MetroWest

METROWEST PHASE 1
Outline Business Case

Appendix 2.1

Forecasting Report

December 2017

travelwest

Bath & North East Somerset, Bristol, North Somerset and South Gloucestershire councils working together to improve your local transport

OUTLINE BUSINESS CASE – ECONOMIC CASE

MetroWest Phase 1 Forecasting Report

Prepared for

West of England Councils

December 2017

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Forecasting Report

FINAL REPORT

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Acronyms and Abbreviations

AQMA	Air Quality Management Area
B&NES	Bath and North-East Somerset Council
BCC	Bristol City Council
BRITES	Bristol Integrated Transport and Environment Study
CP5	Control Period 5
CRD	City Region Deal
DCO	Development Consent Order
DfT	Department for Transport
EAST	Early Assessment Summary Tool
GLT	Guided Light Transit
GRIP	Governance for Railway Infrastructure Projects
GVA	Gross Value Added
GWML	Great Western Main Line
GWR	Great Western Railway
IEP	InterCity Express Programme
JLTP	Joint Local Transport Plan
JSP	Joint Spatial Plan
JTB	Joint Transport Board
JTS	Joint Transport Study
LEP	Local Enterprise Partnership
LTPP	Long Term Planning Process
NCN	National Cycle Network
NMU	Non-Motorised User
NR	Network Rail
NSC	North Somerset Council
OAR	Option Assessment Report
OBC	Outline Business Case
PBC	Preliminary Business Case
PEIR	Preliminary Environmental Impact Report
RUS	Route Utilisation Strategy
SEP	Strategic Economic Plan
SGC	South Gloucestershire Council
TAG	Transport Appraisal Guidance
TQEZ	Temple Quay Enterprise Zone
WoE	West of England

SECTION 1

Introduction

1.1 Background

CH2M has been appointed to prepare a Forecasting Report (FR) for MetroWest Phase 1. This forms part of the Department for Transport's (DfT) Transport Appraisal Process, as part of the development of an Outline Business Case (OBC). The OBC is being prepared in support of a submission to the Large Major Scheme fund in December 2017.

1.2 The MetroWest Programme

The West of England (WoE) councils are progressing plans to invest in the local rail network over the next ten years through the MetroWest programme. The MetroWest programme comprises:

- The MetroWest Phase 1 project;
- The MetroWest Phase 2 project;
- A range of station re-opening/new station projects; and
- Smaller scale enhancements projects for the WoE local rail network.

MetroWest is being jointly promoted and developed by the four WoE councils: Bath & North-East Somerset Council (B&NES), Bristol City Council (BCC), North Somerset Council (NSC) and South Gloucestershire Council (SGC). The MetroWest programme will address the core issue of transport network resilience, through targeted investment to increase both the capacity and accessibility of the local rail network. The MetroWest concept is to deliver an enhanced local rail offer for the sub-region comprising:

- Existing and disused rail corridors feeding into Bristol;
- Increased service frequency; cross-Bristol service patterns (e.g. Bath to Severn Beach); and
- A Metro-type service appropriate for a city region.

The MetroWest programme will complement the investment being made by Network Rail (NR) and extend the benefits of projects such as the electrification of the Great Western main line. The programme is to be delivered over the next five to ten years during Network Rail Control Period 5 (2014 to 2019) and Control Period 6 (2019 to 2024).

1.3 MetroWest Phase 1

The MetroWest Phase 1 project includes the delivery of infrastructure and passenger train operations to provide:

- Half hourly service for the Severn Beach Line as far as Avonmouth (hourly for St. Andrews Road and Severn Beach stations);
- Half hourly service for the Keynsham and Oldfield Park local stations on the Bath Spa to Bristol Line; and
- Hourly service (or an hourly service plus) for a reopened Portishead Line, with new stations at Portishead and Pill.

The whole of MetroWest Phase 1 will be operational in 2021. Enhanced services on the Severn Beach line could begin in 2020 and re-opening of the Portishead line will follow in 2021.

For the Portishead Line either an hourly or an hourly plus passenger train service is proposed. The difference between an hourly service and an hourly service plus is:

- Hourly service – Passenger trains operating hourly all day between Portishead and Bristol Temple Meads, calling at Pill, Parson Street, and Bedminster. Providing up to 18 trains in each direction per day (Mon-Sat), and up to 10 trains on Sundays, utilising one train set all day.
- Hourly service plus – trains operating every 45 minutes during the am and pm peak and hourly off peak, between Portishead and Bristol Temple Meads, calling at Pill, Parson Street, and Bedminster. Providing up to 20 trains in each direction per day (Mon-Sat), and up to 10 trains on Sundays, utilising one train set all day and an additional set during the am and pm peaks.

Note though that, while the infrastructure required to deliver the 'hourly service plus' on the Portishead line is identical to that required for an hourly service, it has not been appraised as part of the OBC. Only the hourly service has been considered at this stage, because analysis to confirm the shape of an 'hourly service plus' is still on-going. Note also that, although infrastructure for an hourly service (or hourly service plus) is being provided at this stage, it remains the aspiration of the promoting authorities to develop a 30 minute service in the future.

Figure 1.1 shows the proposed MetroWest Phase 1 passenger network with a more harmonised service frequency, providing the foundation for 'Metro' local rail network.

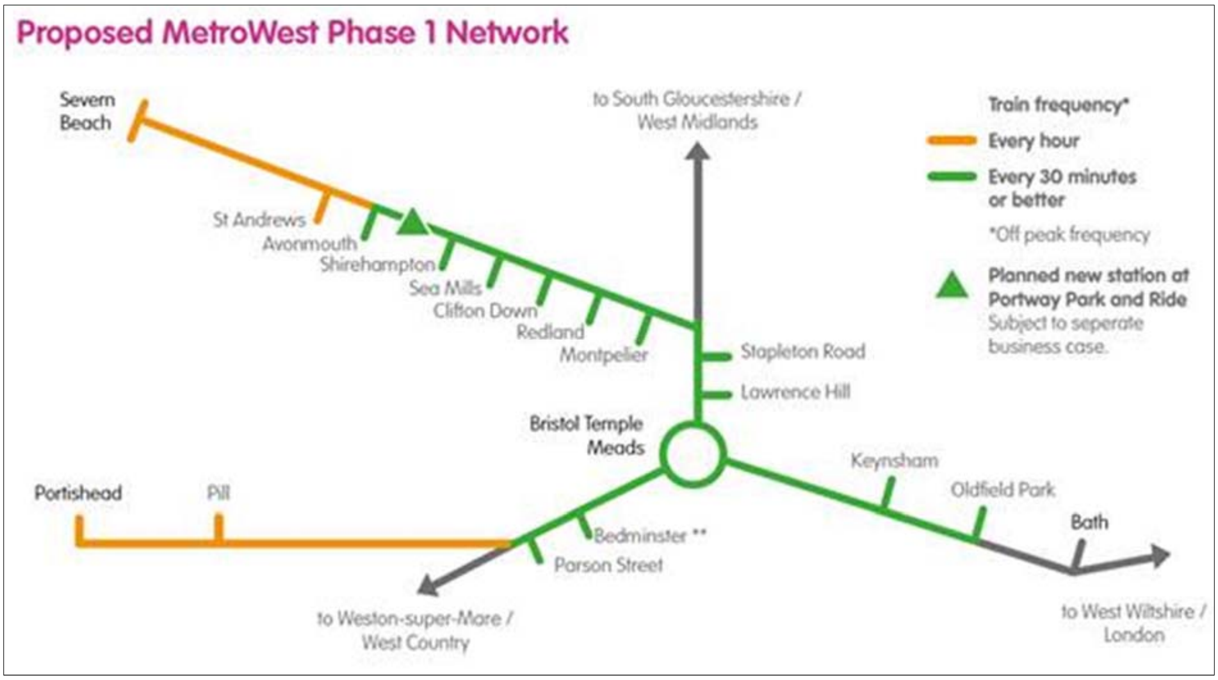


Figure 1-1: MetroWest Phase 1 network

1.4 Modelling approach

The key rationale of the methodology is that it makes best use of available tools. In particular, it utilises tools and approaches accepted by the rail industry and the West of England's GBATS4 multi-modal demand model. The methodology is in accordance with both WebTAG and Governance of Railway Investment Projects (GRIP) demand forecasting requirements.

1.5 Structure of this Forecasting Report

Following this introductory chapter, the report is structured as follows:

- Chapter 2 discusses the methodology used;
- Chapter 3 sets out results of the rail demand forecasts, including benchmarking of results for the new stations;
- Chapter 4 goes on to identify highway network impacts, including related benefits; and
- Chapter 5 provides a brief summary.

Methodology

2.1 Introduction

The assessment approach makes best use of available assessment tools. In particular, it uses approaches accepted by the rail industry such as MOIRA and the existing GBATS4 multi-modal model, a WebTAG compliant demand model. The methodology used is in accordance with both WebTAG and Governance of Railway Investment Projects (GRIP) demand forecasting requirements.

Advice relating to demand forecasting of rail-based schemes is in TAG Units M1-1 and M4, noting in the first instance that there are two main approaches to modelling rail passenger demand. 'Multi-stage' modelling may be employed, such as making use of an existing multi-modal transport model. Alternatively, an elasticity based approach may be used.

The guidance notes there are advantages and disadvantages to both. In particular though, multi-stage models are cited as often being less accurate (than elasticity approaches) when forecasting rail. This is not necessarily a problem specific to rail but to 'minority modes' in general (rail accounts for only about 2% of all journeys in the UK). Multi-stage models do not always reflect growth in the demand for travel by modes, as they concentrate on overall demand modelled as a function of demographic characteristics and car ownership trends. For instance, the National Travel Survey (NTS) indicates a disconnect between demographic changes and growth in rail use, such that the rate of rail trip making has risen by more than simply population.

Elasticity approaches are therefore commonly used in rail forecasting. Those suggested in TAG Unit M4 (section 8) draw heavily on the Passenger Demand Forecasting Handbook (PDFH), which sets out relationships between rail demand and service related characteristics, and are enshrined in MOIRA.

Note that demand forecasts described are for scheme appraisal purposes. Some benchmarking is included, but this should be considered in using the forecasts for financial assessments.

2.2 Overall approach

A combination of bespoke spreadsheet models and MOIRA were used to assess rail enhancements offered by MetroWest Phase 1, before bringing the results together in an aggregate forecast for use in subsequent analyses. There are two main elements covered:

- Changes in demand at existing stations from new or amended services (including suppression of demand by extra station calls); and
- Demand at newly opened stations (including assessment of the number of trips that are made by people who are already rail users, albeit using other stations).

It should be noted that a key feature of the rail demand forecasting techniques used is that they all produce figures that are current (or recent) year equivalents, as a result of being models that draw heavily on actual previous demand. Hence, there is a need to determine future changes in demand, in the first instance to forecast opening years (as this is not current year), but also to feed into annual profiles of demand to drove economic and financial analysis. The future year growth in rail demand is based on a combination of historic local trends and future industry projections, and is set out later in this chapter.

2.2.1 Demand at existing stations

MOIRA is a key modelling tool used by the rail industry to forecast the impact of service related changes on passenger revenue, including analysing the effect of changes such as stopping patterns, infrastructure and rolling stock on the passenger numbers carried and the revenue impact, based on comprehensive ticket and demand data for the whole rail network. MOIRA cannot be used to assess the demand at new stations, but has been used to assess the impacts of MetroWest Phase a on existing stations in the WoE as well as the wider rail network. In addition, generalised journey time, demand and revenue figures have been extracted from MOIRA for stations in the MetroWest area to use in the forecasts of the new stations. [1]

A series of tests have been run using MOIRA, with different supply-side assumptions, as follows:

- Do minimum – it is not possible to know how the wider timetable in the WoE area will look at this stage, as the process of timetable planning and adjustment is constantly evolving over time, so the do minimum is based on the current timetable including the key changes anticipated by 2021, essentially those envisaged by the introduction of IEP trains and electrification of the GWML.
- OBC scheme – incorporating the do minimum services plus amended Severn Beach Line and Bath Spa local services, plus existing station calls by Portishead line services.

2.2.2 New stations

Forecasts of demand for the new stations proposed as part of MetroWest Phase 1 have been carried out using a methodology derived from that used for previous studies associated with the development of MetroWest Phase 1, as well as work to assess MetroWest Phase 2 and other potential new stations in the WoE area. The methodology makes use of rail industry data and derived techniques to forecast demand at new stations broadly based on relationships at existing stations elsewhere. No data has been specifically collected, forecasts have therefore employed existing data sources.

A series of approaches have been used to assess different aspects of new stations. The three main elements include total trips generated by the new station, existing rail trips diverted to the new station, and suppression of demand at existing stations by an extra station call by passing services. These elements together, along with supporting assumptions and ancillary models, enable the net total benefit to the railway to be established. New stations demand has been benchmarked against similar stations across the UK rail network.

More information about the demand forecasting methodology for new stations can be found in the next section of this chapter (section 2.3).

2.2.3 Rail Demand Model (RDM)

The results from the two main elements (existing and new stations demand forecasts) combine to form an aggregate forecast known as the MetroWest Phase 1 'rail demand model' (RDM). Along with the application of future year projections, the aggregated RDM results feed directly into appraisal of benefits, as well as into financial assessment of scheme performance.

2.3 New stations demand methodology

This section discusses the new stations demand methodology, including:

- Main data sources;
- Total trips generated by the new station;
- Existing rail trips diverted to the new station; and
- Suppression of demand at existing stations by an extra station call by passing services.

[1] MOIRA is updated several times a year, based on ticket sales. MetroWest Phase 1 demand at existing stations has been assessed by Network Rail using MOIRA containing 2015-16 annual figures. MOIRA1 has been used; an augmented version with greater functionality, (MOIRA2) is only just coming into regular use, after a significant period of testing.

2.3.1 Main data sources

Office of Rail and Road (ORR) station usage statistics

Passengers entering and exiting stations. The latest ORR station usage estimates were published in late 2016, covering the annual period 2015-16 ORR station usage totals are used in conjunction with other data sources to update figures as required.

West of England annual station survey

Passenger counts and surveys at stations in the West of England have been undertaken over a number of years, being conducted on or around the same day in November each year. Counts are annual, with questionnaires included every other year. Survey results are used in conjunction with ORR station statistics where appropriate.

MOIRA

As noted earlier, MOIRA1 has been used to assess the impacts of MetroWest Phase 1 on existing stations in the WoE as well as the wider rail network. In addition, generalised journey time, demand and revenue figures have been extracted from MOIRA1 for stations in the MetroWest area, and form a key data source used in the forecasts of the new stations.

