these benefits would reach residents of some of the most deprived communities in the Heads of the Valleys Strategic Regeneration Area.	+ +	£12.6m benefits
ACCESSIBILITY	**Option values**	Electrification of the network and reduced journey times would substantially change the availability of passenger rail services within the study area. Benefits of electrification would reach communities across the South Wales Valleys, and particularly Aberdare, Merthyr Tydfil and Maesteg where journey time savings would be high.	+ + +	
	Severance	This option is not expected to result in additional hindrance to pedestrian movement in communities served by the Valley Line Network.	0	
	Access to the Transport System	The extent of the Valley Lines Network will not markedly increase as a result of this option however new train services are likely to increase service frequency and hence improve access. New rolling stock would also improve access for disabled people ensuring compliance with DDA regulations.	+ +	
INTEGRATION	**Transport Interchange**	The scheme is not likely to have an impact on passenger interchange quality. However, the proposed service upgrades would improve timetable coordination and act as a catalyst for wider transport coordination and integration, thus encourage interchange between public transport modes (such as bus-train) and between public and private modes (such as park & ride).	+	
	Land-Use Policy	An improved rail service would support Welsh Government's Wales Spatial Plan and SEWTA's Regional Transport Plan. This guidance promotes sustainable travel by improving accessibility to employment opportunities and key services in South East Wales through better public transport.	+ +	
	Other Government Policies	Electrification is well aligned with both Welsh and UK government policy on improving the attractiveness of public transport, decreasing reliance on the private car and improving social equity through access to key services and employment.	+	

