



## ***Network Rail – Analysis & Forecasting***

### ***MetroWest Interim Report***

**November 2013**



## **West of England**

Bath & North East  
Somerset Council



**Network Rail – Analysis & Forecasting**  
**MetroWest Interim Report**

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## 1. Executive Summary

The West of England Partnership are promoting the MetroWest scheme in order to achieve wider economic benefits and modal shift across the Bristol, Bath, North East Somerset and South Gloucestershire area. MetroWest will deliver more opportunities to travel by rail and improved journey times for rail passengers.

Phase 1 of the scheme supports the delivery of these benefits by:

- Reopening the Portishead Branch to passenger services, and;
- Increasing train frequencies on the Severn Beach line and between Bristol and Bath Spa.

Phase 2 will build on these changes and deliver further benefits by:

- Reopening the Henbury line to passenger services, and;
- Increasing train frequencies on the Yate to Weston-super-Mare route.

### Revisiting Phase 1

The development of Phase 1 is relatively well advanced with detailed infrastructure proposals for the Portishead Branch (following a previous GRIP study) and an indicative Phase 1 service pattern and associated business case completed by Halcrow on behalf of the West of England Partnership. Following a review of the work completed to date, Network Rail identified some opportunities for further improvement and recommended that further testing of the case for investment for Phase 1 is required for the following reasons:

1. The service pattern developed by Halcrow assumed that other services in the area could theoretically be retimed in order to support the delivery of the MetroWest proposals. The service pattern also excluded some freight paths therefore validation over a wider area the inclusion of all freight assumptions is required.
2. A key infrastructure intervention – the enhancement of Bristol East Junction – was assumed to be delivered outside of the scope of MetroWest, and therefore not included in the business case. Network Rail's current investment plan allows only for a like for like renewal of this junction, and therefore this assumption will need detailed testing in the context of delivering the MetroWest services.
3. The primary focus to date for the development of the timetable and associated business case has been to minimise the number of rolling stock units required. Whilst this has resulted in a timetable which delivers very efficient use of rolling stock, it results in a service pattern which may introduce a significant level of performance risk, both for MetroWest services and other services in the area. Options to mitigate these risks, such as the introduction of a turnback facility beyond Bath, themselves probably drive the need for additional rolling stock units, thus



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undermining the case for investment.

Therefore Network Rail undertook an initial exercise to develop indicative service patterns using these findings and updated assumptions.

#### **Balancing the case for investment**

In order to support the case for investment, these service patterns had to minimise rolling stock numbers whilst ensuring efficient use of the limited platform capacity at Bristol Temple Meads. Linking at least some of the proposed services across Bristol Temple Meads supports both these requirements, and could also deliver additional benefits.

Focusing on these additional benefits, a high level demand analysis was undertaken. This demonstrated that the greatest uplift in demand, over and above that delivered through the increased frequencies on each of the branches, is delivered by directly linking the Severn Beach line (mainly the Clifton Down area) with the Bath route. A direct link between Portishead and Bath offers about half of these additional benefits, and linking the (primarily residential) areas of Portishead and Severn Beach offers only about 5% of the additional benefits.

Although linking Clifton Down to Bath is shown to deliver the most incremental benefit in terms of demand, it also introduces a significant number of crossing moves at the constrained Bristol East Junction. This introduces potential performance risk and could drive the need for enhancements in this area, thus undermining the case for investment.

#### **Developing the options further**

A useful summary table of the various options for linking services is given from page 25 of this report, indicating at a high level the impact of each service pattern on costs, benefits and performance. Given the complexity of balancing the various factors which drive the case for investment, a number of these options will be taken forward for further development.

There is also an opportunity to develop these options further in a wider context. The opening of Crossrail, the electrification of key parts of the Great Western Main Line and the Intercity Express Programme all drive a wholesale change to the timetables in this area from 2017 and beyond. The proposed timetables (Crossrail Iteration 5) will have been developed further by the end of 2013 and these changes can be better taken into account in assessing the service pattern options for MetroWest, including those for Phase 2.

This work will be remitted over the coming months and is planned to start in January 2014. It is required in order to confirm which service patterns can deliver the best value for money, by balancing the need to minimise rolling stock numbers and the scale of capital infrastructure interventions, whilst maximising the impact on demand and also managing performance risk.



## 2. Introduction

MetroWest (previously named Greater Bristol Metro) is a proposed scheme in the West of England offering new and improved rail services across the region around Bristol, with the objectives of achieving modal shift to public transport and supporting economic growth. The scheme is promoted by West of England Partnership on behalf of North Somerset Council, Bath and North East Somerset Council, South Gloucestershire Council and Bristol City Council.

The MetroWest scheme is split into two phases of deliverables. Phase 1 includes re-opening of the Portishead Line for passenger services and improving service frequencies on the Severn Beach and Bath Spa Lines. Phase 2 includes improving service frequencies between Weston-super-Mare and Yate, and the introduction of passenger services on the Henbury Line.

A series of timetable and business case assessments have been undertaken over the last few years, including the West of England Partnership commissioning Halcrow to develop a high level feasibility study for the service aspirations they have developed. A proposed service pattern and associated demand and revenue forecasts were produced.

Subsequently, West of England has asked Network Rail to develop the scheme to GRIP 1 - 2 and undertake further feasibility assessment to confirm the preferred service pattern, infrastructure requirements and to undertake a socio-economic appraisal based on these assumptions. This is to inform the West of England Partnership in their ambitions of seek funding for the delivery of MetroWest.

The purpose of this report is to summarise the position with regard to MetroWest and will cover:

- The review of the work completed to date, i.e.
  - GRIP 3 development of the Portishead Line
  - Halcrow analysis
- Outline the initial findings and options developed by Network Rail in conjunction with West of England Partnership and stakeholders
- Identify next steps for timetable analysis

### 3. MetroWest Proposals

This section summarises the aspirations set out by the West of England Partnership and outlines the proposed interventions to deliver the objectives of MetroWest Phase 1 and 2.

#### 3.1 MetroWest Phase 1

Phase 1 of the MetroWest scheme proposes the re-opening of the Portishead Line & increasing service frequencies on the Severn Beach Line and at intermediate stations between Bristol Temple Meads and Bath Spa.

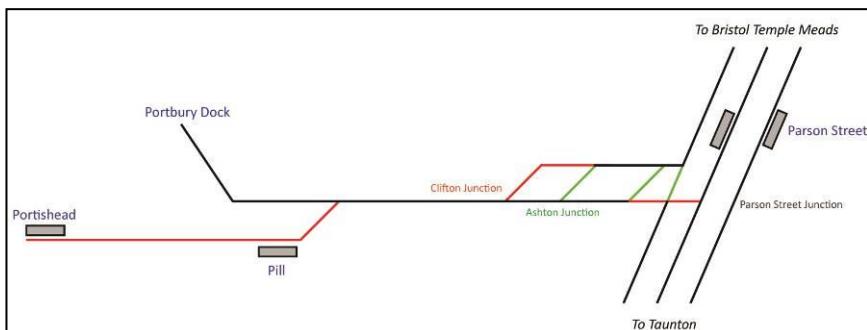
##### 3.1.1 Re-Opening of the Portishead Line

Phase 1 of the MetroWest scheme includes the re-opening of the former Portishead Line for passenger services between Bristol Temple Meads and Portishead with the re-opening of Pill station as an initial intermediate calling location in order to realise modal transport shift and provide socio-economic benefits to the surrounding areas;