National Rail Travel Survey (NRTS, 2010 and 2013 data)

The NRTS estimates the number of rail trips at stations on a typical day and includes origins and destinations of trips using the rail network, both the rail journeys themselves (first, intermediate and last stations used) and the 'true' origin and destination of trips (including the locations where the overall journey started and finished, such as home, work or other location and the mode of station access/egress). Other journey characteristics derived from NRTS data includes ticket types, journey purposes and journey frequency. NRTS data is used as part of the modelling for new stations, in particular relating to diversions from existing stations, to augment information from local WoE rail surveys where this is too limited.

Passenger Demand Forecasting Handbook (PDFH v5.1)

The PDFH summarises knowledge of the effects of changes to services, fares and other factors on rail passenger demand, and provides guidance on applying this to forecasts. Values in the PDFH can be used to assess demand responses to timetabling and operating decisions. PDFH relationships have been used to adjust forecasts where needed (such as scaling demand from a station relating to service frequency).

2.3.2 Total station demand

The demand forecasts for new stations at Portishead and Pill have been refreshed from those previously prepared for the PBC. In the first instance, this has updated the models used in the PBC with recent station usage data and extracts from MOIRA of 2016 journeys and revenue. In addition, a secondary modelling exercise has been incorporated, making use of a trip-end demand model. The resulting total station demand forecast is a combination of the two models outputs.

2.3.2.1 Refreshed PBC model

Total demand

The refreshed PBC model uses a simple regression technique, which takes into account the relationship between journeys and catchments at a number of similar stations. Regression has been used to identify a series of demand/catchment relationships for several types of movements, including journeys made using full price tickets, reduced price tickets and season tickets. Information used in the regression is drawn from MOIRA extracts (trips and generalised journey times, GJT) and 2011 Census (population and employment). MOIRA information used is for trips between all stations in the MetroWest area and the rest of the national rail network.

Catchments

Population and employment in the catchments of the new stations is taken from the 2011 Census, based on centroid points for Output Areas (OA) and Workplace Zones (WZ). This is adjusted to 2016 values using TEMPRO7 values, and to allow for new developments that have already taken place (or are anticipated). Population and employment figures are weighted by distance, with remoter populations counting for less. Table 2.1 shows the 1km and 2km catchment population and employment figures used in the forecasting.

Table 2.1: New station catchments
2011 Census, adjusted where appropriate

Station	Population		Employment	
	<1km	<2km	<1km	<2km
Portishead	14,400	20,200	4,700	7,900
Pill	5,000	6,000	1,800	2,300

For each new station, the models are applied to a full set of potential origin-destination pairs. This generates demand for each movement and ticket type. Initially, this is calibrated to local stations (total demand by ticket type). MetroWest Phase 1 new stations models are calibrated using demand quantum and catchments at Nailsea & Backwell station, with allowance made for direct London services being present at Nailsea & Backwell, that won't be at Portishead or Pill.

Distribution of trips

Total new station demand has been derived from the regression model. This is distributed to determine the destinations of trips from the new stations using a synthetic gravity model. A gravity model has been set up that makes use of the full catchment of destination stations for rail users in the MetroWest area (derived from local stations). Generalised journey times have been derived for each potential movement from MOIRA data, and population/employment catchments extracted from Census data.

Gravity model powers were calibrated with reference to Nailsea & Backwell and Yatton stations' trip distributions, to build in inherent local tendencies to make long or short distance trips. This process doesn't manifestly change the total demand, adjusting it slightly to accentuate or reduce the new stations' propensity for longer trips compared to the calibration stations. Most importantly though, it facilitates calculation of revenue based on the mix of short, medium and longer distance trips in the distribution.

Station parking charges

The demand forecasts implicitly assume that the new stations would charge for parking at a similar rate to the charges at comparator stations. The two nearest existing stations to Portishead (Nailsea & Backwell and Yatton) have charges for parking in the range £2-£3. If a different car park charging regime is considered as the project develops, such as premium pricing or free parking, car park access and capacity considerations would then be built into the models to assess in more detail.

2.3.2.2 Trip end model

An amended version of the trip-end demand model that was used in the derivation of demand at new stations in Gloucestershire ('Gloucestershire Rail Study'[2]) and the potential extension of MetroWest Phase 2 to Gloucester ('MetroWest Phase 2, Gloucestershire Extension Study'[3]) has also been used in the demand forecasts for the new stations.

[2] 'Gloucestershire Rail Study, Rail Study Report', prepared by Amey for Gloucestershire County Council, September 2015: http://glostext.gloucestershire.gov.uk/documents/s26092/7.%20Background%20document%20Study%20Report%20May%202015.pdf

[3] 'MetroWest Phase 2, Gloucestershire Extension Study', CH2M, December 2016: https://s3-eu-west-1.amazonaws.com/travelwest/wp-content/uploads/2015/09/MW2-GlosCC-extension-report_2016-12-16.pdf

The trip-end models are capable of producing a high-level forecast of the total passengers per year at a new station on any site, to provide a quick check of the likely viability of a station in a particular site rather than a detailed prediction of travel patterns following station opening. The forecasts from the trip end models do not take into account trip destination, the destinations served by services from a station, or 'atypical' local factors such as sports stadia or tourist attractions whose demand impacts cannot be adequately represented by the model variables.

The original model was based on earlier research at the University of Southampton[4] updated using recent station usage data (2015) and further calibrated for this study to generate 2016 demand commensurate to that at stations in the West of England

2.3.3 Diversions of existing trips to new station

An estimate of how many trips are new to the railway or transferring from other stations has been made using a station access logit model, with generalised costs calculated for journeys from origin (usually home) to existing stations, compared with a similar trip using a new station. This is based on true origin to station trips in the WoE rail survey and NRTS for stations in the MetroWest area, calibrated to recent ORR station usage figures. Both the WoE survey and NRTS identify true origin and destination of rail users, as well as the time taken and distance from true origin to the origin station.

The diversions model calculates propensity to change stations based on proximity of other stations in the area. WoE survey and NRTS figures for time and distance between origins and stations are adjusted using factors derived from straight-line distances calculated from true origin to existing station versus the distance from origin to new station. A forecast 'station share' is calculated based on the new station versus existing station.

This initial 'station shift' derives the theoretical share based purely on generalised cost, which if not adjusted could result in higher transfers than would be realistic. As such, this has been calibrated using behaviour at existing stations, comparing interaction between existing stations and main principle being that unrealistic transfers are eliminated. For example, some trips will transfer from Nailsea & Backwell to Portishead, as this is currently a railhead for Portishead area residents, but care has been taken to consider longer distance railhead movements that use Nailsea & Backwell (as it has direct London services).

2.3.4 Suppression of demand

Overlaying demand of a new station is potential loss of existing rail passengers, where there is potential to affect demand on services passing through (and stopping) at the new station, and lengthening journey times. This could have a significant effect on revenue if the services are fast and/or long distance, where the journey time penalty is greater and/or fares paid are higher than more local journeys.

The new stations at Portishead and Pill are not located on a current passenger rail line, and no existing services would be delayed to stop at them. As such, suppression of demand does not explicitly apply to these new stations. Indeed, all the services proposed as part of MetroWest Phase 1 are new to the rail network, and there are no additional stops to existing services. As such, suppression of demand also does not apply to existing stations.

2.4 Future demand

The future year growth in rail demand is based on a combination of historic local trends and future industry projections.

Demand for rail travel has grown significantly in recent years across the local WoE network, with a 63% increase (5.6% per annum) in passenger numbers being recorded through stations in the WoE

[4] Blainey SP (2010) Trip End Models of Local Rail Demand in England and Wales, *Journal of Transport Geography*, 18(1):153-165

between 2006/07 and 2015/16 (ORR station usage). Larger increases have been observed at specific stations, such as on the Severn Beach line. Historic growth rates at groups of West of England stations are shown in Table 2.2 and Figure 2.1. Apart from a slight downward blip in Bristol in 2006/07 and general levelling between 2008 and 2010, growth has continued since then in spite of recession. It is likely to continue, albeit being debatable whether rates will be as high as in the past.

Table 2.2: ORR historic patronage growth in West of England area
2006/07 – 2015/16 figures

Station groupings	**06/07 – 15/16** TOTAL	**06/07 – 15/16** per annum
Main stations (Bristol Temple Meads, Bristol Parkway & Bath Spa)	54%	4.9%
Severn Beach Line [1]	185%	12.3%
Other Bristol City urban stations [2]	143%	10.4%
B&NES stations (excluding Bath Spa)	91%	7.4%
North Somerset stations	52%	4.7%
South Gloucestershire stations (excluding Bristol Parkway)	128%	9.6%
OVERALL	63%	5.6% [3]

Table notes
1: Excludes Lawrence Hill and Stapleton Road
2: Parson Street, Bedminster, Lawrence Hill and Stapleton Road
3: As a comparison, the West of England station survey showed a 6.9% per annum increase from 2006 to 2015

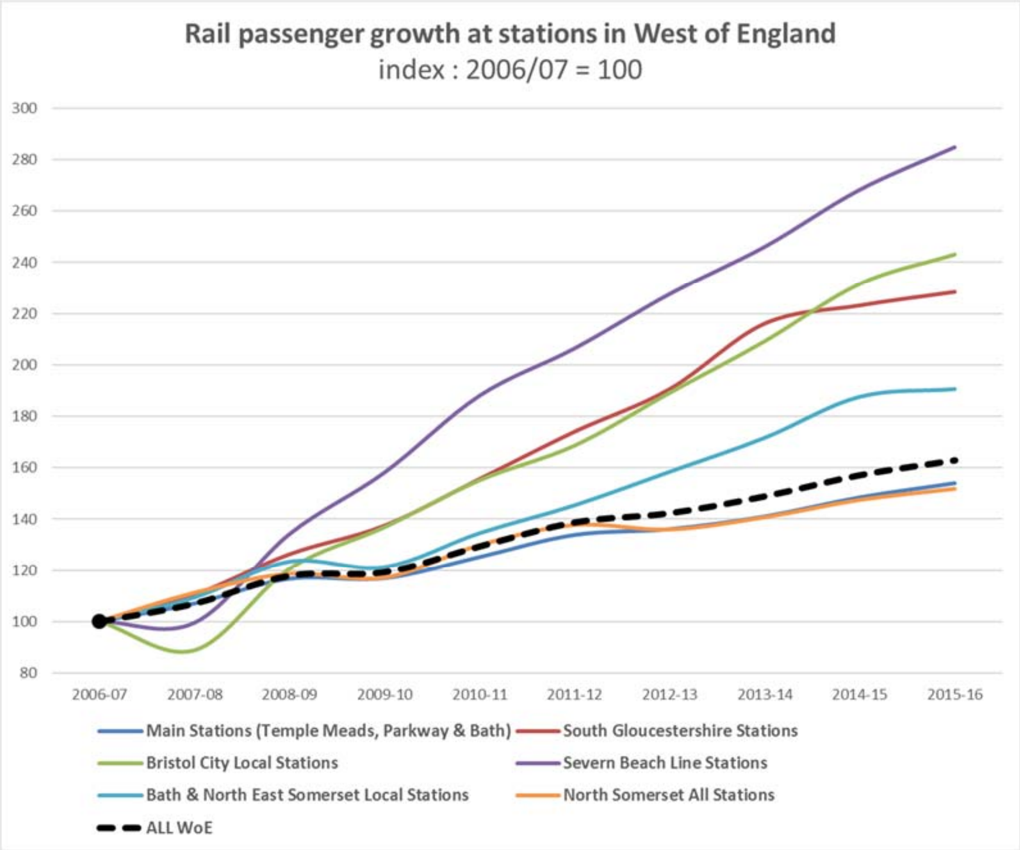
Looking to the future, the Network Rail Long Term Planning Process (LTPP) Regional Urban Markets study (published October 2013) uses a series of wider economic scenarios to frame changes in rail use, and forecasts are presented for rail use in/around key urban centres. The resulting growth rates for the Bristol area vary from 0.6% per annum to 3.9% per annum. More details of the LTPP growth rates are shown in Table 2.3.

Table 2.3:: Network Rail LTPP: Regional Urban Markets Study – Bristol area forecast growth
October 2013

Economic scenario	**2013-23** total	**2013-23** per annum	**2023-2043** total	**2023-2043** per annum
'Prosperity in isolation'	14%	1.3%	33%	1.4%
'Global stability'	47%	3.9%	44%	1.8%
'Struggling in isolation'	6%	0.6%	15%	0.7%
'Global turmoil'	35%	3.0%	21%	1.0%
AVERAGE	26%	2.3%	29%	1.3%

In spite of recorded growth in recent years, it is unlikely that historic rates would continue unabated. As such, future year forecasts for West of England stations have been produced using a combination of historic rates and LTPP figures, as follows:

- Current year to 2023 – taper from recent historic growth rates at West of England stations (initially using 2006-07 to 2014-16 at 5.6% per annum) to an LTPP average rate derived from the four economic scenarios (2.3% per annum); and
- 2023 to 2043 – taper from 2023 LTPP average rate (2.3% per annum) to 2043 LTPP average rate (1.3% per annum).