Table 4.8 – Appraisal Summary Table for Option 2 Cascaded Electric Units

Option: 2		Description: Cascaded Electric Units - (Class 315 or equivalent)	Problems	Present Values (£m 2002)
OBJECTIVE	**SUB-OBJECTIVE**	**(a) QUALITATIVE IMPACTS**	**(b) QUANTITATIVE ASSESSMENT**	
ENVIRONMENT	Noise	Electric rolling stock would have significantly reduced noise emissions in comparison to diesel rolling stock. This would affect a significant population living in close proximity to the rail corridor.	+ + +	
	Local Air Quality	Electric rolling stock would have significantly reduced local emissions in comparison to diesel rolling stock, since there will now be no emissions from the rolling stock. This would affect a significant population living in close proximity to the rail corridor.	+ + +	£15.6m Benefits
	Greenhouse Gases	Electric rolling stock would reduce carbon emissions by switching to a less carbon intensive source of energy whilst stimulating rail demand and encouraging reduced car use. The extent of emissions reduction provided will depend on the carbon intensity of the grid electricity. Further reductions in emissions would be expected to result from mode shift from car to rail. Deployment of cascaded rolling stock in stages would offer a slightly larger benefit in carbon emission in the first 15 years than the new electrification.	+ + +	£42.0m Benefits
	Landscape	The introduction of overhead lines would have a visual impact however this would be confined to the existing railway corridors.	-	
	Townscape	There are no significant effects on the townscape of the routes since the railway corridors will not alter from the existing situation. The visual impact of overhead lines is considered to be reduced in an urban environment where there is typically a greater level of infrastructure.	0	
	Heritage of Historic Resources	Electrification will require additional headroom under structures to accommodate overhead power lines, in some cases this may necessitate the alteration of historic or listed bridge structures. (One listed structure currently identified as being affected.)	-	
	Biodiversity	During construction minor localised clearance of the surrounding areas is likely to be required. In operation the railway lines would be quieter and cleaner which may encourage increased local biodiversity.	0	
	Water Environment	This option is expected to have negligible effect on the local water environment.	0	
	Physical Fitness	Mode shift may lead to higher levels of active travel as new passengers travel to stations by walking and cycling.	+ +	
	Journey Ambience	Electrification is likely to significantly improve journey ambience. In-vehicle noise levels and extent of crowding are likely to reduce substantially in the long term. It is also considered that refurbished rolling stock would be able to offer a standard of accommodation that is near indistinguishable for the end user.	+ +	£32.5m benefits on crowding
SAFETY	Accidents	This option is not expected to result in a significant difference from the existing situation on the rail network, however mode shift is expected to have associated accident benefits on the road network.	+	£0.15m Benefits
	Security	Electrification may lead to an increase in railway related crime as a result of the value and danger of overhead cables. Refurbished rolling stock is likely to include security measures/design to include improved lighting and CCTV.	0	
ECONOMY	Public Accounts	Central government funding would need to be increased moderately as investment costs of electrification would outweigh benefits from increased revenue and reduction in operating costs. In terms of wider public finances, reduction in indirect tax revenue would also moderately reduce central government funding.	-	£39.4m costs to Central Government Budget - £17.4m change in Wider Public Finance
	Business Users & Providers	For business users the network is likely to offer time savings and increased reliability. For the service operator the financial implications will be dependent on how the rolling stock is procured. The operator would however benefit from reduced maintenance and improved reliability. The operating costs would also be reduced in comparison to options using new diesel or electric rolling stock.	+ +	£3.5m benefits to business users £207.9m operating costs savings to providers
	Consumer Users	The introduction of electrification with new rolling stock would have significant effect in decreasing journey times and improving reliability. With comprehensive refurbishment cascaded electric rolling stock could be near indistinguishable from new rolling stock to members of the public thus still encouraging a significant mode shift.	+ +	£71.4m benefit
	Reliability	It is anticipated that the introduction of electric rolling stock would result in a significant improvement in journey time reliability and overall reliability of the Valley Lines Network.	+ +	
	Wider Economic Impacts	Timetable enhancements are expected to result in a significant improvement in journey times and access to services and employment. A significant of these benefits would reach residents of some of the most deprived communities in the Heads of the Valleys Strategic Regeneration Area.	+ +	£12.6m benefits
ACCESSIBILITY	Option values	Electrification of the network and reduced journey times would substantially change the availability of passenger rail services within the study area. Benefits of electrification would reach communities across the South Wales Valleys, and particularly Aberdare, Merthyr Tydfil and Maesteg where journey time savings would be high.	+ + +	
	Severance	This option is not expected to result in additional hindrance to pedestrian movement in communities served by the Valley Line Network.	0	
	Access to the Transport System	The extent of the Valley Lines Network will not markedly increase as a result of this option however new train services are likely to increase service frequency and hence improve access. Deployment of refurbished cascaded rolling stock would also improve access for disabled people ensuring compliance with DDA regulations.	+ +	
INTEGRATION	Transport Interchange	The scheme is not likely to have an impact on passenger interchange quality. However, the proposed service upgrades would improve timetable coordination and act as a catalyst for wider transport coordination and integration, thus encourage interchange between public transport modes (such as bus-train) and between public and private modes (such as park & ride).	+	
	Land-Use Policy	An improved rail service would support Welsh Government's Wales Spatial Plan and SEWTA's Regional Transport Plan. This guidance promotes sustainable travel by improving accessibility to employment opportunities and key services in South East Wales through better public transport.	+ +	
	Other Government Policies	Electrification is well aligned with both Welsh and UK government policy on improving the attractiveness of public transport, decreasing reliance on the private car and improving social equity through access to key services and employment.	+	

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Table 4.9 – Appraisal Summary Table for Option 3 New Diesel Units