*“The population of the town of Portishead has grown rapidly over the past 5 years, with a population today of just under 22,000 compared with 17,000 at the 2001 census. Future developments planned for the town are to continue for several more years, with the population rising to around 25,000.*

*Employment opportunities are limited hence many people commute to nearby centers, particularly Bristol, for work. There is only one main road (A369) out of Portishead, linking to the M5 at junction 19. At peak times the A369, M5 Junction 19, and the Bristol end of the A369 all become very congested. At one time, a rail passenger service operated from Bristol Temple Meads to Portishead, but ceased in 1964. Part of the line was re-opened in 2002 for freight traffic only to serve Portbury Dock.” [002]*

**Figure 1: Portishead Line Schematic Infrastructure Layout 6**



Currently part of the Portishead Line (GW548) operates as a freight route with services operating between Portbury Dock and Parson Street Junction, with no operational line beyond Portbury Dock Junction to Portishead. Freight operations are typically up to 20 train

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paths per day in each direction. Previous GRIP 3 development on the Portishead Line has presented six infrastructure options, of which infrastructure layout 6 was proposed as the preferred option. Details on the Portishead Line options are included in APPENDIX A and summarised in Figure 1 above. The proposals for includes operating 2tph in the peak and 1tph off peak.

#### **3.1.2 Increasing Service Frequencies on Existing Routes**

In addition to re-opening the Portishead Line, Phase 1 also includes an aspiration to increase service frequency on the Severn Beach Line and the opening of a new station; Portway Park & Ride. The new station, Portway P&R will be located at approximately 8mi on the Severn Beach Line from Bristol Temple Meads, between Shirehampton and Avonmouth.

Currently the Severn Beach Line operates with a ~2 hourly service between Severn Beach and Bristol Temple Meads and a ~30-40\* minute service frequency between Avonmouth and Bristol Temple Meads. Phase 1 proposes to increase the service frequency on the Severn Beach Line to half hourly services between Severn Beach and Bristol Temple Meads.

The Phase 1 proposals also include increasing the service frequency of services to 2tph between Bristol Temple Meads and Bath Spa at intermediate stations, Keynsham and Oldfield Park. Currently these stations are served by an hourly through services operating between Westbury and Gloucester axes<sup>†</sup>. The proposals include an additional service operating between Bristol Temple Meads and Bath Spa calling at the intermediate stations to form half hourly services with the existing timetable.

#### **3.2 MetroWest Phase 2**

Phase 2 of the MetroWest scheme proposes the re-introduction of hourly passenger services on the Henbury Line, and the increase of service frequencies at intermediate stations between Weston-super-Mare and Yate to 2tph.

#### **3.2.1 Re-Introduction of Passenger Services on the Henbury Line**

The Henbury Line is currently designated as a freight route between the Avonmouth Docks and Filton Junctions. MetroWest proposes the re-introduction of passenger services on the Henbury Line with several new stations in order to enable the planned Filton Airfield mixed use redevelopment. The opening of the Henbury Line to passenger services also needs to

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\* Frequency of services to Bristol Temple Meads includes the 2 hourly Severn Beach Service.

† Westbury – Gloucester services vary by origin and destination every hour. Some peak time services also call at these intermediate stations.

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take into account the future aspirations of the Avonmouth Docks which includes the development of international deep sea docks.

#### **3.2.2 Additional Increase of Service Frequencies on Existing Routes**

Phase 2 also proposes the increase of intermediate station service frequencies between Weston-super-Mare and Yate. It is proposed that increased service frequency is delivered by potentially extending the current Weston-super-Mare - Bristol Parkway service to Yate, and adding services to provide all day half-hourly services.

## 4. A summary of work completed

A series of feasibility analysis has been undertaken to accommodate the aspirations of West of England as described in Section 2. The work completed to date includes:

- GRIP 3 option design and selection for the re-opening of the Portishead Line
- Timetable assessment and business case development by Halcrow on behalf of West England Partnership for MetroWest Phase 1.
- Initial analysis on timetable feasibility and option development

The following sections summarise this work.

### 4.1 Portishead GRIP 3 Development

The re-opening of the Portishead Line progressed through the GRIP stages to GRIP stage 3 by October 2010. This included detailed infrastructure and timetable optioneering and option selection. A total of six options for timetabling and infrastructure designs have been developed with various demand, cost and deliverability assessments. The work focused solely on the Portishead Line area. Option 6 was chosen to be taken forward; this option provides a half-hourly service in the peak and hourly off peak between Portishead and Bristol Temple Meads with an intermediate stop at Pill. The journey time developed in this option is 17 minutes in each direction and is planned to operate between the freight traffic to/from Portbury Dock. See APPENDIX A for further details on option 6 of the Portishead Line development.

### 4.2 MetroWest Phase 1 Timetable and Business Case Development

Timetable and economic business case analysis for all of MetroWest Phase 1 has been completed by Halcrow on behalf of the West of England Partnership, which was finalised in February 2013. This set out the investment case for Phase 1 and included:

- Rail Operations (timetable analysis)
- Demand & Revenue forecasts (including the proposed new stations) based on the proposed timetables
- An estimate of capital expenditure and operating costs
- An estimate of the socio-economic benefits of the schemes

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#### 4.2.1 Area Covered

The geographic scope covered in the Halcrow timetable analysis included the following boundary locations on the rail infrastructure;

- Portishead
- Severn Beach
- Uphill Junction (Weston-super-Mare)
- Standish Junction
- Swindon
- Severn Tunnel Junction
- Bradford-on-Avon

These boundary locations are represented in Figure 2 below.

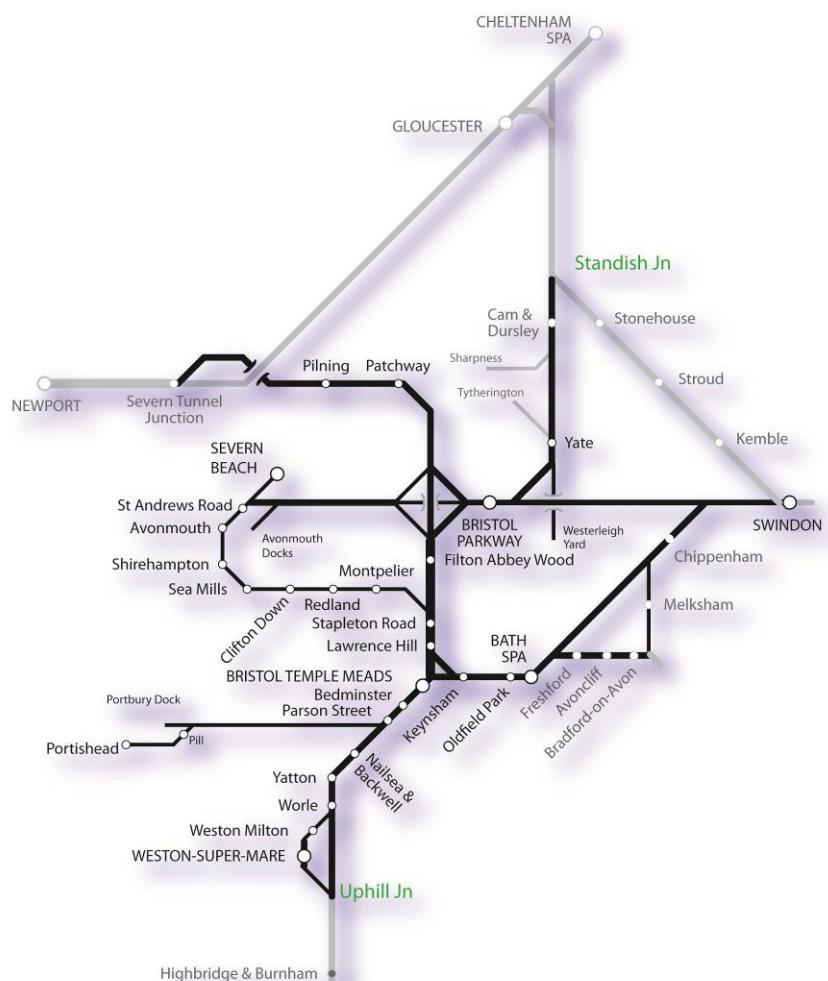


Figure 2: Halcrow Analysis Geographic Scope Map

#### **4.2.2 Assumptions used in the Halcrow Analysis**

To develop the timetable, a number of infrastructure interventions were assumed to be in place and therefore their costs were not included in the business case. These are the following:

- Filton Bank four track. (BTM to BPW)
  - Infrastructure proposal to 4-track between Dr Days Junction and Filton Abbey Wood (part of the IEP program)
- Bristol Parkway platform alterations
  - Infrastructure proposal for an additional platform face at Bristol Parkway (part of the IEP program)
- Bristol Temple Meads alterations
  - Infrastructure proposals to extend the current Platform 1 into the 'Midland Shed' and include an additional Platform 0 alongside the extended Platform 1
- Bristol East Junction enhancements
  - Proposed enhancements to Bristol East Junction (BEJ) to provide greater operational flexibility and access to the proposed Platforms 0 & 1.

Further infrastructure enhancements were then identified in order to deliver the aspirations of MetroWest Phase 1. These were included in the timetable analysis and the capital costs were factored into the business case.

- Portishead Line
  - Infrastructure Option (taken from the GRIP 3 proposals October 2010) which proposes the extension of the double track between Parson Street Junction and Ashton Junction to a new Clifton Junction, and an amended Parson Street Junction to include a double junction and alterations to the signalling to accommodate the opening of Pill and Portishead Stations.
- Portway P&R Station
  - Additional station proposal on the Severn Beach Line between Avonmouth Station and Shirehampton station at approximately 8mi 0ch from BTM.

Halcrow developed an off-peak standard hour timetable to represent all the existing services, which forms the base of the Metro West timetable. See APPENDIX B for the assumptions regarding the train service specification.

#### **4.2.3 Timetable Findings**

The findings concluded that a basic MetroWest Phase 1 service was achievable. The proposed timetable was designed to meet the aspirations of Phase 1 of MetroWest, i.e.:

- a half-hourly service on the Portishead Line,
- a half hourly service on the Severn Beach Line; and

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- an additional stopping service between Bath Spa and Bristol Temple Meads.

The key drivers to the business case include:

- Operational Costs
  - Rolling stock requirement (e.g. units, drivers, train guards), leasing and mileage related costs and staff costs.
- Capital Costs
  - Infrastructure enhancements required
- Demand
  - Demand and revenue impact.

Minimising operational costs (particularly rolling stock costs) was defined as key to the overall business case. Therefore, the timetable was designed with a primary focus on minimising the unit numbers required to operate the proposed Phase 1 services, which resulted in the connection of different routes across Bristol Temple Meads in order to optimise rolling stock use.

The timetable proposed linking each of the three routes across Bristol Temple Meads as follows;

- An hourly service from Bath Spa to Severn Beach via Bristol Temple Meads (forming half hourly services between Bath Spa at Bristol Temple Meads with the existing timetable at the time of analysis)
- An hourly service from Portishead to Severn Beach via Bristol Temple Meads & Avonmouth
- An hourly shuttle between Portishead and Bristol Temple Meads in the peak hours

See APPENDIX C for an illustrative diagram representing the connectivity and service frequency proposed.

As a result the connectivity between the Phase 1 routes has been proposed along with the following unit diagramming pattern;

*The proposed Severn Beach "... half hourly service is connected at Temple Meads so that one forms a through-service to Portishead and the other reverses in Temple Meads then runs to Bath..." and vice-versa to form the return services along with a peak hours shuttle between Portishead and Bristol Temple Meads. [001]*

This diagramming pattern along with other services in the timetable delivers half hourly services on the Severn Beach Line, near half-hourly services between BTM and Bath Spa and peak half hourly services on the Portishead Line.

Turnround times and journey times were kept as low as possible in order to deliver a



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timetable as efficient as possible in terms of the unit numbers required to deliver it.

#### **4.2.4 Halcrow Economic Business Case Summary**

A demand assessment and business case was undertaken based on the proposed timetable outlined in 4.2.3. The demand forecasts included:

- Trips at new stations
- Changes in demand at existing stations, and
- Suppression of demand by extra station calls.

The impact of the proposed timetable on existing stations/routes was estimated by following the PDFH (Passenger Demand Forecasting Handbook).

Demand forecasts for the new stations were developed using trip rate analysis and comparison of stations with similar catchment areas. The revenue impact was estimated, taking account of abstracted demand from existing stations to the station.

The report concluded that Phase 1 of the scheme had a high value for money business case with a benefit to cost ratio (BCR) estimated at 2.51. The majority of benefits were found from travel time savings; which were compared against the cost of the infrastructure requirements and operating costs. The business case also included the benefits to non-rail users (e.g. reduction in road congestion).

## 5. Network Rail Review of Halcrow Analysis

Network Rail has undertaken a review of the previous timetable analysis completed by Halcrow with a focus on updating assumptions as required and on understanding the feasibility of the proposals in a wider context.

### 5.1 Phase 1 Timetable Development Limitations

The previous timetable analysis completed by Halcrow on behalf of the West of England Partnership concluded with an option that could deliver a Phase 1 timetable. However, the review of the proposed timetable has identified several constraints which would need to be addressed in order for this timetable to be taken forward for further GRIP development.

#### 5.1.1 Performance Risk

Section 3 of this report highlighted that the Halcrow timetable was developed with a primary focus on minimising the operational costs by limiting the number of units required. Whilst this has resulted in a timetable which is very efficient in its use of rolling stock, it also results in a number of potential performance risks. These are described in more detail below.

#### Unit Diagramming

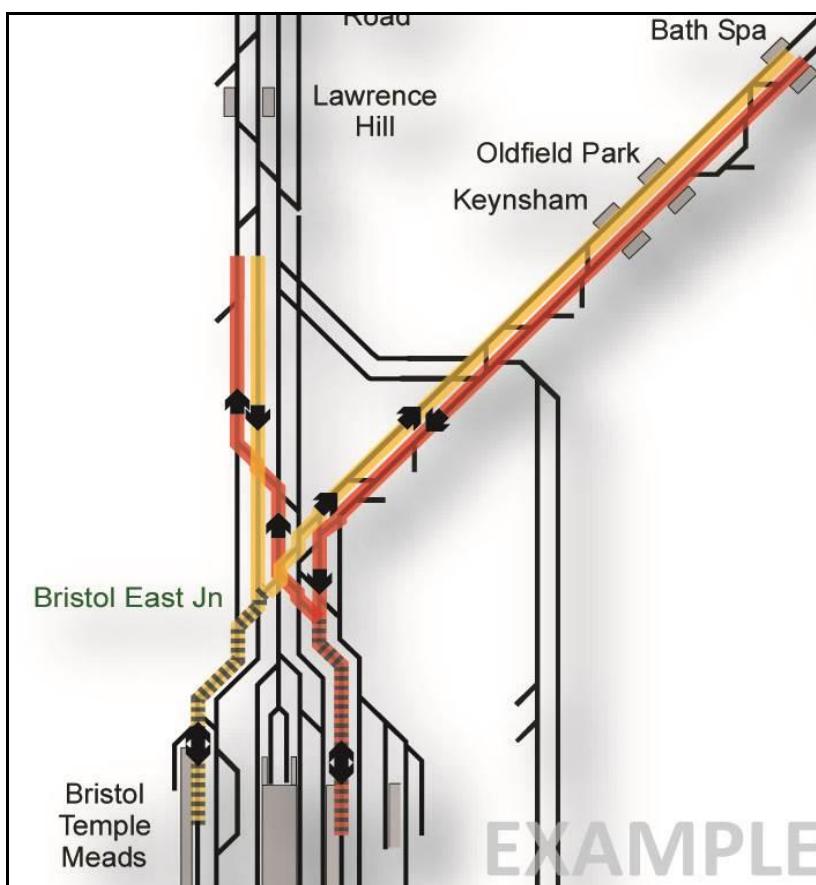
The diagramming of units operating between Portishead, Severn Beach and Bath Spa required each unit to operate a cycle as follows:

Portishead – BTM – Severn Beach – BTM (reverse) – Bath Spa – BTM (reverse) Severn Beach – BTM - Portishead

The unit cycle therefore links all three routes and thus links the constraints on each of these routes. The Portishead and Severn Beach lines contain single track sections with crossing loops, and the Bath Spa route is constrained due to the number services operating on the route from various origins and destinations. Linking these constraints through the service pattern potentially introduces significant performance risk on both the MetroWest services and the existing services in the wider area. A primary delay event on one route would potentially cause reactionary delay across each of the three routes, impacting on these and other services.

The timetable also introduces a number of crossing moves to the east of Bristol Temple Meads in order to link Severn Beach to Bath Spa. Each trip between Bath Spa and Severn Beach requires units to cross at Bristol East Junction conflicting with services between Bristol Temple Meads and Filton Junction. Several of the services between Bath Spa and Severn Beach are timed with minimum junction margins resulting in potential performance risk. Figure 3 on the following page demonstrates the crossing moves required for linking

services between Bath Spa and Severn Beach.



**Figure 3: Bath Spa - Severn Beach Crossing moves at BEJ. A service timed as Bath Spa – Severn Beach results 2 crossings at BEJ junction in order to turnback services at BTM.**

### Turnback Time

MetroWest services have been timetabled to turnback on the main running line at Bath Spa. The turnback time planned for the MetroWest services at Bath Spa is 4 minutes with a following IEP service arriving 12 minutes after the departure of the MetroWest service, and a preceding service departing Bath Spa 7 minutes before the arrival of the MetroWest service. Although there is a moderate margin before and after the MetroWest service turning back at Bath Spa, using the main running line to turnback the service can potentially present significant performance risk both to MetroWest services, and to other services using this route.

The analysis does however suggest the use of a turnback facility at Bathampton Junction to mitigate against the performance risk of turning back services on the main running lines at Bath Spa. However given the efficiency of the proposed timetable (requiring a 4 minute turnback time at Bath Spa in order to meet the return journey), using a turnback facility



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beyond Bath Spa at Bathampton Junction would require additional train units to operate the proposed timetable due to the extended journey time required.

There are a number of 'close to' minimum turnrounds across the timetable, offering little opportunity for recovery across the routes. The turnback time available for the MetroWest services at Severn Beach and Portishead is 7 minutes and 5 minutes respectively. Although the minimum Timetable Planning Rules turnround value for class 15x is 3 minutes this presents limited capability for the timetable to recover any delays which might occur. Coupled with the unit diagramming any delays occurring in the timetable could mount up over time, with recovery only easily achievable by requiring services to be cancelled or turned back early.

#### **5.1.2 Assumptions**

The assumptions used in the Halcrow analysis regarding both the wider timetable and infrastructure proposals would now need updating, in order to take the proposals through to GRIP 3.

#### **Timetable assumptions**

The standard hour approach utilised in the previous analysis resulted in several existing timetable paths changing at the model boundaries. For example the timings for services currently operating between Cardiff Central and Portsmouth Harbor have changed outside the model boundary without any validation on the impact of doing so on the wider area. The assumptions regarding freight paths are also reduced or not included that that required for the model area. It is therefore a potential risk to assume that the changed services interacting outside the model boundary can still be accommodated without further timetable analysis covering an expanded geographic boundary.

Since the previous analysis has been completed assumptions regarding IEP services have changed in regard to the timings and the service specification, a future analysis would therefore also require further validation to test against the latest IEP timetabling assumptions available.



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#### **Infrastructure Assumptions**

The previous analysis assumed that Bristol East Junction (BEJ) had an enhanced layout providing greater operational and timetabling flexibility.

Network Rail's current investment plans allow for a like for like renewal of BEJ. Whilst there is ongoing work investigating the possibility of delivering an enhanced layout, the latest assumption for this area is to assume a like for like renewal in terms of capability.

This therefore requires the previous analysis to be re-validated against BEJ in its current layout. The previous analysis noted that an enhanced BEJ is significant in supporting the delivery of the timetable option, and therefore the current BEJ layout will need testing to understand whether it could support the level of services proposed.

## 6. MetroWest Network Rail Analysis

### 6.1 Introduction

Given these findings, and the requirements to consider a number of service pattern options in order to progress Phase 1, Network Rail has completed an initial high level timetable analysis in order to support this further option development. This focused on the feasibility of delivering the MetroWest Phase 1 proposals, based on the following updated assumptions:

- Current capability of Bristol East Junction
- December 2012 timetable is fixed at model boundaries
  - Updated with the latest IEP assumptions
- Filton Bank 4-tracking latest assumptions
- Portishead Head Line GRIP Infrastructure layout 6 tested
- Platform 1 extension at Bristol Temple Meads only (i.e. no Platform 0)

The timetabling for this initial timetabling analysis focused on the minimal service specification for MetroWest Phase 1, namely;

- 2tph Severn Beach – Bristol Temple Meads (calling all stations)
- 1tph Bath Spa – Bristol Temple Meads (calling all stations)
- 1tph Portishead – Bristol Temple Meads (calling Pill only)
- 1tph (Peak only) Portishead – Bristol Temple Meads (calling Pill only)

The starting point for this analysis was to maintain the timings within the December 2012 timetable (other than IEP timings), so as to confirm or otherwise the feasibility of delivering MetroWest services within this context. Therefore for the purposes of the initial analysis by Network Rail, the geographic scope mirrored that used in the previous analysis by Halcrow.

### 6.2 Findings

The initial analysis focused firstly on providing shuttle services to and from Bristol Temple Meads in order to build up a timetable in the context of the updated assumptions. This analysis demonstrated that shuttle services are not preferred because:

- They are inefficient in the use of the limited platform capacity at Bristol Temple Meads
- They are inefficient in terms of rolling stock unit numbers
- It proves difficult to deliver an even pattern for the MetroWest services

Therefore, some or all of the routes would require linking in order to achieve greater efficiency of rolling stock use and platform capacity, confirming the key findings of the



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previous Halcrow analysis.

The analysis then continued by understanding at a high level the feasibility of linking some or all of the routes. This analysis highlighted that delivering connected services on the proposed infrastructure was challenging, particularly whilst minimising the number of rolling stock units. Key constraints identified were:

- The requirement to move services within the existing timetable (and therefore the need to test the impact over a wider study area)
- The capability of Bristol East Junction
- The linking of constraints (single tracks, congested sections etc.) across each of the routes

Further detailed work was therefore proposed to include updated assumptions and a larger study area. A development workshop was held in order to determine the preferred connectivity options for MetroWest Phase 1 in terms of both demand and capacity, in order to provide a focus for the next phase of analysis. The options from the workshop are presented on the following pages in section 7.