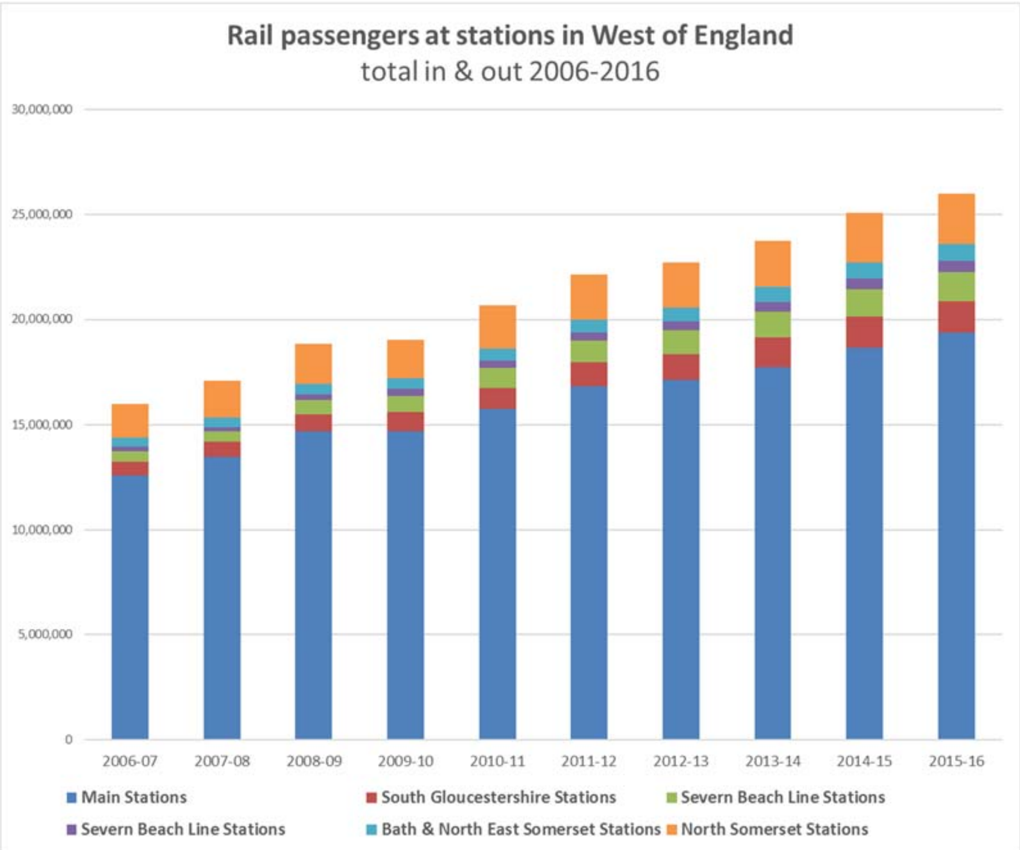


Figure 2-1: ORR station usage, historic growth in West of England area

Note that demand and revenue growth is capped after 2036 for appraisal. Sensitivity testing considers variations on growth assumptions that illustrate scenarios with higher and lower profiles, and earlier and later growth capping.

The growth profile derived for and used in OBC appraisal is, as noted, based on historic trends and future projections in rail industry planning documents. There are, however, competing features and challenges that link with these key drivers, that could mean the profile is potentially pessimistic.

For instance, the potential specification of the new GWR franchise is unknown at present, and indeed elements of the next franchise are currently out for consultation, but it is arguable that there is scope for a new franchise to increase generic demand for rail in the Bristol area through the operating regime of the new operator (such as new services and trains, and ticketing initiatives, etc). Ticketing initiatives may be more widely applicable than just the local franchise, but are typically boosted through franchise commitments. For instance, smart ticketing is becoming the norm, and this can drive demand up, especially off-peak (evidence in TfL suggests off-peak demand increases have been around 20% as a result of the Oyster system). Linked to this, new sales channels are very effective at revenue management and passenger choice, again potential factors for extra revenue. These are all unknowns that have the potential to be upside effects on future demand.

However, while historic demand growth rates have been high, there is some evidence that this is slowing down, and indeed rail demand growth stagnating in some areas (ORR station usage figures). Hence, the growth profile follows a decrementing path from current (recent) local growth rates, to (lower) future industry projected rates. The local WoE area has hitherto though resisted this slow-down, and local surveys indicated demand may be more than recorded in industry data such as ORR station usage figures.

Overall therefore, the forecast growth rates assumed can be considered comparatively conservative. Note that they differ slightly in values (if not overall methodology) from those used in previous analysis of MetroWest Phase 1 (and 2), in that they have been updated to reflect the most recently available ORR station usage figures.

2.5 Rail appraisal

The value for money assessment of MetroWest Phase 1 has been undertaken using a combination of techniques. Principally, a Discounted Cash Flow (DCF) model developed by Network Rail provides the main rail appraisal results. This model is used for socio-economic appraisal and was developed in accordance with WebTAG. It enables the quantification and monetisation of benefits and costs. The model considers a stream of costs and benefits, which are presented in 2010 present values over the appraisal period. The key outputs of the assessment is the Benefit Cost Ratio (BCR) to the Government, Transport Economic Efficiency (TEE) tables and associated Appraisal Summary Table (AST) inputs as required by DfT for enhancement schemes that require Government funding.

The DCF model has been used to develop business cases that have informed development of Network Rail scheme, as well as High Level Output Statement (HLOS) and Network Rail's Business Plan for Control Periods 6 (CP6). The model has been audited by consultants commissioned by DfT.

The DCF model incorporates the following elements:

- Investment cost (capital expenditure);
- Operating cost;
- Other government impacts (e.g. indirect taxation);
- Revenue impact;
- Rail demand;
- Benefits to rail users;
- Benefits to non-rail users; and
- Disbenefits to rail and non-rail users.

More information about the DCF assessment is contained in the MetroWest Phase 1 OBC Economic Assessment Report as well as the Network Rail technical note, 'MetroWest Phase 1, Socio-economic impacts for rail users'.

2.6 Highway network impacts

It is possible to rely solely on Network Rail's DCF model to calculate all benefits in the appraisal. The DCF model uses the External Cost of Car Use (ECCU) model from WebTAG, based on estimates of the total road mileage removed by incorporating MOIRA rail mileage output and converted to equivalent road mileage. The ECCU shows the unit rate of removing one mile of road journey for each road type and congestion level by Government Region, and the ECCU unit rate for the South West region could be applied to road mileage to calculate the non-rail user benefits. This rate comprises of impact on road congestion, greenhouse gases and noise and air pollution.

However, WebTAG recommends that a local transport model should be used if available. Indeed, it was recognised during previous assessments of MetroWest Phase 1 (in particular the Preliminary Business Case in 2014), that ECCU based calculations of highway benefits may substantially underestimate the level of benefit in a congested highway network. As such, highway benefit figures calculated by the DCF model were cross-checked for the PBC using the GBATS3 model, at the time the multi-modal demand model for the WoE area, which includes a highway assignment model. GBATS3 has since been significantly updated and upgraded. GBATS4 is the new multi-stage multi-modal demand model system put together that meets WebTAG requirements. For the reasons outlined earlier, namely that multi stage models do not always reflect changes to 'minority modes' particularly well, this model has not been used to derive rail demand forecasts. It has though been used to calculate highway based non-rail user benefits, bringing together the rail demand forecasts.

Hence, the principal tools used in the derivation of highway impacts are the GBATS4 multi-modal transport model and TUBA, taking rail demand outputs from the RDM. More information about the derivation of highway network impacts can be found in chapter 4.

2.6.1 GBATS4

GBATS4 is the existing WebTAG compliant multi-modal model for the West of England area which has been developed from the predecessor model, GBATS3. The development of GBATS4 has incorporated a substantial review of the highway and public transport networks, new base year highway and public transport matrices (the former incorporating information from a programme of roadside interview surveys), and a new demand model process. GBATS4 has two forecast years, 2021 and 2036. The latest model is called the GBATS4 Metro Model (GBATS4M). The GBATS4M model consists of:

- A Highway Assignment Model representing vehicle based movements across the Greater Bristol area for a 2013 autumn weekday morning peak hour (08:00-09:00), an average inter-peak hour (10:00-16:00) and an evening peak hour (17:00-18:00);
- A Public Transport (PT) Assignment Model representing bus and rail based movements across the same area and time periods; and
- A five-stage multi-modal incremental Variable Demand Model (VDM) that forecasts changes in trip frequency and choice of main mode, time period of travel, destination, and sub-mode choice, in response to changes in generalised costs across the 12-hour period (07:00-19:00).

The GBATS4M highway model is closely integrated with the GBATS4M PT model. The two models use different software packages (SATURN and EMME, respectively) but are identical in terms of road network structure, and zone system. The bus routes and frequencies in the PT model are used in the highway model. The GBATS4M highway model is fully integrated within the GBATS4M VDM. The GBATS4M highway model provides highway transport costs to the GBATS4M VDM which, in turn, provides trip matrices for the GBATS4M highway model. The relationship between the elements of the modelling system is shown in Figure 2.2, which shows the structure of the model and interactions between demand and assignment models.

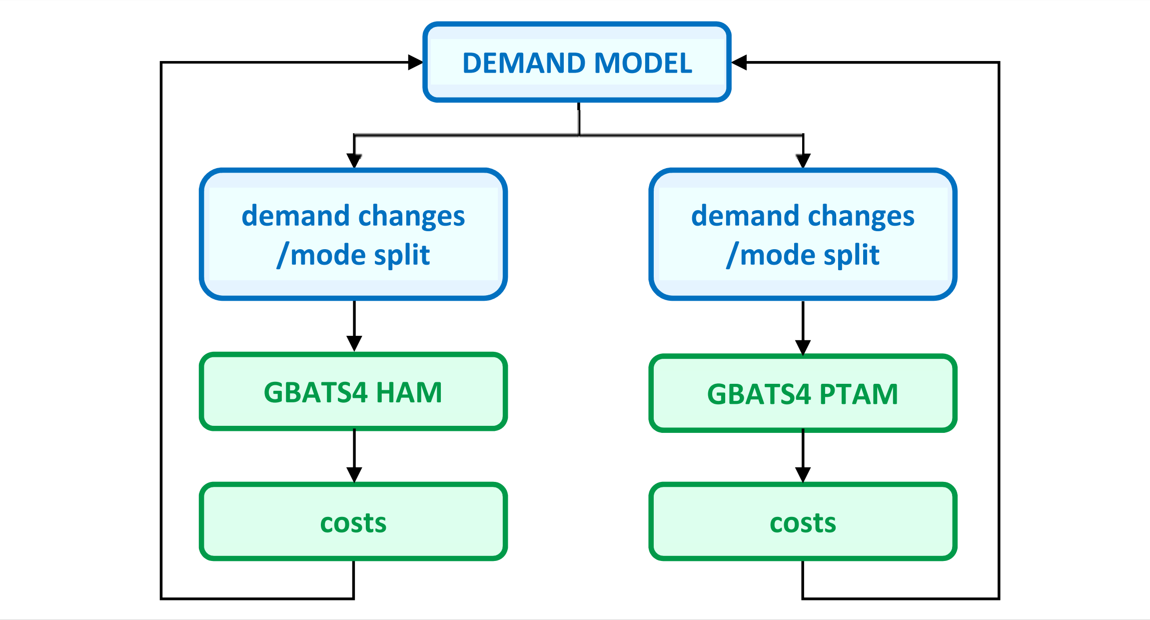


Figure 2-2: GBATS4 demand model structure

The current version of GBATS4 has been put together with MetroWest analysis as a key driver, with the validation and calibration carried out with MetroWest testing in mind, and is known therefore as GBATS4M. Further information about the GBATS4M model, can be found in the following reports which are included as supporting documents to the Outline Business Case:

- GBATS4M Model Update, Report of Surveys and Existing Data Review, August 2015
- GBATS4M Model Update, Highway Model Local Model Validation Report, October 2015
- GBATS4M Model Update, Public Transport Model Local Model Validation Report, October 2015
- GBATS4M Model Update, Demand Model Report, August 2015
- GBATS4M Future Year Do Minimum Model Report, February 2016

The methodology for assessing highway benefits involves taking the results from the RDM and using them to adjust the inputs to GBATS4 (and thence inputs to TUBA) accordingly. The steps in the process are illustrated in Figure 2.3.

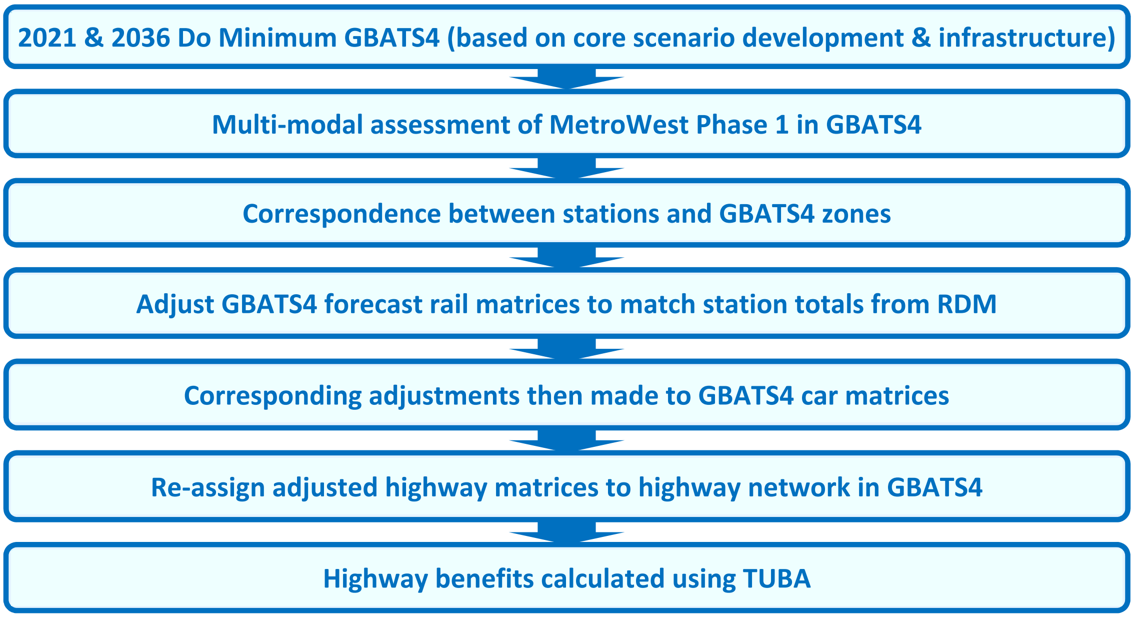


Figure 2-3: Highway benefits calculations methodology

2.7 Modelling responsibilities

The modelling approach has been carried out jointly by CH2M and Network Rail, with the lead taken on individual elements as appropriate. This is summarised as follows (and illustrated in Table 2.4):

- CH2M took the lead on developing the new stations model and diversions model, building on models previously developed for MetroWest Phases 1 and 2;
- Network Rail runs MOIRA to determine new demand at existing stations;
- CH2M incorporates new stations and existing stations demand into the overall demand forecasts that constitute outputs from the RDM;
- Network Rail prepares the socio-economic appraisal (value for money assessment) using the DCF model; and
- CH2M calculates highway benefits, taking outputs from the RDM and utilising GBATS4 and TUBA to calculate benefits and finalises the socio-economic assessment prepared using the DCF with GBATS4/TUBA results from the highway benefits cross check.

Table 2.4: MetroWest Phase 1 modelling responsibilities for each element

Elements		CH2M	Network Rail
RDM	New stations model	✓	
	Diversions model	✓	
	MOIRA		✓
Socio-Economic Analysis	DCF		✓
	GBATS4	✓	
	TUBA	✓	

2.8 Sensitivity tests

Sensitivity testing has been carried out to consider the socio-economic performance of MetroWest Phase 1 in the event that some of the key assumptions vary. Drawing on WebTAG unit M4, these are mostly based future year growth, and include:

- High demand – an increase growth profile assumptions in line with WebTAG recommendations (TAG unit M4);[5]
- Low demand – decrease growth profile assumptions in line with WebTAG recommendations (methodology as per footnote alongside ‘high demand’);
- Fare/demand growth cap at 10 years (instead of 20 years);
- Fare/demand growth cap at 30 years (instead of 20 years); and
- Operating cost risk – include all risk elements identified (by GWR) –operating costs are described further in the next chapter of this report.