Option: 3		Description: New Diesel Units – (Class 372 or equivalent)	Problems	Present Values (£m 2002)
OBJECTIVE	**SUB-OBJECTIVE**	**(a) QUALITATIVE IMPACTS**	**(b) QUANTITATIVE ASSESSMENT**	
ENVIRONMENT	Noise	New diesel rolling stock is likely to have positive, albeit limited effects on noise emission compared with existing rolling stock.	+	
	Local Air Quality	New diesel rolling stock is likely to improved fuel efficiency and exhaust filtration. However diesel engine would continue to have significant implications for local air quality.	-	- £0.5m benefits
	Greenhouse Gases	New diesel rolling stock would be likely to have improved fuel efficiency but this change is minimal in the context of general fuel requirement. The network would continue to be diesel powered which has significant implications for carbon and greenhouse gas emissions.	-	- £0.9m benefits
	Landscape	New diesel rolling stock would have no effect on existing landscape, as it does not require new infrastructure.	0	
	Townscape	There are no significant effects on the townscape of the routes since the railway corridors will not alter from the existing situation.	0	
	Heritage of Historic Resources	There are no significant effects on the heritage of historic resources of the routes since the historic or listed bridge structures will not alter from the existing situation.	0	
	Biodiversity	There are no significant effects on biodiversity of the routes since the railway corridors will not alter from the existing situation.	0	
	Water Environment	There are no significant effects on water environment of the routes since the railway corridors will not alter from the existing situation.	0	
	Physical Fitness	This option is anticipated to have a minor effect on physical fitness since the degree of mode shift is forecast to be lower than for electrification options.	+	
	Journey Ambience	New diesel rolling stock is likely to have lower benefit in terms of in-vehicle noise and crowding levels however new rolling stock would be likely to offer an improved standard of internal comfort and facilities for passengers.	+	£4.1m benefits on crowding
SAFETY	Accidents	This option is not expected to result in a significant difference from the existing situation on the rail network, however mode shift is expected to have associated accident benefits on the road network.	+	£0.13m benefits
	Security	New rolling stock is likely to include security measures/design to include improved lighting and CCTV.	+	
ECONOMY	Public Accounts	Central government funding would need to be increased moderately as increase in operating costs would outweigh benefits from increased revenue. In terms of wider public finances, increase in indirect tax revenue would also slightly increase central government funding.	-	£44.8m costs to Central Government Budget + £0.9m change in Wider Public Finance
	Business Users & Providers	For Business users the network is likely to offer time savings and increased reliability. For the service operator, the deployment of new diesel rolling stock would significantly increase operating costs. The operator would however benefit from reduced maintenance and improved reliability.	- -	£3.5m benefits to business users - £90.6m operating costs savings to providers
	Consumer Users	New diesel rolling stock would have some effect on decreasing journey times and improving reliability. It is however anticipated that these improvements would not be as significant as the electric rolling stock and the journey ambience/noise would remain of a lower standard.	+ +	£71.3m benefits
	Reliability	It is anticipated that the introduction of new diesel rolling stock would result in some improvement in journey time reliability and overall reliability of the Valley Lines Network.	+	
	Wider Economic Impacts	Timetable enhancements are expected to result in a significant improvement in journey times and access to services and employment. A significant of these benefits would reach residents of some of the most deprived communities in the Heads of the Valleys Strategic Regeneration Area.	+ +	£12.6m benefits
ACCESSIBILITY	Option values	Deployment of new diesel rolling stock and reduced journey times would substantially change the availability of passenger rail services within the study area. Benefits of the new rolling stock would reach communities across the South Wales Valleys, and particularly Aberdare, Merthyr Tydfil and Maesteg where journey time savings would be high.	+ + +	
	Severance	This option is not expected to result in additional hindrance to pedestrian movement in communities served by the Valley Line Network.	0	
	Access to the Transport System	The extent of the Valley Lines Network will not markedly increase as a result of this option however new train services are likely to increase service frequency and hence improve access. New rolling stock would also improve access for disabled people ensuring compliance with DDA regulations.	+ +	
INTEGRATION	Transport Interchange	The scheme is not likely to have an impact on passenger interchange quality. However, the proposed service upgrades would improve timetable coordination and act as a catalyst for wider transport coordination and integration, thus encourage interchange between public transport modes (such as bus-train) and between public and private modes (such as park & ride).	+	
	Land-Use Policy	An improved rail service would support Welsh Government's Wales Spatial Plan and SEWTA's Regional Transport Plan. This guidance promotes sustainable travel by improving accessibility to employment opportunities and key services in South East Wales through better public transport. However, the effect on mode shift would not be as significant as it is less attractive than the electrification options	+	
	Other Government Policies	New diesel rolling stock would contribute to some Welsh and UK government objectives to improve the attractiveness of public transport, decreasing reliance on the private car and improving social equity through access to key services and employment. However, the continuation of diesel rolling stock does not align well with aims to reduce carbon emissions or energy security.	- -	

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