## 7. Connectivity Options

The initial timetable analysis completed demonstrates that interventions are required in order to realise a Phase 1 MetroWest scheme. Interventions include the retiming of the December 2012 services (which would require an expanded geographic scope in order to validate the timetable against any re-timings of existing services made), or providing further infrastructure enhancements such as Bristol East Junction.

The analysis completed previously by Halcrow highlights that operational and capital expenditure are marginal for developing a business case for MetroWest Phase 1. Therefore in order to reduce the impact on expenditure it's necessary to devise timetabling solutions which require the least costs but deliver value for money whilst considering the aspirations of MetroWest. Through a value management workshop several potential timetabling solutions have been proposed for further analysis. Each potential solution, led by demand forecasts and likely timetabling impacts are discussed below.

Each option presented outlines any likely potential impact on performance, the service achievement, and demand forecasts when compared to a shuttle service option as the base case. The outputs presented here are indicative and are all subject to further detailed analysis in the next phase.

For options 1-4 a sub-option is also presented (option #b). These sub options offer the potential to reduce the unit requirements by turning back 1tph of the 2tph Severn Beach services at Avonmouth. Each of the sub-options is presented in a summary table in 7.6.

### 7.1 Option 1: Shuttles (Base Case)

This option presents the base case for MetroWest Phase 1 offering the basic aspirations without any connectivity between the three routes. This option will likely result in high operational costs due to the inefficient use of rolling stock required to operate a MetroWest service. There is also the potential for this option to require additional infrastructure interventions such as additional platforming capacity at BTM to facilitate the additional services.

For the purposes of a high level comparison of the benefits of each option, Option 1 has been assumed the base case. The benefits of providing through services across Bristol are thus compared against the base (of option 1), in order to 'value' the different connectivity options.

## 7.2 Option 2: Portishead – Bath Spa

The first option to connect MetroWest services suggests linking 1tph of the 2tph from Portishead to the 1tph Bath Spa service, with the remaining 1tph Portishead service operating as a peak only shuttle between Portishead and BTM. The Severn Beach 2tph service would operate independently as a half hourly shuttle between BTM and Severn Beach.

This option potentially reduces the rolling stock inefficiencies of the shuttle option, whilst also providing direct connectivity between Portishead and Bath Spa. It also reduces the number of crossing moves at BEJ, and therefore may be better supported by the current layout. However, it may prove difficult to achieve even service intervals on the Portishead and Bath Spa routes of MetroWest.

A high level assessment of demand of this option (against the base option) was undertaken. Demand increases as this option provides an opportunity to travel across Bristol without the need to interchange. In this case, the connection between Portishead and Bath Spa provides a medium increase in revenue and value of time improvements, significantly more than Option 3, but less than half of Option 4.

## 7.3 Option 3: Portishead – Severn Beach

This option links both the 2tph Portishead Services with the 2tph Severn Beach services with the 1tph Bath Spa service operating as a shuttle service. This option is presented as an all day timetable without a peak variant.

This option potentially reduces the inefficient rolling stock usage further than that in Option 1 & 2 by linking both of the 2tph required between Severn Beach and Portishead together. It also does not introduce additional crossing moves to be made at Bristol East Junction potentially removing a requirement for enhancements.

However, it is unlikely the Severn Beach and Portishead routes will achieve an even service interval. Significant performance risk is also inherent in linking these two routes together due to the nature of single lines of each route.

A high level analysis shows that the demand for travel between Portishead and Severn Beach is low and therefore the value of time improvement and revenue impact is significantly less when compared to other connectivity options.

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#### **Option 4: Severn Beach – Bath Spa**

This option links 1tph of the 2tph Severn Beach services to the 1tph Bath Spa service and the remaining Portishead services can operate as 2tph peak and 1tph off peak shuttles.

This option would improve the rolling stock inefficiencies of the Bath Spa services operating as a shuttle by linking it to Severn Beach. This option also links the key demand between stations on the route. It also potentially allows for the Portishead services to operate with 2tph even shuttles in the peak with the removal of 1tph in the off peak to reduce operational expenditure.

This option does however increase the likelihood of requiring enhancements to Bristol East Junction, and presents performance risk in requiring its use for additional crossing moves between the Bath Spa route and the Severn Beach route. It may also result in uneven intervals on the Severn Beach Line limiting the extent to which services can reach Severn Beach.

Option 4 provides the largest incremental increase in passenger demand and revenue due to better connections, and is over double that offered by Option 2. Demand increases as this option provides an opportunity to travel across Bristol without the need to interchange and connecting large catchment areas (e.g. Clifton Down) with the major employment centres (e.g. Bath and Bristol). Historic demand data shows that a large number of passengers (72,000 in 2012) travel currently from Clifton Down to Bath Spa .

#### **7.4 Option 5: Previous Proposed Timetable (Halcrow Model)**

Option 5 is presented as the previously developed solution for MetroWest and is described fully in 4.2. This option would require updated analysis in order to validate the findings and feasibility of delivering this option against the updated assumptions. It is likely that these changes would drive amendments to the business case.

#### **7.5 Option 6: Portishead - Severn Beach & Bath Spa**

Further option development by West of England Partnership continued after the workshop which led to Option 6. Option 6 provides a hybrid option formed from Option 2 and Option 3. The option presented is similar to option 5, but with slightly reduced linking of MetroWest routes. This option links 1tph Severn Beach - Portishead, 1tph Bath Spa – Portishead and 1tph Severn Beach – BTM shuttle.

This option potentially offers a more efficient use of rolling stock and platform capacity at Bristol Temple Meads when compared to Option 2 or 3. It also provides additional connectivity for Phase 1 services when compared to Options 1-3.

However it may result in uneven frequencies across all three routes potentially constraining the Severn Beach Line's ability to achieve 2tph to Severn Beach. Also with all three routes



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linked together the potential impact on performance may be worse than Options 1-3. Option 6b has been developed to reduce the potential impact on performance and the operational costs.

#### **7.5.1 Option 6b: Portishead – Avonmouth & Bath Spa**

Option 6b reduces the Portishead – Severn Beach service to turnaround at Avonmouth, therefore reducing the round trip time per unit and thus the total number of units required to operate this option. The 1tph Severn Beach –BTM shuttle would remain providing services at St Andrews Road and Severn Beach. This option is unlikely to resolve the possible outcome of uneven frequencies on the Severn Beach Line and Portishead Line but could potentially reduce the operational costs.

#### **7.6 MetroWest Options Summary**

The following table summarises Options 1- 6 for ease of comparison. For each option a brief overview of the following key factors is included;

- Operational expenditure
- Capital expenditure
- Benefits
- Risks

Note that Operation and Capital costs are subject to further detailed timetable analysis in order to confirm the requirements for each option. The table is provided as a guide to highlight the likely outcomes.