[5] A proportion of base year demand is added to the growth profile assumed for the core scenario. The proportion to be added is based on a parameter p which varies by mode. The parameter 'p' for rail schemes is +2.0% for high demand sensitivity and -2.0% for low demand. For 1 year after the base year, proportion p of base year demand added to the core scenario. For 36 or more years after the base year, proportion 6*p of base year demand added to the core scenario. Between 1 and 36 years after the base year, the proportion of base year demand should rise from p to 6*p in proportion with the square root of the years.

In addition, a further sensitivity test has been conducted to specifically consider the benefits that could be generated by the changes to Ashton Vale Road junction with Winterstoke Road, associated with the level crossing at Ashton Vale Road. This has not been included in the core scheme assessment, because the modelling work carried out is very localised and only considers the current year in detail. As such, it does not take into account the potential for wider area impacts that would be associated with this scheme, some of which may be disbenefits, or temporal changes in demand that are reflected in the business case more generally.

Only the high and low demand sensitivity tests include some changes to forecast models in order to assess highway related benefits. The other tests are directly related to assumptions that feed into the appraisal process. As such, sensitivity testing is considered in the MetroWest Phase 1 OBC Economic Assessment Report.

Rail demand forecasts

3.1 New stations demand

Demand forecasts for Portishead and Pill are shown in Table 3.1, showing initial 2016 forecasts of demand and revenue, as well as opening year 2021 and future year 2036 figures[6]. For illustration of the potential for increased demand, this table also includes an assessment of the demand at the new stations for a 45 minute interval peak time only infill service at Portishead and Pill, based on 45 minute interval services during the morning and evening peaks.[7]

Future year figures were derived using the growth profile discussed in chapter 2. Note that these figures also include uplifts to demand assumed to take into account an enhanced tourism market on the line compared to other local stations (5%) and an uplift to account for the potential for greater demand from local stations to take advantage of enhanced London services with the introduction of IEPs (2.6%)[8]. The uplifts were derived from investigation of demand and revenue information from MOIRA base data and do minimum forecasts (including IEP).

Table 3.1: New stations demand forecasts
All forecasts assume shuttle services between Bristol Temple Meads and Portishead
Two-way journeys, annual totals for the years indicated

	OBC scheme Severn Beach & Bath Spa local services and 1tph Portishead		**'Hourly service plus'** Severn Beach & Bath Spa local service & 45 min peak Portishead	
	Journeys	Revenue	Journeys	Revenue
PORTISHEAD				
2016 initial	242,945	£1,488,680	284,816	£1,697,215
2016	261,725	£1,603,755	306,832	£1,828,410
2021	321,014	£1,967,057	376,340	£2,242,604
2036	433,529	£2,656,511	508,247	£3,028,637
PILL				
2016 initial	40,497	£196,667	47,791	£224,880
2016	43,628	£211,869	51,485	£242,263
2021	53,511	£259,864	63,148	£297,143
2036	72,266	£350,947	85,281	£401,292

Except for '2016 initial', demand and revenue shown include uplifts of 5% for tourism effects and 2.6% for an IEP effect.

Early years ramp-up is not factored into the figures in this table.

6 Revenue is calculated from the total number of journeys and potential geographical distribution, generating a total passenger mile figure. An effective average revenue per passenger mile of 26.5p is applied, which takes into account the mix of ticket types (full price, reduced and seasons). This is based on a local comparison of revenue and demand, and does not include Severn Beach line fares, as these are out of step with surrounding fares (much cheaper).

7 The methodology of building the 45 minute peak infill demand and revenue assumes that demand for the 3 hour morning and 3 hour evening peak periods is taken from the 45 minute interval forecasts for Portishead and Pill, with the remainder of the day being based on the 60 minute interval service forecasts.

8 The 5% uplift reflects that Portishead has an element of tourism related economy already, but further specific tourism initiatives could be developed with the train operator and tourism promoters and attraction owners. This has the potential to generate more demand, and as such the 5% assumption could be conservative.

3.2 Existing stations

The effects of service enhancements at existing stations has been modelled using MOIRA. This used the latest available update of MOIRA at the time (December 2016) to test MetroWest Phase 1 services. By far the greater majority of the effects modelled in MOIRA are as a result of improved services on the Severn Beach Line and to Bath Spa local stations. New services to the re-opened Portishead line only provide minimal enhancements at existing stations, specifically only at Bedminster and Parson Street stations. The total number of new journeys forecast by MOIRA are shown in Table 3.2.[9]

Table 3.2: MOIRA demand forecasts – new journeys per annum

Year	**OBC scheme** Severn Beach & Bath Spa local services and 1tph Portishead	**'Hourly service plus'** Severn Beach & Bath Spa local service & 45 min peak Portishead
2016	492,694	497,126
2021	604,305	609,742
2036	816,114	823,456

Note: Early years' ramp-up is not factored into the figures in this table.

3.3 New journeys on the rail network

Table 3.3 illustrates the number of new journeys that MetroWest Phase 1 generates on the rail network, for each of the scenarios being considered in this technical note. The figures in this table show the total of new journeys at existing stations and new stations, net of those journeys at the new stations that previously travelled by rail via an existing station.

Table 3.3: MetroWest Phase 1 demand forecasts – net annual new journeys on the rail network

Year	**OBC scheme** Severn Beach & Bath Spa local services and 1tph Portishead	**'Hourly service plus'** Severn Beach & Bath Spa local service & 45 min peak Portishead
2016	781,863	836,469
2021	958,980	1,025,957
2036	1,295,103	1,385,555

Notes:

Net of transfers from existing rail users to new stations. New stations demand forecasts considered the amount of potential transfer from existing stations. At Portishead, some 6.1% of demand was modelled to have come from existing rail users transferring to Portishead from existing stations. At Pill the figure was much lower, reflecting the more local nature of the catchment of Pill, at 0.5%

Early years' ramp-up of demand is not factored into the figures in this table.

[9] Note that no specific MOIRA analysis has been carried out to determine the effects of 45 minute interval infill peak time services on the Portishead line. The greater proportion of the effects of this service are already captured by the new stations forecasts. As such, the effects at existing stations are based on interpolation between the 60 and 30 minute interval service tests.

3.4 Access modes and distribution

3.4.1 Access modes

The total demand forecasts have been further analysed to start to build up a picture of the locations that potential users of the potential new stations could come from, as well as the modes of transport they may use to reach the stations. A combination of first principles analysis using population weighted centroids from 2011 Census output areas (OAs) as de facto origins and Census workplace zone (WZs) centroids as destinations, and WoE survey and NRTS data has been used to determine potential patterns of trip distance and mode of access, as this provides an indication of the true origin of trips through a station, as well as the mode of transport used to get there.

A simple gravity model approach has been used to distribute outgoing trips to OAs and incoming trips to WZs, for trips on foot, by bike, by car and using bus services, using generalised costs of station access by each mode. The resulting pattern of mode use by various distance bands has been compared to the patterns observed in NRTS and WoE survey data, and appropriate adjustments made to weightings in generalised costs, as well as introduce other modes into the distribution, such as differentiate between car access as a driver or drop-off/pick-up. This has used a combination of information from Yatton, Nailsea & Backwell, Keynsham and Bridgwater stations, with adjustments related to possible availability of access facilities, such as car parking and bus services.

Table 3.4 shows indicative catchment distances and mode shares of access for origin trips using Portishead station, with similar information for destination trips in Table 3.5. Table 3.6 shows indicative catchment distances and mode shares of access for origin trips using Pill, with similar information for destination trips in Table 3.7.

Both new stations are envisaged as having significant levels of local access, on foot or by cycle, with between 50%-60% of access trips by these modes. Car access will also be significant, with around 45% of access trips arriving by car, split broadly 2:1 between needing to park a car and drop-off movements. At Portishead, this could generate parking demand of 150-200 vehicles at peak times by around 2030, with demand at Pill around 40 parked vehicles at the same time. Note that this analysis is based on the premise that people park a car “at or near” the station, as this is the designation that surveys of station users are set at, so this does not specifically distinguish between those who are prepared to pay to park and those who will park (free) in surrounding streets, as much as such opportunities are available. It also assumes therefore that parking charges at the station car park are of a similar order to the those at stations in the area.

Table 3.4: Rail users access/egress at Portishead – origin trips

Catchment	**Walk**	**Bus**	**Car** parked	**Car** drop off	**Bicycle**	**Taxi**	**ALL**
Less than 1 km	42.4%	1.1%	14.5%	6.4%	1.8%	0.1%	66.3%
from 1 to 2 km	3.2%	0.7%	8.5%	3.7%	2.2%	0.1%	18.3%
from 2 to 3 km	0.2%	1.1%	3.1%	1.4%	0.3%	0.0%	6.1%
from 3 to 4 km	-	0.2%	2.0%	0.9%	0.2%	0.0%	3.2%
from 4 to 5 km	-	0.0%	1.1%	0.5%	-	0.0%	1.7%
from 5 to 10 km	-	-	0.7%	0.3%	-	0.0%	1.0%
More than 10 km	-	-	2.3%	1.0%	-	0.0%	3.4%
TOTAL	45.8%	3.0%	32.2%	14.3%	4.4%	0.3%	100.0%

numbers may not add up exactly to totals due to rounding

Table 3.5: Rail users access/egress at Portishead – destination trips

Catchment	Walk	Bus	Car parked	Car drop off	Bicycle	Taxi	ALL
Less than 1 km	83.6%	-	-	-	0.5%	-	84.0%
from 1 to 2 km	2.8%	4.7%	-	-	0.8%	-	8.3%
from 2 to 3 km	0.5%	0.2%	-	2.1%	0.3%	0.8%	4.0%
from 3 to 4 km	-	2.5%	-	0.7%	0.1%	0.3%	3.5%
from 4 to 5 km	-	-	-	0.1%	-	0.0%	0.1%
from 5 to 10 km	-	-	-	0.1%	-	0.0%	0.1%
More than 10 km	-	-	-	-	-	-	-
TOTAL	86.8%	7.4%	-	2.9%	1.7%	1.2%	100.0%

numbers may not add up exactly to totals due to rounding

Table 3.6: Rail users access/egress at Pill – origin trips

Catchment	Walk	Bus	Car parked	Car drop off	Bicycle	Taxi	ALL
Less than 1 km	51.0%	0.6%	-	-	3.0%	-	54.6%
from 1 to 2 km	0.7%	0.2%	21.6%	9.6%	0.5%	0.2%	32.7%
from 2 to 3 km	-	-	1.1%	0.5%	0.0%	0.0%	1.7%
from 3 to 4 km	-	-	2.9%	1.3%	0.1%	0.0%	4.3%
from 4 to 5 km	-	-	0.8%	0.4%	-	0.0%	1.2%
from 5 to 10 km	-	-	3.8%	1.7%	-	0.0%	5.6%
More than 10 km	-	-	-	-	-	-	-
TOTAL	51.7%	0.7%	30.3%	13.4%	3.5%	0.3%	100.0%

numbers may not add up exactly to totals due to rounding

Table 3.7: Rail users access/egress at Pill – destination trips

Catchment	Walk	Bus	Car parked	Car drop off	Bicycle	Taxi	ALL
Less than 1 km	75.9%	-	-	-	-	-	75.9%
from 1 to 2 km	7.6%	4.5%	-	-	2.5%	-	14.5%
from 2 to 3 km	-	0.6%	-	3.2%	1.4%	1.3%	6.5%
from 3 to 4 km	-	-	-	1.5%	0.2%	0.6%	2.4%
from 4 to 5 km	-	-	-	0.2%	-	0.1%	0.3%
from 5 to 10 km	-	-	-	0.2%	-	0.1%	0.3%
More than 10 km	-	-	-	-	-	-	-
TOTAL	83.5%	5.1%	-	5.2%	4.1%	2.1%	100.0%

numbers may not add up exactly to totals due to rounding

3.4.2 Distribution of origins/destinations

Reflecting the local nature of MetroWest services, station pairs that are forecast to be responsible for most of the journeys made by users of Portishead and Pill are largely within the WoE area. The forecasts indicate that (at both Portishead and Pill) over 85% of journeys at all stations are likely to be to and from other stations in the MetroWest area, with around 40% being to/from Bristol Temple Meads itself, 30% to/from other station in Bristol and the rest elsewhere in the WoE. Of the remainder, trips to/from London account for between 1%-2% of demand, but around 7% of revenue as a result of the comparatively higher fares these trips incur. It is interesting to compare this distribution of trips to that at Nailsea & Backwell. In essence, the local domination of journey numbers is very similar, with just over 80% of trips at Nailsea & Backwell being to/from stations within the WoE area (and 37% to/from Bristol Temple Meads). However, within the WoE the distribution is different, with direct services to other stations in the WoE (such as Bath Spa and Bristol Parkway, as well as stations within North Somerset) there are more trips from Nailsea & Backwell to/from these stations than local stations in Bristol (over 35%, compared to under 20% from Portishead and Pill). Similarly, London trips to/from Nailsea & Backwell account for over 8% of journeys as a result of through services being available.

3.5 Benchmarking

To present a comparison of demand and catchment in a graphical form, a benchmark comparison has been carried out. This takes the catchment (population and employment) and plots demand versus the weighted and unweighted population and employment (for weighted figures, similar weighting are used in the demand forecasting model for new stations). Stations in the comparison are included from around the rail network, and have been selected to lie in similar ranges of demand and catchment characteristics as the new stations at Portishead and Pill.

A series of charts are included that compare demand forecasts for Portishead and Pill with a 1 train per hour service (in 2016 demand terms) with current demand at other stations across the rail network, in the context of station catchment population and employment, as well as other characteristics. In the first instance, this starts with a simple global comparison, moving on to look at stations with more similar characteristics.