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Connectivity Option	Operational Expenditure	Capital Expenditure/ Infrastructure Requirements	Additional Benefits	Risks
<b>Option 1: Shuttles</b> <i>No direct cross Bristol connectivity between MetroWest services.</i>	<b>High</b>  Inefficient rolling stock requirements when compared to linked options, likely requires several units to operate	<b>High</b>  Likely to require enhancement to BEJ. Likely to require Platforms 0, 1 & 2 at BTM	<b>Some</b>  Potential for even service patterns on each route. Lower Performance risk – unlinked services	<b>High</b>  OpEx, CapEx could negatively impact BCR No direct links between MetroWest routes



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Connectivity Option	Operational Expenditure	Capital Expenditure/ Infrastructure Requirements	Additional Benefits	Risks
<b>Option 2a: Portishead - Bath Spa</b> <i>Portishead – Bath Spa 1tph    Portishead Shuttle 1tph    Severn Beach shuttle 2tph</i>	<u>High</u>  Each route would require multiple units to operate, potential unit reduction from option 1.	<u>Moderate</u>  Likely to require Platforms 0 or 2 at BTM	<u>Moderate</u>  Through services from Portishead to Bath improving Cross-Bristol connectivity.  Medium positive impact on Value of Time and Revenue (compared to Option1)	<u>Some</u>  Performance risk increased on Portishead – Bath Spa route, and potentially uneven frequencies with current TT. Reduced conflicting crossings required at BEJ (Bath-Spa) Portishead planned to cross at BWJ
<b>Option 2b: Portishead - Bath Spa</b> <i>Portishead – Bath Spa 1tph    Portishead Shuttle 1tph    Severn Beach Shuttle 1tph    Avonmouth Shuttle 1tph</i>	<u>Moderate</u>  Some reduction of unit requirements may be possible when compared to 2a	<u>Moderate</u>  Likely to require Platforms 0 or 2 at BTM	<u>Some</u>  Through services from Portishead to Bath improving Cross-Bristol connectivity. Reduced frequency for services beyond Avonmouth.  Slight reduction in Value of Time and Revenue compared with Option 2a.	<u>Moderate</u>  Performance risk increased on Portishead – Bath Spa route and potentially uneven frequencies with current TT. Reduced conflicting crossings required at BEJ (Bath-Spa) Portishead planned to cross at BWJ  Uneven Frequencies between Avonmouth and BTM.



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Connectivity Option	Operational Expenditure	Capital Expenditure/ Infrastructure Requirements	Additional Benefits	Risks
<b>Option 3a: Portishead – Severn Beach</b> <i>Severn Beach – Portishead 2tph Bath Spa Shuttle 1tph</i>	<b>High</b>  Likely to require several units to operate each route, potential unit reduction from option 1	<b>Some</b>  May require Platform 0 at BTM	<b>Some</b>  Through services from Portishead to Severn Beach improving Cross-Bristol connectivity  Minimal Value of Time and Revenue (compared to Option 2 and 4)	<b>High</b>  Performance risk introduced by linking two single lines together.  Severn Beach – Portishead unlikely to achieve 30mins frequency (20/40). Bath Spa route potentially uneven frequencies with current timetable.
<b>Option 3b: Portishead – Severn Beach</b> <i>Severn Beach – Portishead 1tph Avonmouth – Portishead 1tph Bath Spa Shuttle 1tph</i>	<b>High</b>  Likely to require several units to operate each route.	<b>Some</b>  May require Platform 0 at BTM	<b>Some</b>  Through services from Portishead to Severn Beach improving Cross-Bristol connectivity  Even frequency potentially more likely to achievable except on Bath Spa route  Slightly reduced Value of Time and Revenue compared with Option 3a.	<b>Moderate</b>  Performance risk is reduced from 3a due to the Avonmouth service operating a shorter route.



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Connectivity Option	Operational Expenditure	Capital Expenditure/ Infrastructure Requirements	Additional Benefits	Risks
<b>Option 4a: Severn Beach – Bath Spa</b> <i>Severn Beach – Bath 1tph</i> <i>Severn Beach Shuttle 1tph</i> <i>Portishead Shuttle 2tph</i>	<b>High</b>  Likely to require several units to operate each route, potential reduction from option 1	<b>Moderate</b>  Platform 2 and 0 BTM may be required.	<b>Moderate</b>  Uneven frequencies on Severn Beach and Bath Spa routes (with current TT on Bath Spa Route).  Highest Value of Time and Revenue (compared to Option 1, 2 and 3)	<b>High</b>  Increased performance risk requiring 2x BEJ crossings and turnbacks at BTM. Linked single line with constrained Bath Spa route.
<b>Option 4b: Severn Beach – Bath Spa</b> <i>Severn Beach/ Avonmouth – Bath Spa 1tph</i> <i>Severn Beach/ Avonmouth – BTM 1tph</i> <i>Portishead Shuttle 2tph</i>	<b>Moderate</b>  Potential reduction in unit requirements using Avonmouth to turnback services	<b>Moderate</b>  Platform 2 and 0 BTM may be required.	<b>Moderate</b>  Potential slight improvement to frequencies on Severn Beach Line from 4a. Bath Spa route remains with potentially uneven frequencies  Slightly reduced Value of Time and Revenue compared with Option 4a.	<b>High</b>  As 4a however; 1tph on Severn Beach Line turns back earlier reducing single line risks



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Connectivity Option	Operational Expenditure	Capital Expenditure/ Infrastructure Requirements	Additional Benefits	Risks
<b>Option 5: (Halcrow Proposal) Severn Beach – Bath Spa &amp; Portishead</b> <i>Severn Beach – Bath Spa 1tph  Severn Beach – Portishead 1tph  Portishead Shuttle 1tph</i>	<b>Low</b> <p>Potential reduction in unit requirements (moderate if using Bathampton Turnback)</p>	<b>High</b> <p>Requires Platform 1 &amp; 0 at BTM  May also result in requiring BEJ enhancements</p>	<b>Some</b> <p>MetroWest routes linked improving cross Bristol connectivity.</p> <p>Long turnaround and dwell times between some connecting routes.</p>	<b>High</b> <p>Increased performance risk to services via Bath Spa if not using Bathampton Turnback (otherwise increases OpEx)</p> <p>All three Phase 1 routes are linked introducing performance risk through linking of several constrained routes due to single line section or timetable constraints</p> <p>Would require re-working of current timetable expanding the scope to cover long-distance services (e.g. Cardiff – Portsmouth corridors)</p>



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Connectivity Option	Operational Expenditure	Capital Expenditure/ Infrastructure Requirements	Additional Benefits	Risks
<p><b>Option 6a: Portishead – Severn Beach &amp; Bath Spa</b>  <i>Portishead – Bath Spa 1tph    Portishead – Severn Beach 1tph    Severn Beach shuttle 1tph</i></p>	<b>High</b>  Likely to require several units to operate each route	<b>Some</b>  Platform 0 BTM may be required	<b>Some</b>  Through services from Portishead to Bath Spa/Severn Beach improve Cross-Bristol connectivity. Less conflicting crossings at BEJ (Bath-Spa Portishead planned to cross at BWJ)	<b>Moderate</b>  Performance risk increased on Portishead – Bath Spa & Portishead – Severn Beach route due to linking Single lines & constrained Bath Spa route. Likely require a unit to run between all routes as in Halcrow Proposal May result in long turnaround times at BTM All routes potentially uneven frequencies.
<p><b>Option 6b: Portishead – Avonmouth &amp; Bath Spa</b>  <i>Portishead – Bath Spa 1tph    Portishead – Avonmouth 1tph    Severn Beach shuttle 1tph</i></p>	<b>Low</b>  Potential reduction in units from 6a requirements using Avonmouth to turnback services	<b>Some</b>  Platform 0 BTM may be required	<b>Moderate</b>  Through services from Portishead to Bath Spa/Avonmouth maintain some cross Bristol Connectivity Possibility to improve frequencies from option 6a.	<b>Moderate</b>  As 6a however some potential improvement to performance risk as services turnback earlier on Severn Beach Line

## 8. Timetable Analysis Next Steps

The analysis and stakeholder workshops carried out to date have identified the key factors which will need to be taken into account in developing the preferred service patterns and associated infrastructure options. Further detailed analysis is required in order to confirm unit numbers, end to end journey times, infrastructure requirements and performance risks for each of the preferred options.