- Figure 3.1 – Forecasts with 1 tph – comparison with stations across the network with 1 tph
- Figure 3.2 – 1 tph forecasts – comparison with stations of similar demand and catchment sizes
- Figure 3.3 – 1 tph forecasts – showing comparator stations by location
- Figure 3.4 – 1 tph forecasts – showing comparator stations by service level – off peak times
- Figure 3.5 – 1 tph forecasts – showing comparator stations by service level – peak times
- Figure 3.6 – 1 tph forecasts – 1 tph comparator stations by service level – other characteristics

Note that Figure 3.1 is based on plots of demand with population within 2km. Figures 3.2-3.6 are based on plots off demand with weighted population and employment in the catchment areas, derived using the same weightings as the demand forecasts. Demand forecasts for Portishead and Pill are all for the 1 train per hour scenario (except Figure 2 as noted).

Figure 3.1 is based on comparison of unweighted population within 2km around each station (from 2011 Census, uplifted to 2016 values using Tempro) and its demand (from the latest ORR station statistics), with Portishead and Pill demand forecasts based on 1 train per hour. Other stations with a 1 train per hour service have been identified using TRACC software, using the rail component of a snapshot from the Traveline National Dataset in mid-2016. There is no real correlation between the 2km population catchment and demand. However, what this chart illustrates is that Portishead is at the higher end of the demand scale for stations with 1 train per hour, and Pill very much in the larger cluster of similar stations (both population catchment and demand). Note that the Y-axis has been truncated at 500,000 journeys and a few outlier stations are above this demand level.

Figures 3.2 identifies a series of stations to compare with Portishead and Pill respectively, based on their local catchment population and employment and demand levels. This indicates that Portishead is at the lower end of the range for its catchment, whereas Pill is in the middle. Figures 3.3 goes on to clarify the types of settlements that support the comparator stations. Perhaps unsurprisingly, the majority of stations included are in small towns.

Figures 3.4-3.6 set out to illustrate that the level of service is important in the comparison of demand forecasts. In the first instance, Figures 3.4 identifies the off peak service level at comparator stations and Figures 3.5 the peak period (AM and PM in the dominant direction) service level. These figures indicate that, while Portishead forecasts are at the lower end of broadly comparator stations' range, many of these have a greater (than 1 train per hour) service level, albeit that some of these have such service levels at peak time only. For the Pill forecast comparators, most stations also have a 1 train per hour service.

The final figure (Figure 3.6) specifically considers comparator stations that have a 1 train per hour service, going on to identify other station characteristics that would affect demand; specifically whether there is a relationship to London, and in particular in the form of regular direct London services that can generate extra demand compared to stations without direct London links. This indicates that most of the stations that compare best with Portishead have direct London services, and in particular most of those with greater demand at a 1 train per hour service level.

In brief summary therefore, the benchmarking exercise indicates that the demand forecasts for Portishead and Pill can be considered comparable with the demand at similar stations, particularly once the type of station and level of service is taken into consideration.

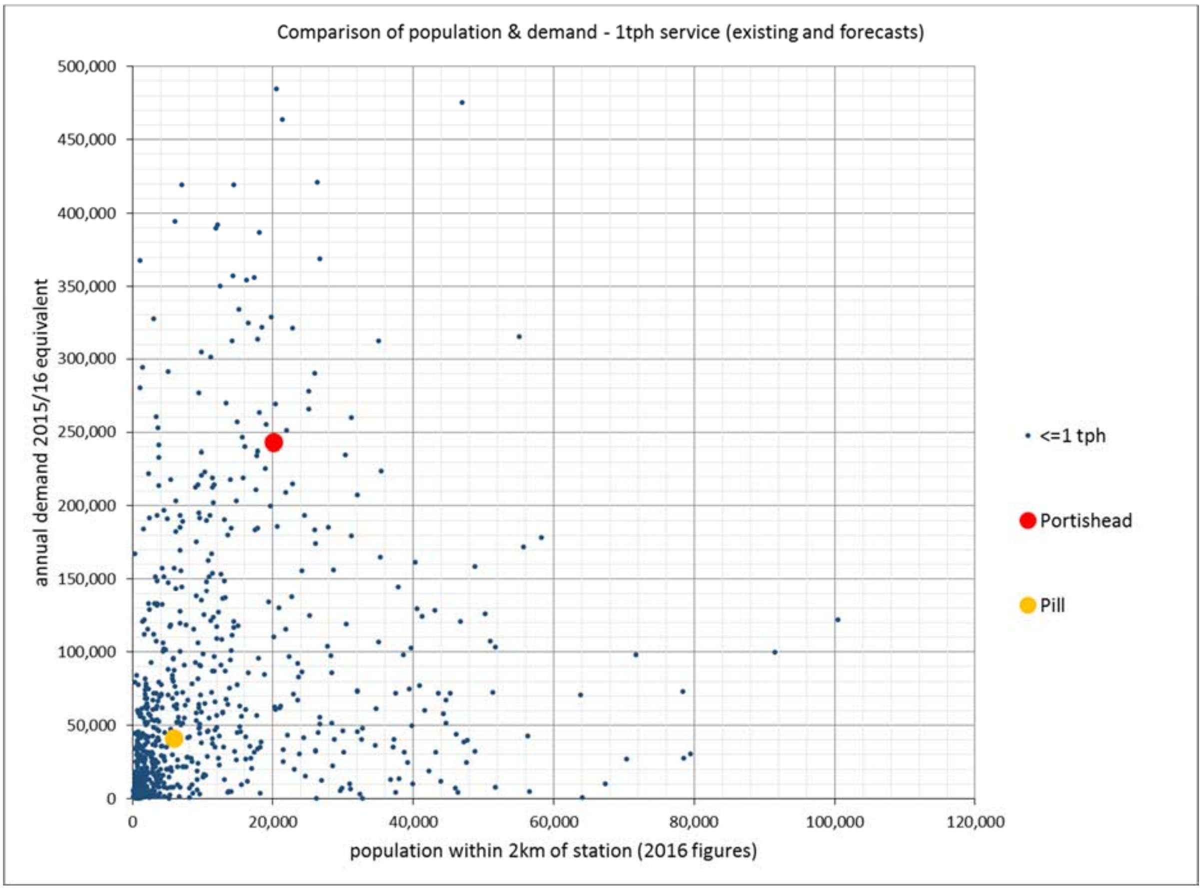


Figure 3-1: New stations forecasts with 1 tph – comparison with stations across the network with 1 tph

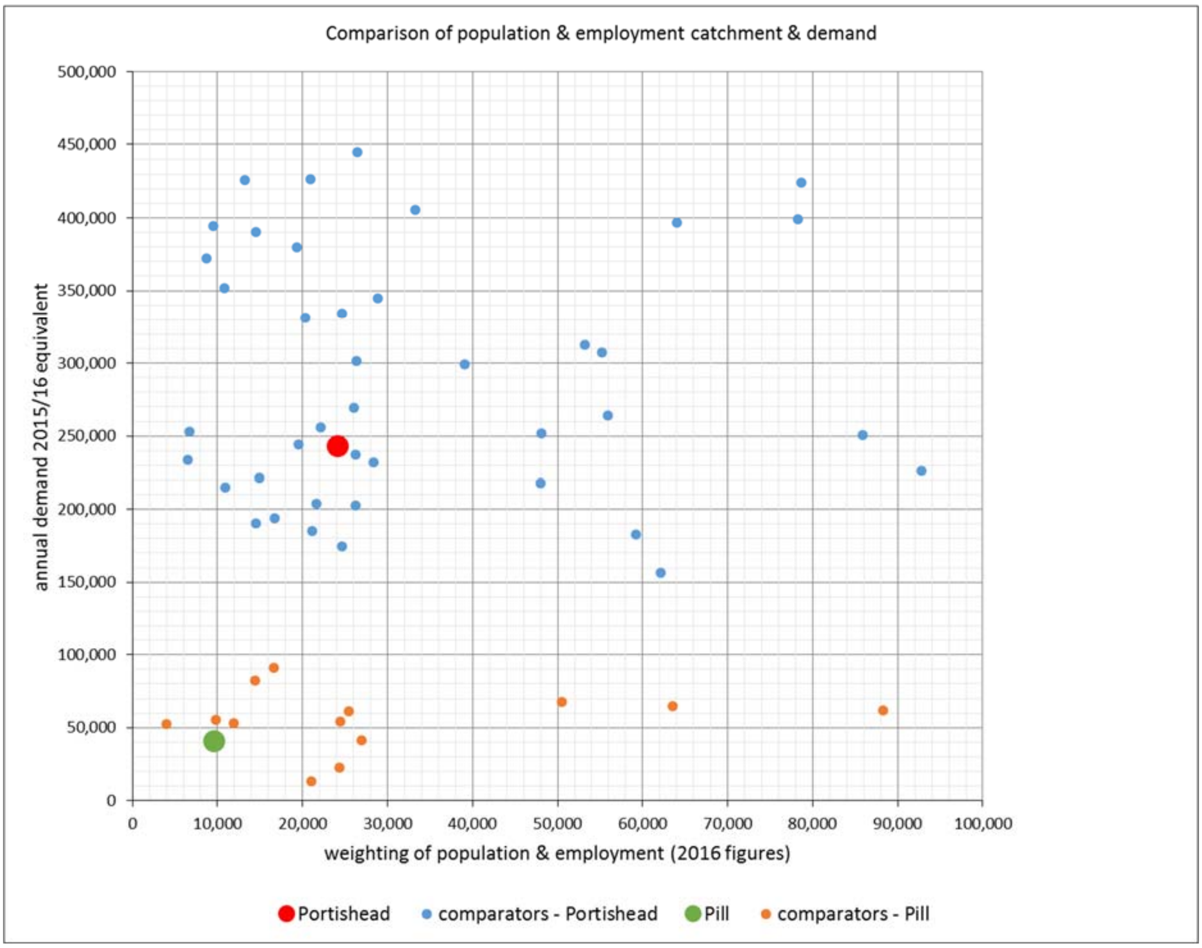


Figure 3-2: 1 tph forecasts – comparison with stations having similar demand levels and catchment sizes

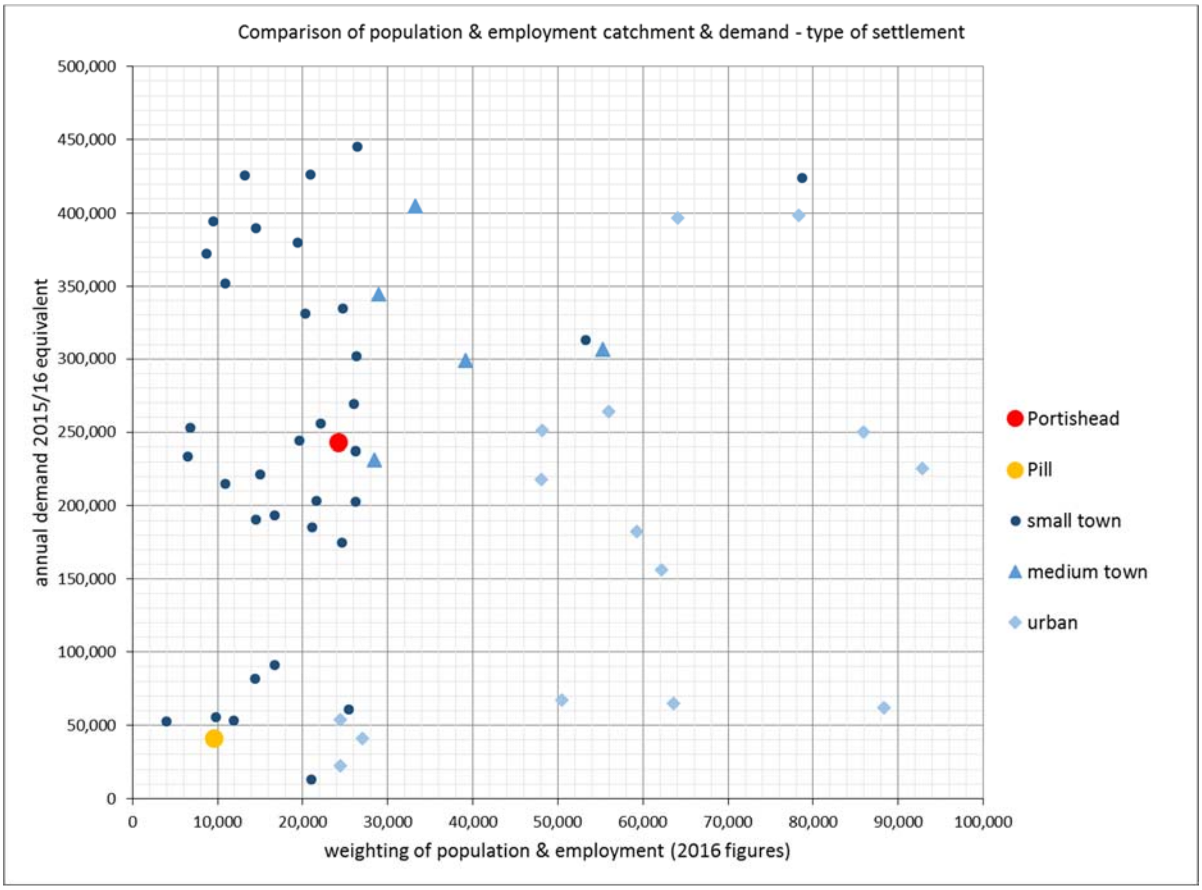


Figure 3-3: 1 tph forecasts – showing comparator stations by location

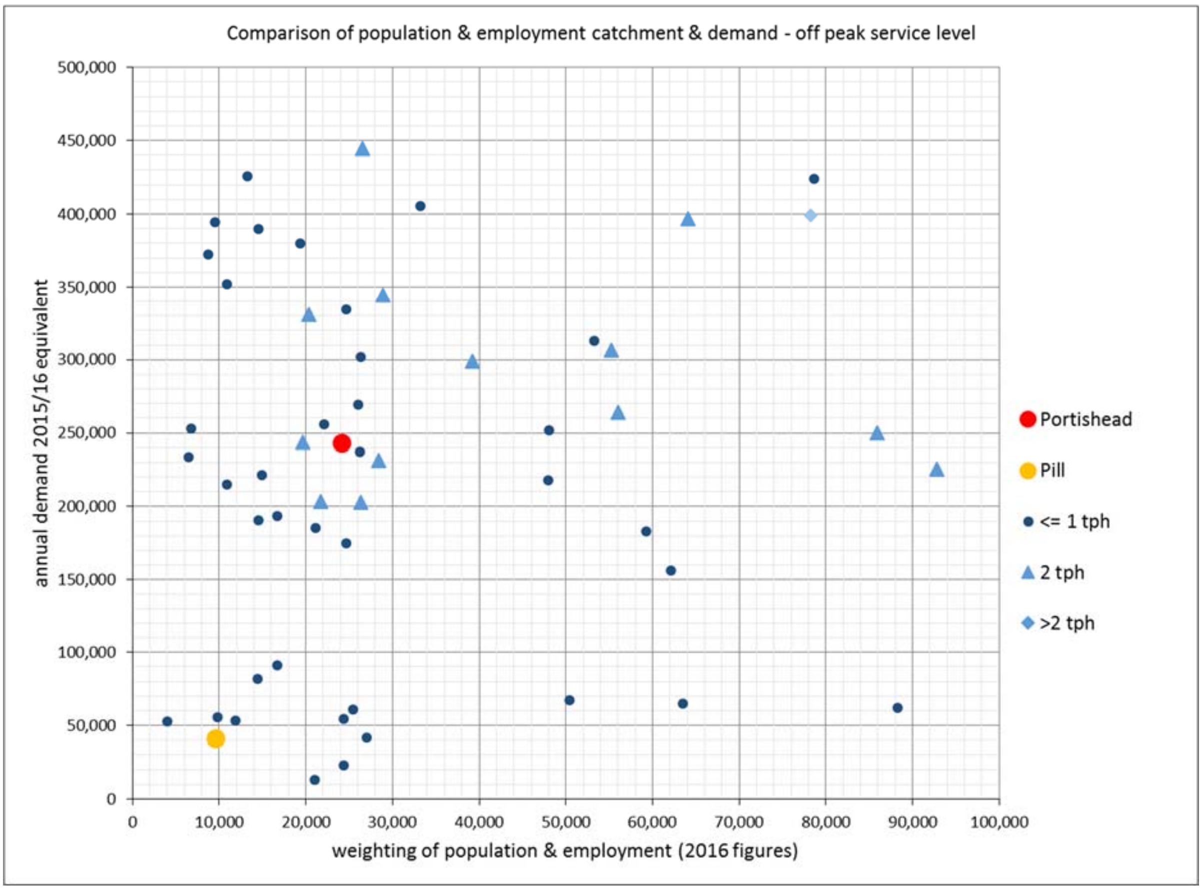


Figure 3-4: 1 tph forecasts – showing comparator stations by service level – off peak times