The Capability Analysis team within Network Rail is currently developing a 24 hour timetable for the Crossrail, Great Eastern and Great Western Routes which incorporates the latest proposed IEP & Crossrail timetables. This is known as the Crossrail Iteration 5 Integrated Timetable (ITT). This work offers an opportunity for the MetroWest programme to understand the preferred options in a wider context, with up to date assumptions for both train services and infrastructure proposals. This timetable can then form the basis for more detailed analysis focused on comparing the MetroWest options.

In terms of MetroWest, the expanded geographic boundary allows for validation of changes made against the current services and provides the latest assumptions regarding services that interact with MetroWest.

For the purposes of the wider Crossrail study, initial assumptions regarding MetroWest services have been developed in order to allow for the quantum of services required in the Bristol area. The proposed service pattern is Option 6b, as follows:

- 1tph Portishead – Bath Spa
- 1tph Portishead – Avonmouth
- 1tph Severn Beach – Bristol Temple Meads

This service pattern will be included in the train service specification for the Crossrail analysis.

This does not preclude other options being considered, but merely allows the testing of an option within the wider Crossrail work. Further detailed analysis and comparison of options will be undertaken from January 2014 following completion of the Iteration 5 timetable study, in order to determine (within this wider context) which options present the best value for money. The approach is summarised on the following page and will be remitted between now and January 2014.



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Figure 5 below outlines the high level process map for timetable analysis for MetroWest Phase 1 & 2, the process map includes testing a number of the options outlined in this report. It is likely by Phase 2 of the timetable analysis several additional options will be developed in order to optimise operational and capital costs for the delivery of Phase 2.

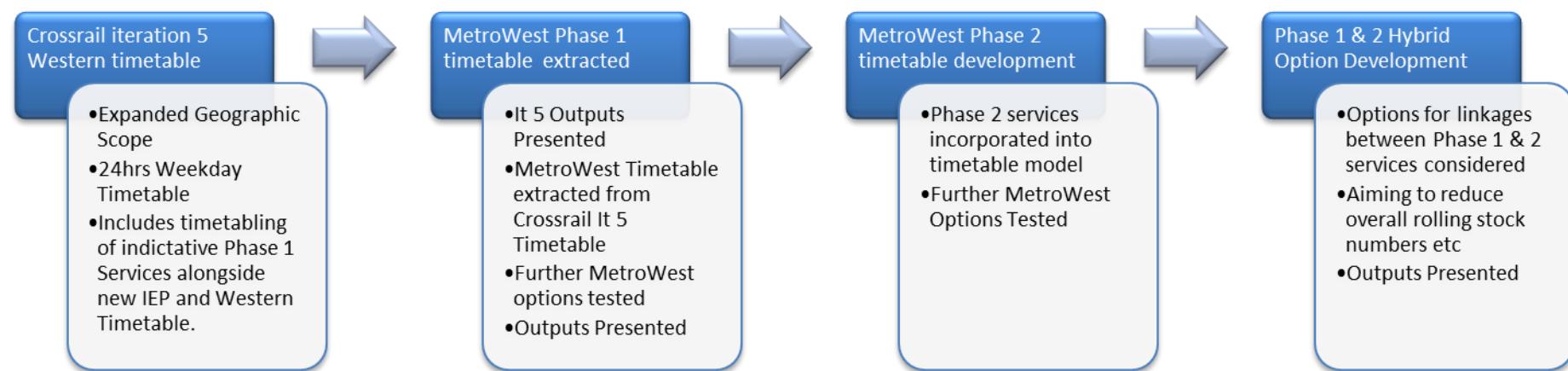


Figure 4: MetroWest Timetable Process Map



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## **9. APPENDIX**

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#### **APPENDIX A Portishead GRIP Summary**

The following table and figures detail the infrastructure Options 1 – 6 for the Portishead Line GRIP2. Option 6 was selected at GRIP 3 for further development. Each option is incremental from the previous option.

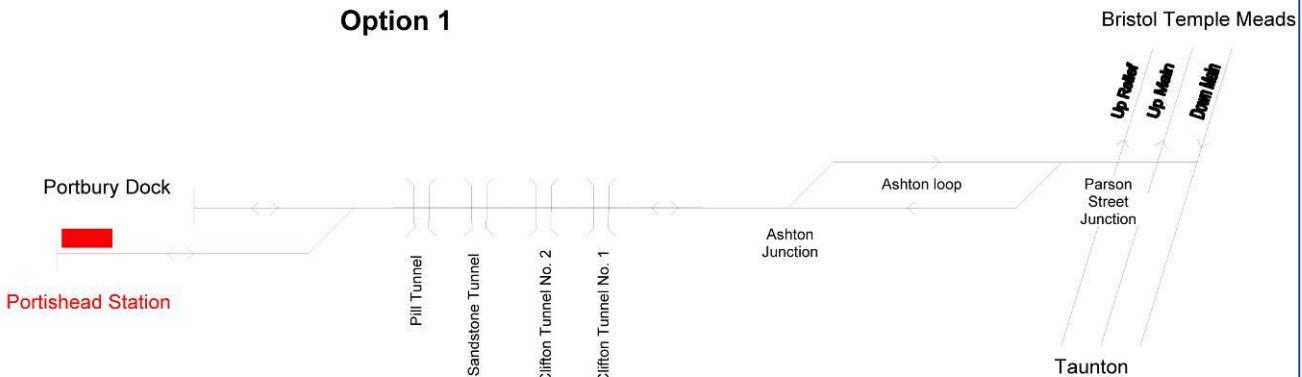
<b>Summary of Portishead GRIP Infrastructure Options 1 –6</b>	
Option 1	Increased line speeds on plain line sections
Option 2	Double track Pill Junction/Pill Station
Option 3	Double track Clifton Junction to Ashton Gate
Option 4	Ashton Gate Station platforms
Option 5	Double lead Parson Street Junction
Option 6	Intermediate signals at Miles Underbridge



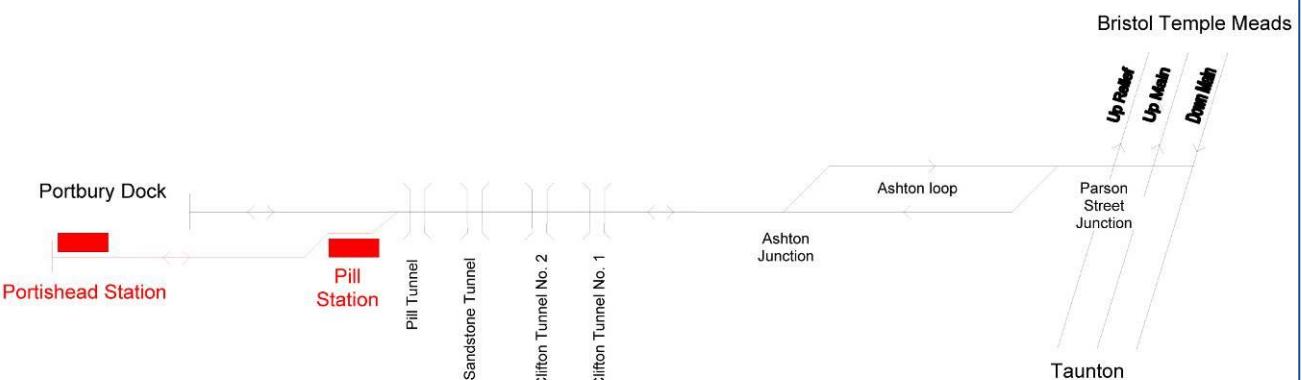
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Below are a number of drawings to articulate the information contained in the table above. New work is shown in red:

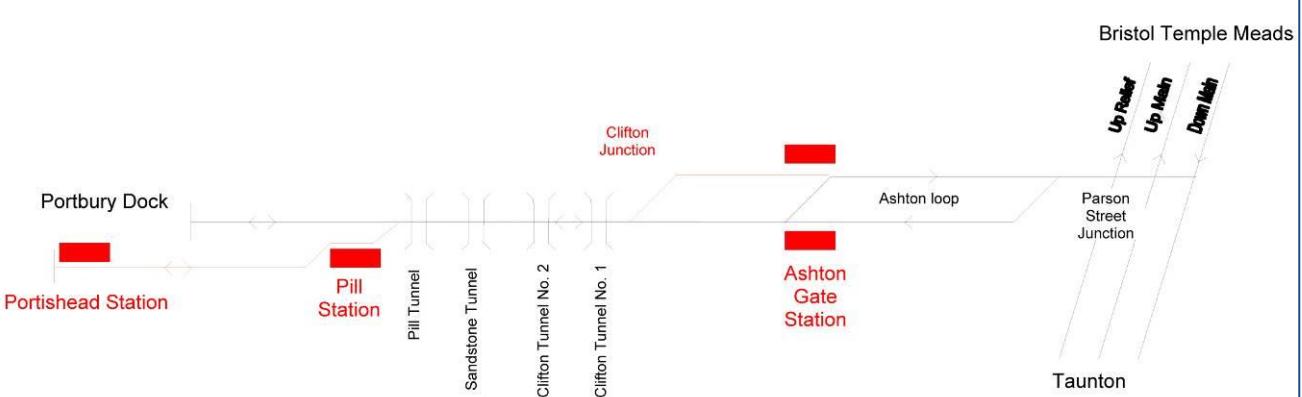
**Option 1**



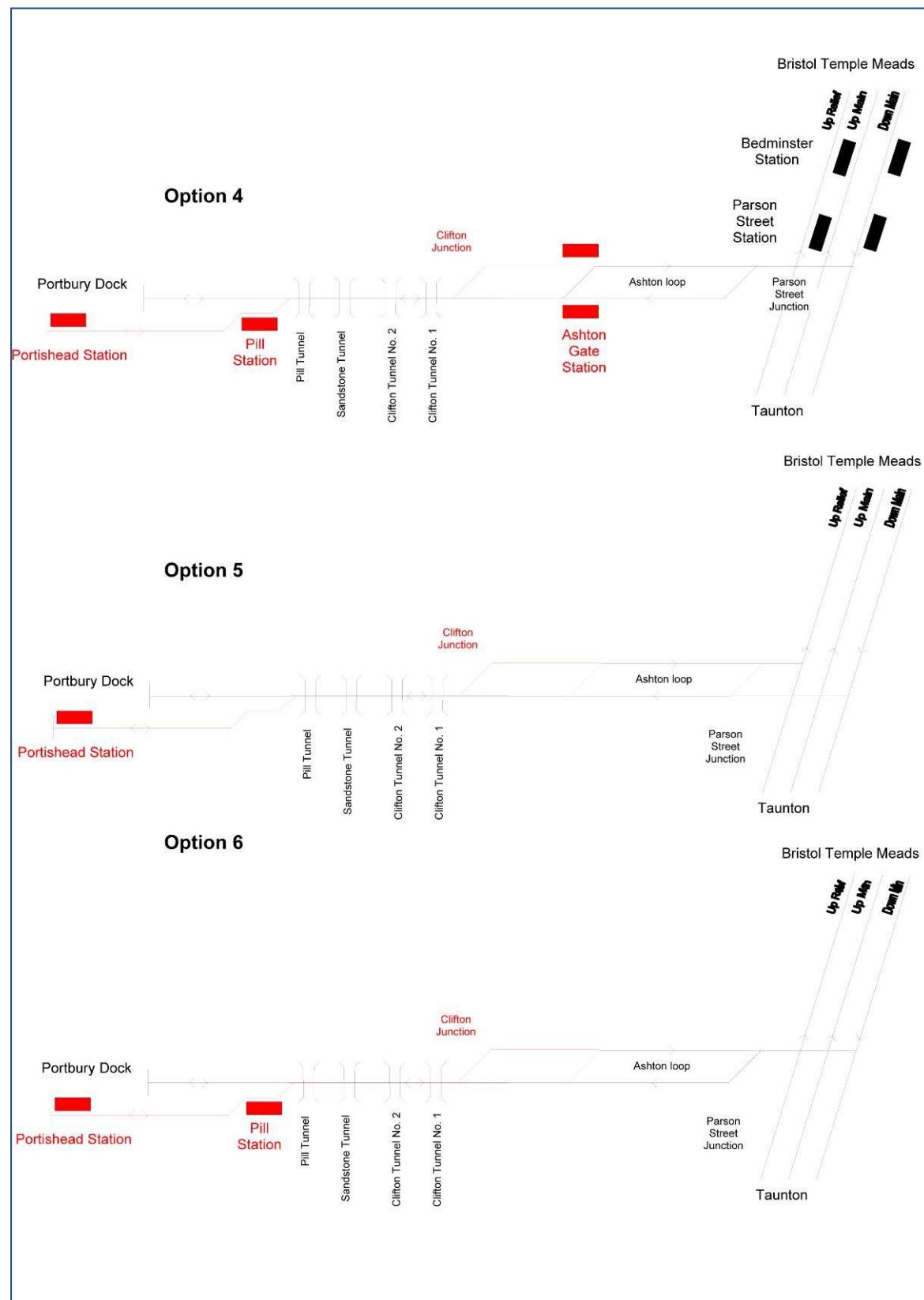
**Option 2**



**Option 3**



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#### APPENDIX B Halcrow Train Service Specification

The following table defined the standard hour train services specification for the Halcrow timetable analysis of MetroWest Phase 1 (excluding MetroWest services).

Train Service Specification – Halcrow Timetable Analysis	
Rail Service	Frequency
Bristol Temple Meads – Bath – London Paddington (IEP)	2 trains per hour
(Weston-Super-Mare) - Bristol Temple Meads – Bristol Parkway – London Paddington (Super Express Train)	2 trains per hour (1 train per hour WSM)
Weston-Super-Mare – Bristol Parkway	1 train per hour
Cross County (Voyager) service terminating/originating at Bristol Temple Meads	1 train per hour
Cross Country (Voyager) service to/from south-west, via Bristol Temple Meads)	1 train per hour
Westbury – Gloucester axis (class 15x service)	1 train per hour
Taunton – Cardiff (class 15x service)	1 train per hour

The TSS table extracted from the Halcrow MetroWest analysis report [001], does not include freight services, however freight assumptions were included within the timetable model as follows:

- One path per hour per direction between Portbury Dock Junction and South Wales; and
- One path per hour per direction between Avonmouth Dock and The Midlands (i.e. via Henbury)

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### APPENDIX C Halcrow Proposed Connectivity and Frequency Schematic

The following figure extracted from the Halcrow timetable analysis report [001] represents the connectivity options offered by the proposed timetable. The figure does not represent the unit diagramming pattern.