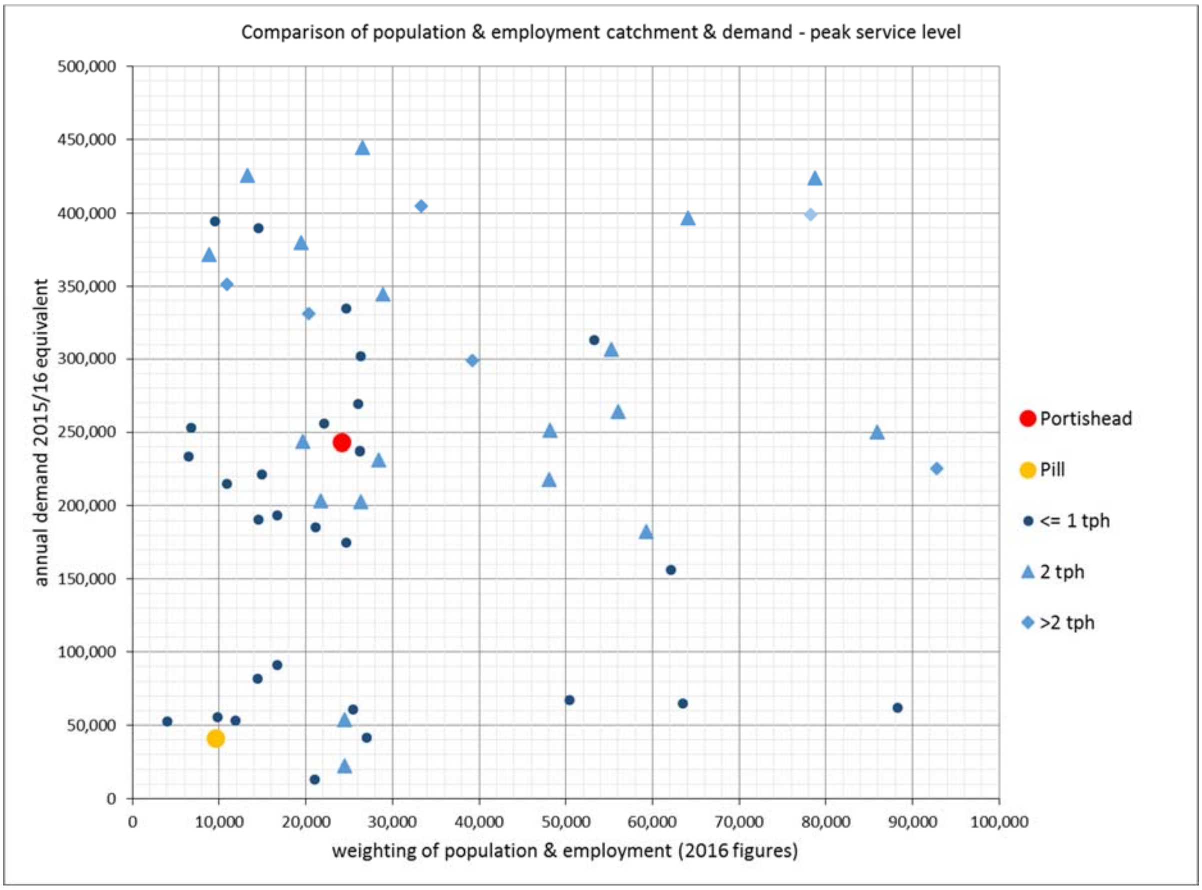


Figure 3-5: 1 tph forecasts – showing comparator stations by service level – peak times

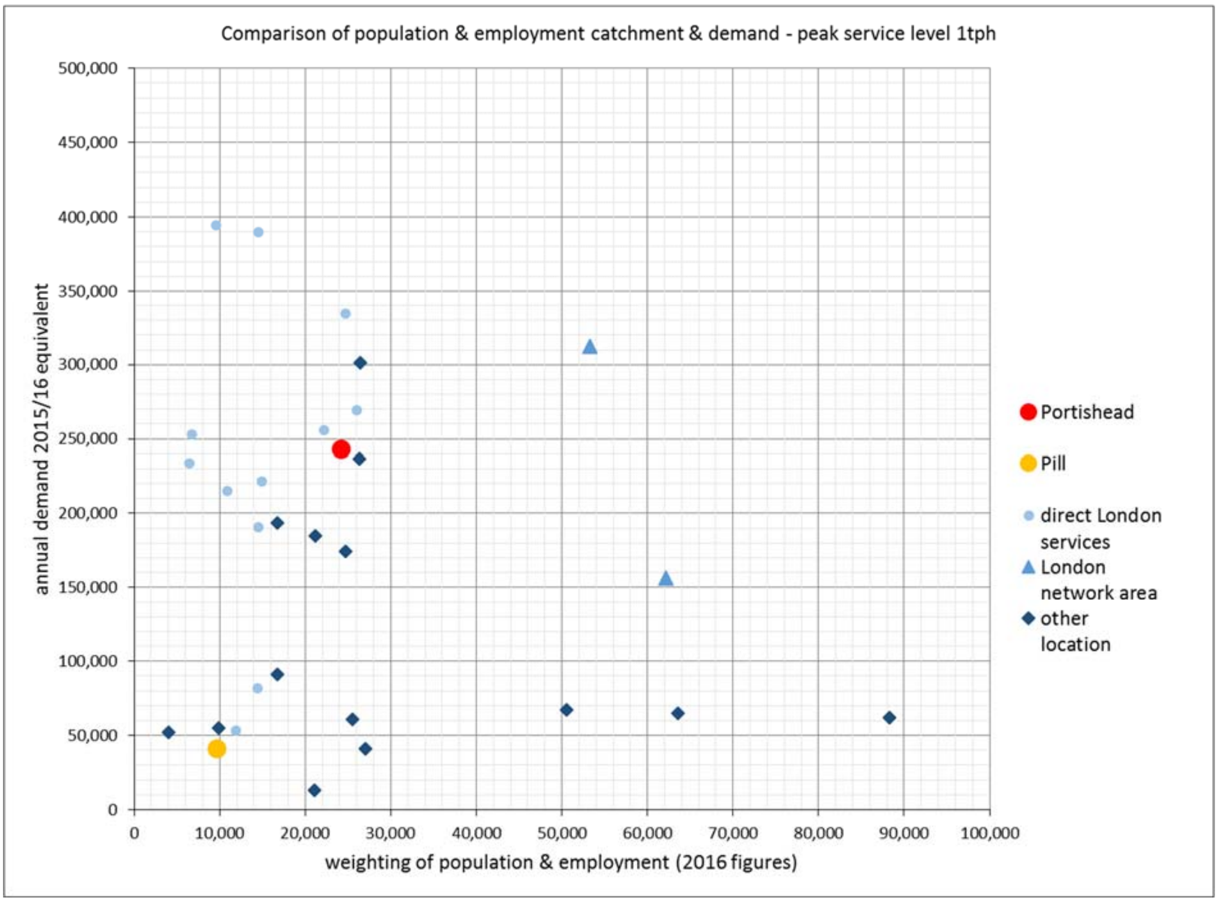


Figure 3-6: 1 tph forecasts – 1 tph comparator stations by service level – other characteristics

3.6 Capacity analysis

Annual demand forecasts can be further processed in order to estimate the amount of patronage that may be seen on a peak time train. A series of assumptions are made to generate daily figures and a profile of demand across the day. Key assumptions include:

- Annualisation – a figure of 253 has been used to go from annual figures to an average weekday. This is based on the relationship between weekdays and annual totals, and represents a busy weekday (Tuesday to Thursday) in a non-school holiday period.
- The daily profile of boardings and alightings (by hour) is based on a combination of MOIRA derived usage profiles and counts of boardings and alightings from the WoE annual rail survey.
- Maximum train load for the Portishead line service is assumed to be between Bristol Temple Meads and Bedminster, including all demand identified for Portishead and Pill stations (by direction) and 50% of additional demand generated at Bedminster and Pill.
- To take into account the propensity for individual trains to attract a disproportionate number of travellers, reference has been made to individual train counts from the WoE annual rail survey. This is a particular issue with an hourly train service, as the peak hour tends to be particularly popular. Patchway is the only station in the WoE area that has a true hourly peak service (others such as Yate and Oldfield Park have infill or re-timed services to reduce service intervals at peak times), so figures from Patchway have informed the allocation to the peak hour.

The maximum number of passengers is likely to be in the 08:00-09:00 hour in the AM peak. Demand also spikes in the PM peak in the hour 17:00-18:00, but to a lower level than in the morning. Table 3.8 sets out summary results for AM and PM peak hour maximum loadings in 2021 and 2036.

Table 3.8: Maximum train loading (passengers per service
1 train per hour Portishead service, 3-car Class 165/166 DMUs

	2021	**2036**	**Capacity**	
			Seats only	+Standing
08:00-09:00 (Portishead to BTM)	220	327	263	355
17:00-18:00 (BTM to Portishead)	201	286		

More detailed results for the AM peak hour (08:00-09:00, train from Portishead to Bristol Temple Meads) are presented in Figure 3.7, showing year-on-year (2021-2036) maximum passengers per train. Figure 3.8 has similar information for in the PM peak hour (17:00-18:00, train from Bristol Temple Meads to Portishead). Figures 3.9 and 3.10 have daily profiles of the number of passengers per train hour-by-hour for Portishead to Bristol Temple Meads in 2021 and 2036 respectively, with similar information for Bristol Temple Meads to Portishead in Figures 3.11 and 3.12.

The table and figures include train capacity, to illustrate how overcrowding could be an issue in each situation. Capacities shown are for the anticipated standard 3-car Class 165/166 DMU (263 seats). Seat numbers are not the ultimate capacity of a train, as standing room is available that can allow more people to travel on the train. However, once seats reach 100% occupied, a train is considered to be crowded when passengers in excess of capacity (PIXC) figures are quoted. This reflects peoples' dislike of boarding very busy trains, as well as ultimately not being able to physically board a crush loaded train. Capacities including standees are also included in the charts (355 total).

Comparison of train capacities and maximum loads suggest that a 1 train per hour service provided by 3-car Class 165s could cope with the forecast peak service demand to 2036. However, this will require regular standing at peak times from the mid 2020s in the AM peak and around 2030 in the PM peak. This could be substantially alleviated though if proposals to run 'infill' peak time services are achieved.

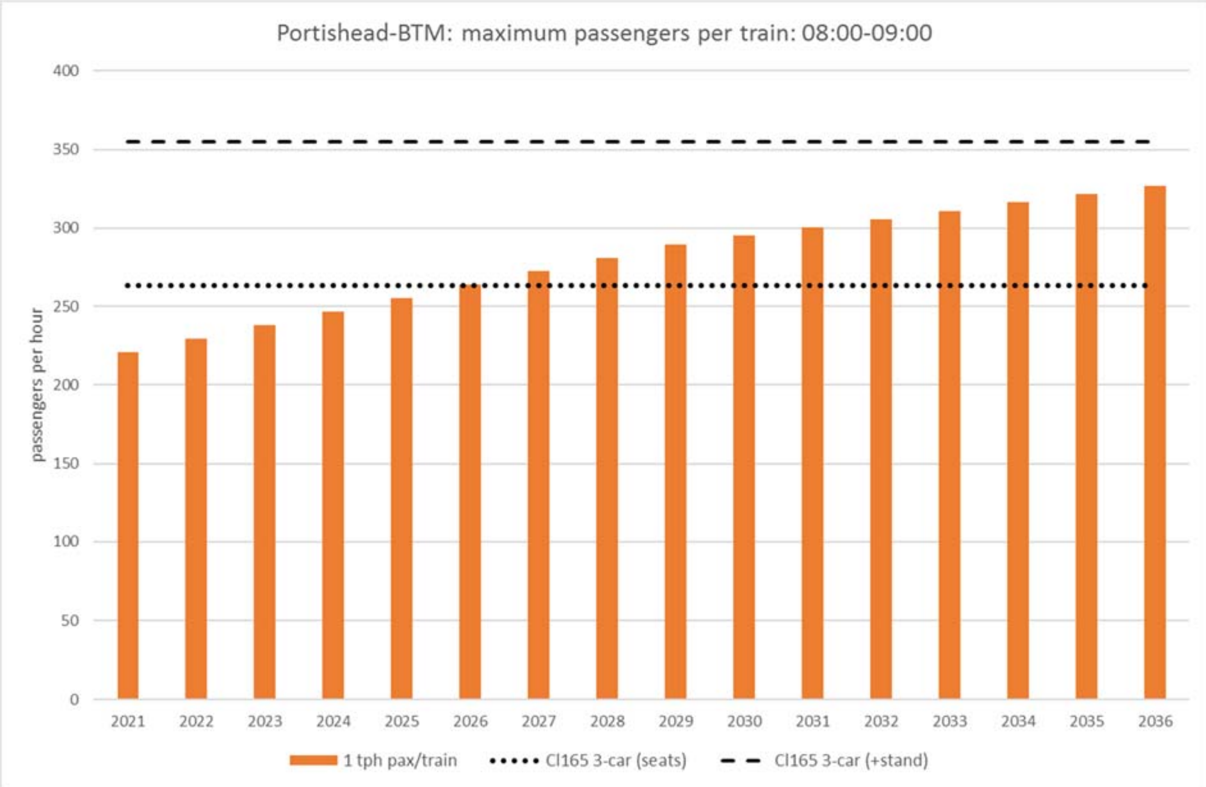


Figure 3-7: Portishead-BTM – maximum passengers per train 08:00-09:00

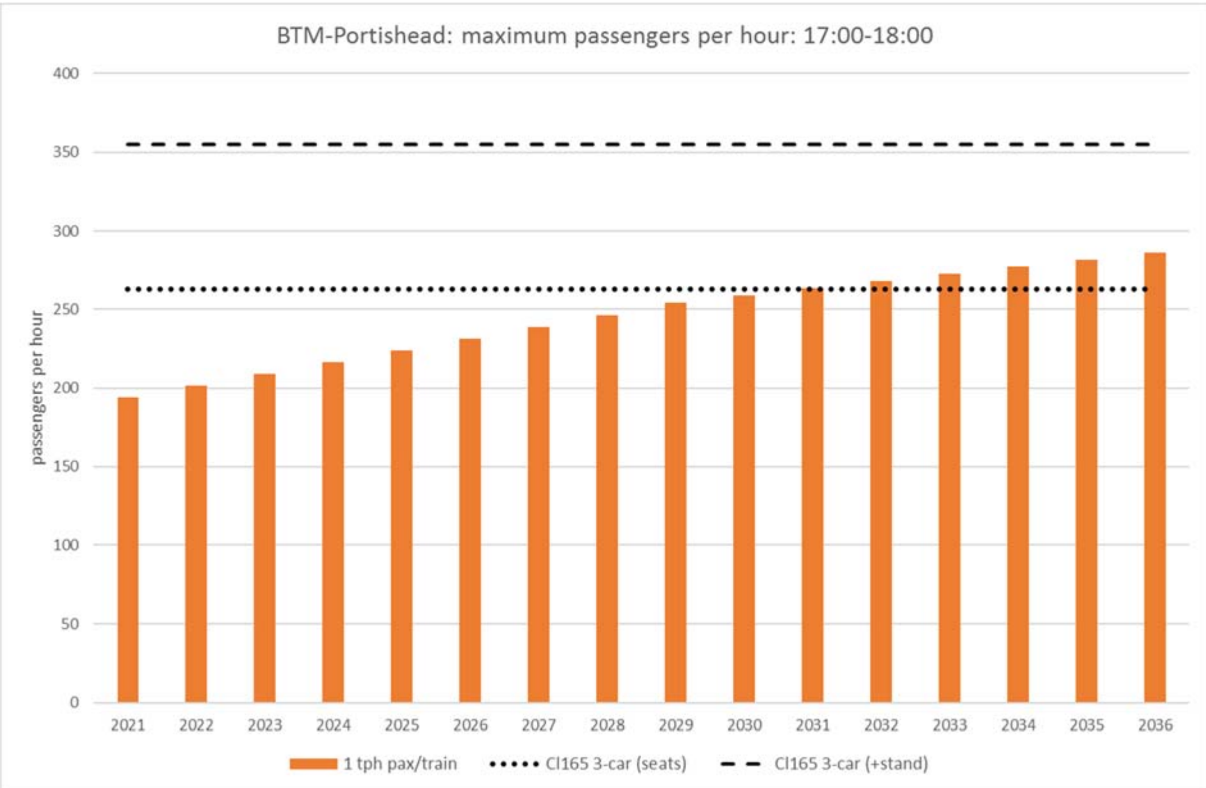


Figure 3-8: BTM-Portishead – maximum passengers per train 17:00-18:00

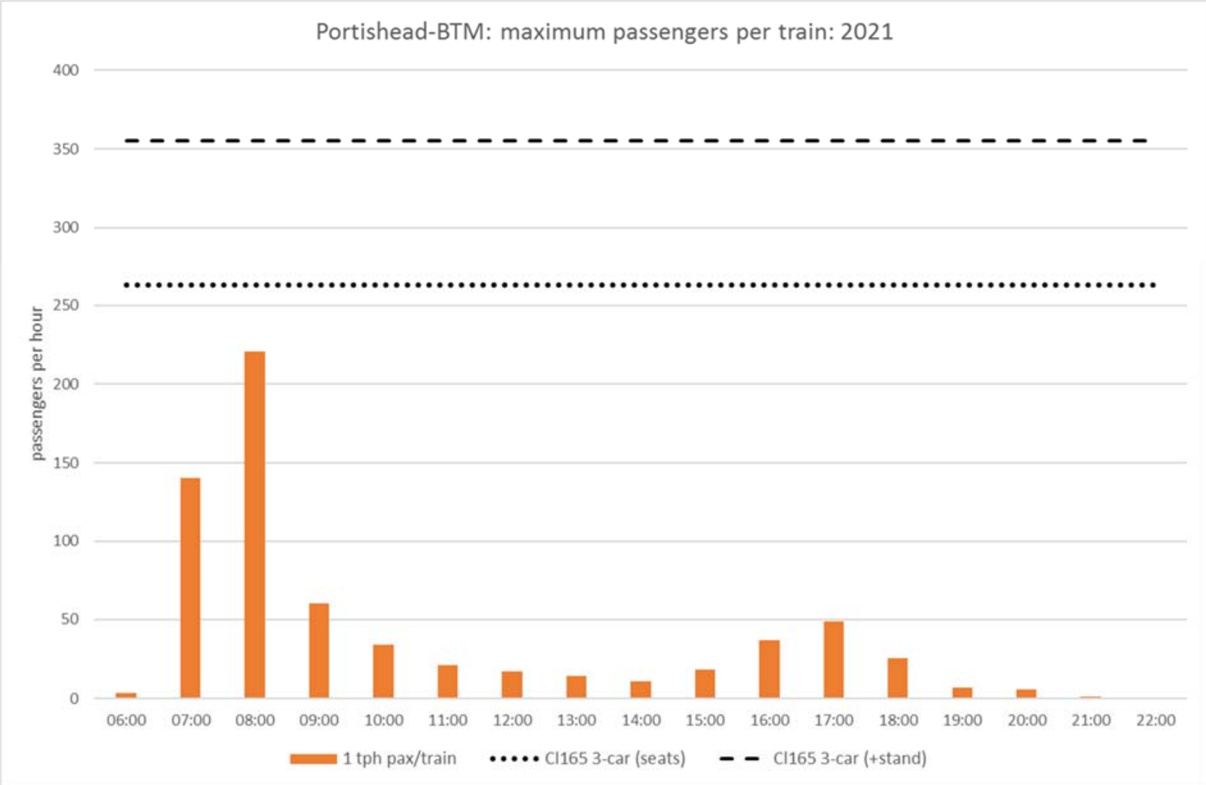


Figure 3-9: Portishead-BTM – maximum passengers per train over the day (2021)[10]

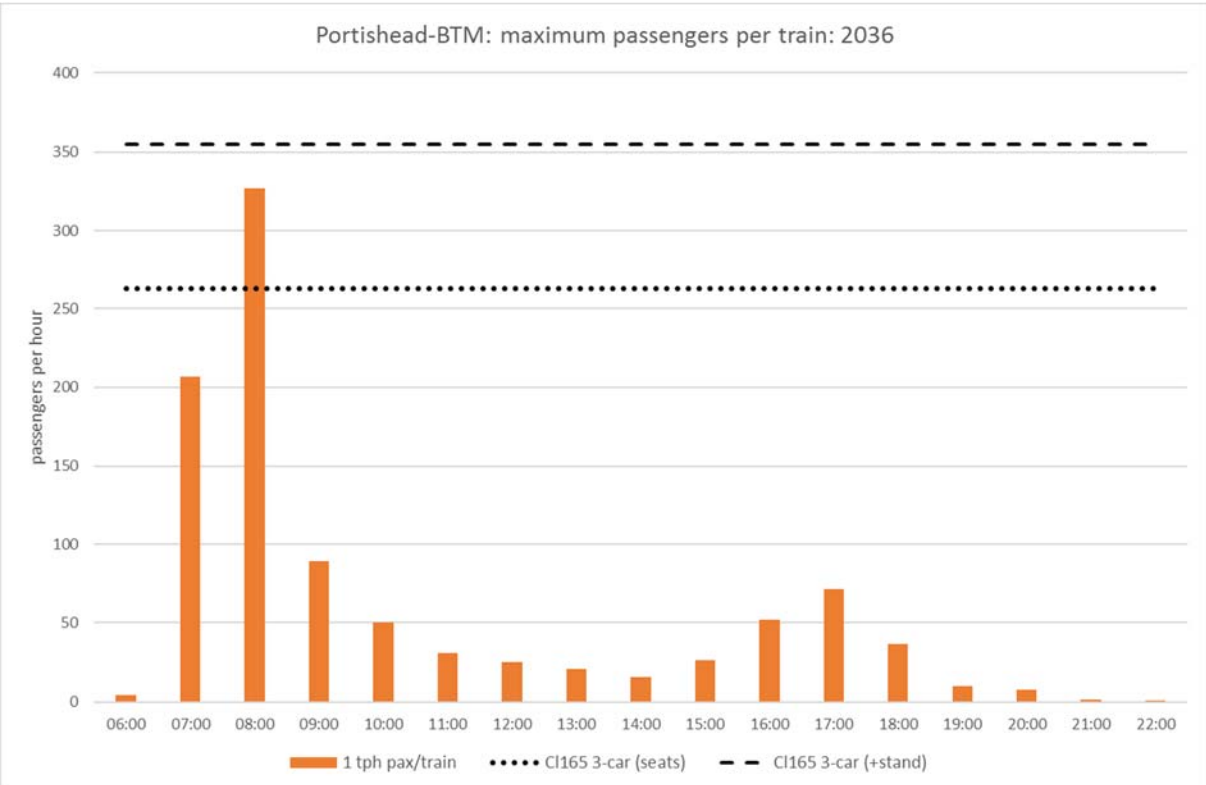


Figure 3-10: Portishead-BTM – maximum passengers per train over the day (2036)

[10] Note that the profiles in Figures 3.9-3.12 do not take into account the potential for 'infill' 45 minute services at peak times, or that the operator could introduce initiatives to promote shoulder or off-peak demand in lieu of peak usage.

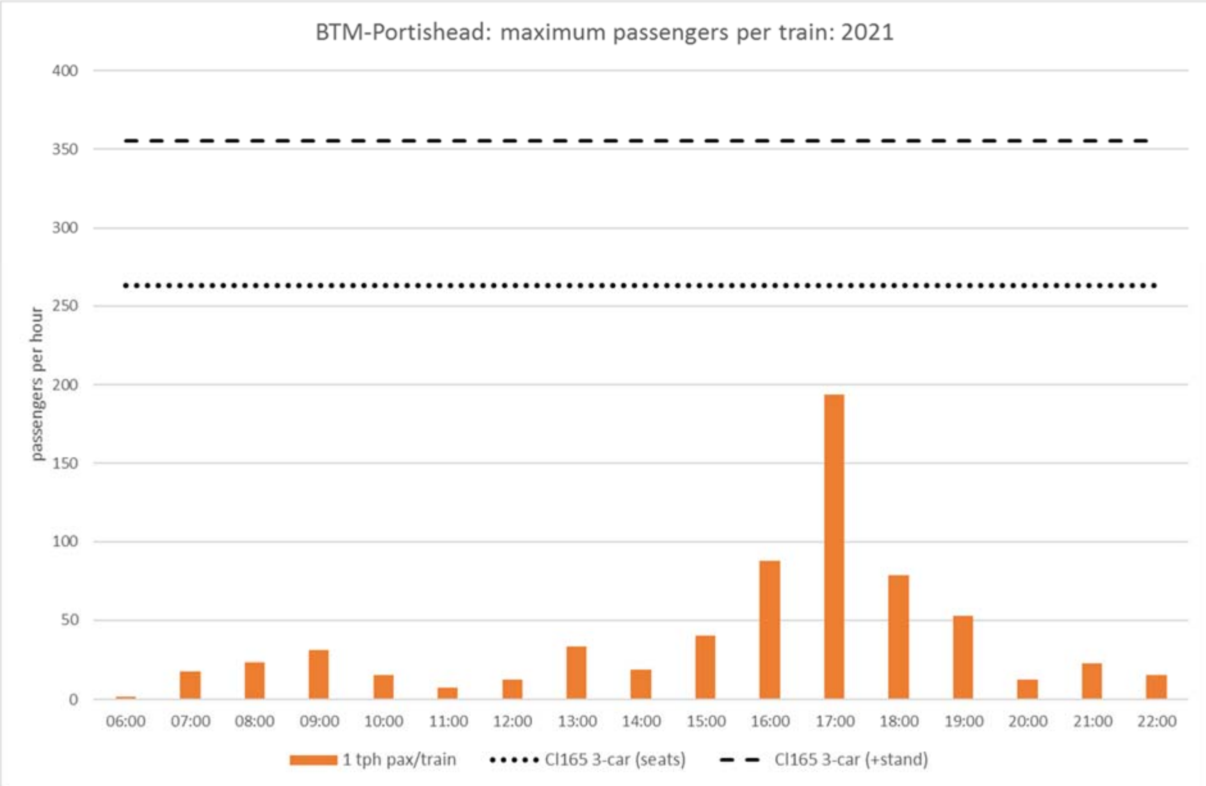


Figure 3-11: BTM-Portishead – maximum passengers per train over the day (2021)

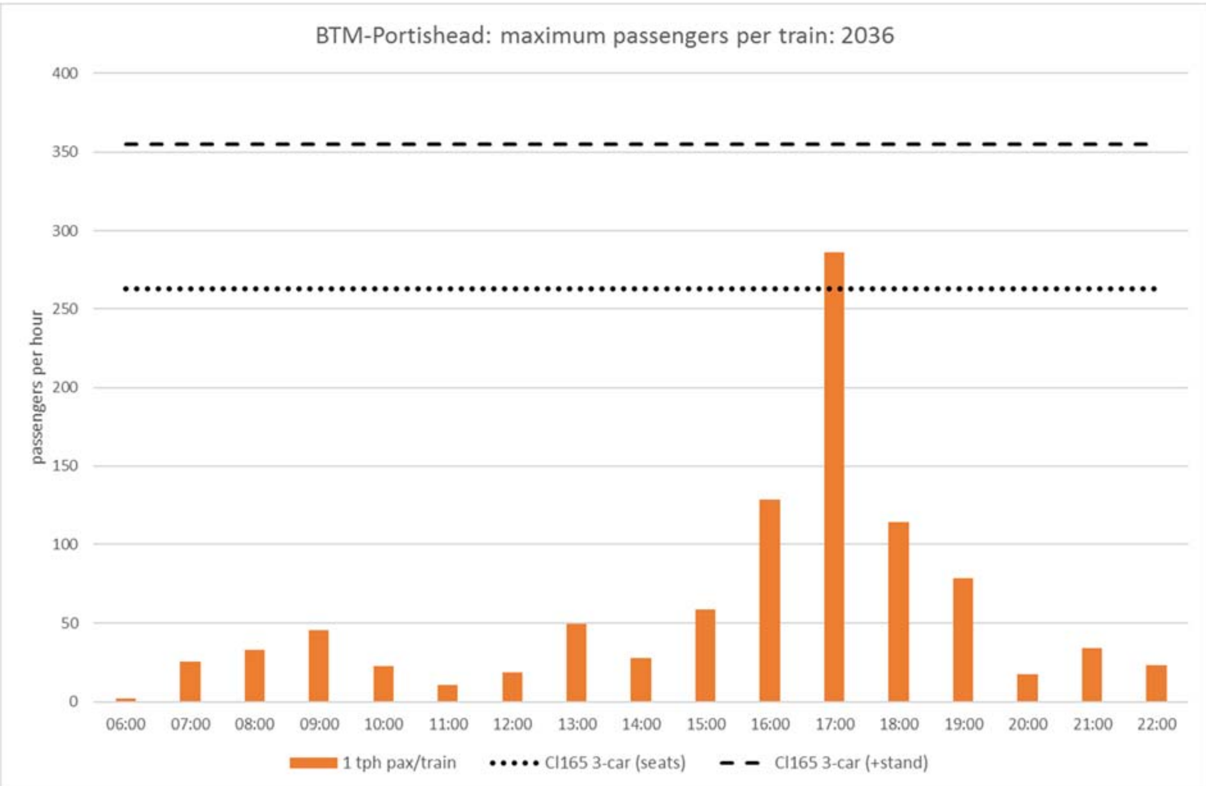


Figure 3-12: BTM-Portishead – maximum passengers per train over the day (2036)

3.7 Financial profiles

A summary of the first 3-year costs, revenues and surplus/subsidy requirements is shown in Table 3.9, with estimated mobilisation costs in the two years prior to opening both included and excluded in the 3-year totals. Profiles assume all MetroWest Phase 1 elements open in 2021.

The table shows initial estimates of operation cost, with no allowance for operating cost risk, as well as illustrating the potential effects the operating cost risks identified in the MetroWest Phase 1 OBC 'Economic Assessment Report' could have on the first three years' financial profiles. It is clear from the profiles, that the ability of the scheme to cover operating cost is markedly affected by the assumptions of risk in operating cost estimates.

A set of 10-year profiles are in Appendix A. The profiles are accompanied by a series of charts, illustrating the relationships between the operating costs and revenues, including initial operating cost estimates and 50% application of operating cost risk elements (and the PBC Option 5B scheme 3-year financial profile for reference).

Based on the mid-range forecast which includes 50% operating cost risk, the scheme could break even after 5 years, and thereafter the revenue should cover scheme operating costs.

Table 3.9: Financial profiles – first three years (plus mobilisation)

Year	**Initial profile** main forecasts of revenue and operating costs	**Risk profile 1** including 50% of operating cost risk	**Risk profile 2** including 100% of operating cost risk
FIRST 3 OPERATIONAL YEARS			
Revenue	£14,505,382	£14,505,382	£14,505,382
Operating cost	£15,079,376	£16,574,409	£18,069,441
Surplus / Subsidy	-£573,994	-£2,069,027	-£3,564,059
INCLUDING MOBILISATION COSTS			
Revenue	£14,505,382	£14,505,382	£14,505,382
Operating cost	£16,958,235	£18,702,962	£20,447,688
Surplus / Subsidy	-£2,452,852	-£4,197,579	-£5,942,306

Highway Network Impacts

4.1 Introduction

The West of England highway networks are reaching capacity and congestion is particularly notable at in some key locations, including Bristol city centre and approaches to Bristol Temple Meads, M4 and M5 junctions and corridors into Bristol city centre(including M32, A38, A4018 and A432).

This not only causes delays and lost productivity for car drivers and goods vehicle operators but also presents a major hurdle for an attractive public transport mode in the area. Table 4.1 shows free flow vs peak hour journey times on the key corridors served by MetroWest Phase 2. This shows peak hour journey times can be more than twice the corresponding free flow times.

Table 4.1: Free flow vs AM Peak journey times on key routes
Observed data from Strategis – used in GBATS4 updates

Route	Observed AM Peak 2013	
	Free Flow JT (mins)	**Net Peak hour JT (mins)**
A370 Inbound (Backwell to Ashton Gate)	8.1	10.8
A370 Outbound (Jessop Underpass to Backwell)	8.6	10.3
A38 Inbound (Barrow Gurney to Bedminster Bridge)	11.3	18.8
A38 Outbound (Bedminster Bridge to Barrow Gurney)	9.7	16.6
A4 Inbound (Keynsham to Bath Bridge)	11.4	30.9
A4 Outbound (Bath Bridge to Keynsham)	10.4	19.2
A431 Inbound (Willsbridge to Old Market St)	14.6	30.7
A431 Outbound (Old Market St Jct to Willsbridge)	13.7	25.8
A38 Eastbound (Ashton Gate to Brislington)	12.4	29.2
A38 Westbound (Brislington to Ashton Gate)	13.2	23.3
A432 Inbound (A4174 Badminton Rbt to Old Market St)	15.2	35.6
A432 Outbound (West St to A4174 Badminton Rbt)	15.4	26.3
M32 Inbound (M32 J1 to Cabot Circus)	4.9	13.1
M32 Outbound (Cabot Circus to M32 J1)	3.8	5.6
A38 Inbound (M5 J16 to St James Barton Rbt)	16.3	33.6
A38 Outbound (St James Barton Rbt to M5 J16)	16.6	35.3
A4018 Inbound (M5 J17 Cribbs to Clifton Triangle)	12.3	29.7
A4018 Outbound (College Green to M5 J17 Cribbs)	12.5	18.9
A4 Portway Inbound (Avonmouth to Hotwells)	10.8	20.8
A4 Portway Outbound (Hotwells to Avonmouth)	9.8	12
A369 Inbound (Portishead to A4 Bristol Gate)	11.6	24.2
A369 Outbound (A4 Bristol Gate to Portishead)	13.2	19
A4174 Eastbound (Filton Rbt to A4)	17.3	31.5
A4174 Westbound (A4 to Filton Rbt)	17.6	31.7
City Centre Outer Loop (Clockwise)	17.2	41.5
City Centre Outer Loop (Anti-Clockwise)	14.5	32.4
City Centre Inner Loop (Clockwise)	13.8	30.5
City Centre Inner Loop (Anti-Clockwise)	8	19.4

Free Flow JT = minimum journey time recorded in the period 06:00-10:00

As indicated earlier in this report, WebTAG recommends that a local transport model should be used to assess highway impacts (in particular) if available. Hence, the principal tool used in the derivation of highway impacts of MetroWest Phase 1 is the GBATS4 multi-modal transport model, the existing WebTAG compliant multi-modal model for the West of England area, in conjunction with rail demand outputs from the RDM, and TUBA to derive benefits.

4.2 Without-Intervention Case

4.2.1 Do minimum model

Full details of the future year do minimum GBATS4M model can be found in the 'GBATS4M Future Year Do Minimum Model Report', February 2016, appended to the MetroWest Phase 1 OBC. This report sets out the assumptions made in the do minimum model, including forecasting approach, future year matrix development, network development, model parameter adjustments and future year do minimum assignments. Some of the key assumptions relating to land use and network are described briefly below.

The GBATS4M model includes two forecast years (2021 and 2036). These include the modelling of all housing and employment development within the main study area that is categorised as either 'near certain' or 'more than likely'. Forecasts are controlled to TEMPRO, so smaller scale developments (i.e. less than 1 hectare for employment sites, less than 50 homes for housing) were not explicitly included as they are implicitly included in the growth factors. Note that the initial version of the future year do minimum model has been re-based to incorporate revisions to TEMPRO (version 7.2) that were finalized subsequent to the future year GBATS4M model being initially prepared. Table 4.2 summarises the total numbers of additional new homes and jobs include in the model.

Table 4.2: Additional Planned Development included in GBATS4M Do Minimum
Sources: WoE local authorities adopted Core Strategies

Year	Additional New Homes	Additional New Jobs
2013-2021	27,719	34,621
2021-2036	7,656	16,937
2013- 2036	35,375	51,559

The main infrastructure schemes included in the future year networks are included in Table 4.3. Further details are contained in the GBATS4M Future Year Do Minimum Model Report. Note that MetroWest Phase 2 is excluded from the model.

Table 4.3: Additional Infrastructure included in MetroWest Future Year Do Minimum
Source: WoE local authorites

Scheme	Description
20mph speed limits	• Roll out of 20mph speed limits across Bristol
CPNN Off-site Works Package	• A38 Filton roundabout. Capacity and safety improvements on 3-arms. • Widening of M5 J16 motorway off-slips, A38 North and circulatory carriageway. • Signing & lining changes on M5 J17 southbound off-slip. Widening of Merlin Road exit from roundabout and Highwood Lane entry to Merlin Road junction. • Widening of southbound approach at A38 Aztec West Rbt. • A4018 Bus Corridor. Crow Lane, Charlton Road, Greystoke Avenue junction improvements. • Local bus service enhancements.

Table 4.3: Additional Infrastructure included in MetroWest Future Year Do Minimum
Source: WoE local authorites

Scheme	Description
MetroBus	• Rapid transit from Ashton Vale to Temple Meads via Bristol city centre. • North Fringe to Hengrove Package. • New highway link and bus route between A370 and Hengrove Park
Temple Circus Project	• Redesign of Temple Circus roundabout. Related changes to the end of Victoria Street, The Friary, Temple Way, Temple Gate, connection with Redcliffe Way, Bath Bridge Roundabout
Managed Motorway Scheme	• M4 Junctions 19-20 & M5 Junctions 15-17
Cribbs Patchway MetroBus Extension	• Extending the NFHP MetroBus route from The Mall back to Parkway
M5 Junction 19	• Replacement of left turn off the south bound exit slip, with a two lanes
London Paddington – South Wales Rail Electrification	• Extra services between Bristol Temple Meads and London Paddington via Bristol Parkway included

4.2.2 Do minimum and scale of highway changes

It should be considered when assessing the effect of MetroWest Phase 1 that changes are forecast to occur to traffic on the highway network, as a result of housing and employment development, as well as other road and public transport schemes being implemented over time. This is reflected in the 2021 and 2036 'do minimum' scenarios developed for GBATS4 from which comparisons of the effect of MetroWest Phase 1 are made. It is therefore worth understanding the scale of the changes forecast without MetroWest Phase 1, as well as that caused by its implementation.

Table 4.4 shows model summary statistics from across the model area of GBATS4, with changes from the model's 2013 base year to 2021 and 2036 do minimum scenarios in Table 4.5.

Table 4.4: Do Minimum GBATS4 model statistics

Network Statistics		2021 Do Min			2036 Do Min		
	units	AM	IP	PM	AM	IP	PM
TOTALS – all modelled area, for hour modelled							
Delay	pcu.hrs/hr	590	326	573	828	538	840
Travel time	pcu.hrs/hr	28,183	19,795	28,045	33,230	23,431	32,808
Travel distance	pcu.kms/hr	1.196m	0.959m	1.224m	1.336m	1.116m	1.361m
Trips loaded	pcu/hr	130,150	111,533	128,777	146,821	129,259	144,413
AVERAGES – per modelled vehicle							
Travel time	mins	13.0	10.6	13.1	13.6	10.9	13.6
Distance	kms	9.2	8.6	9.5	9.1	8.6	9.4
Speed	kph	42.4	48.4	43.6	40.2	47.6	41.5

Table 4.5: GBATS4 model statistics – CHANGES from 2013 Base (%)

Network Statistics	units	2013 Base to 2021 Do Min			2013 Base to 2036 Do Min		
		AM	IP	PM	AM	IP	PM
TOTALS – all modelled area, for hour modelled							
Delay	pcu.hrs/hr	-16.2%	-6.1%	7.1%	17.6%	55.1%	57.2%
Travel time	pcu.hrs/hr	4.4%	4.9%	4.3%	23.1%	24.1%	22.0%
Travel distance	pcu.kms/hr	4.8%	4.5%	4.5%	17.1%	21.6%	16.1%
Trips loaded	pcu/hr	3.6%	4.7%	3.1%	16.9%	21.3%	15.6%
AVERAGES – per modelled vehicle							
Travel time	mins	0.8%	0.2%	1.1%	5.3%	2.3%	5.5%
Distance	kms	1.2%	-0.2%	1.3%	0.2%	0.3%	0.4%
Speed	kph	0.2%	-0.4%	-	-5.0%	-2.1%	-4.8%

Note: Negative changes to travel times, travel distances and trips loaded reflect improvements in conditions on the highway network. Similarly, positive changes to speeds are also an improvement

This shows a worsening of network operation in future years resulting in marked increases in queues, associated travel times and reductions in average speed relative to the current levels of congestion. While it can readily be seen from Table 4.4 that the number of trips generated on the highway network is rising over time, which is reflected in Table 4.5 by increases of between 3% and 5% from the 2013 base to 2021 do minimum, and 15% to 21% in 2036. Larger increases are noted in the inter-peak period as congestion is lower and there is less trip suppression during the inter-peak than in the AM or PM peaks. The increase in trips loaded onto the network is reflected by increases in total travel time and travel distance for vehicles on the network of a similar magnitude to the number of additional trips. Total vehicle delays increase by a greater amount, particularly in 2036 with total delay recorded across the network rising by over 50% in the inter-peak and PM peak. As a result of the additional traffic and delays, average vehicle speeds reduce by around 5% in 2036 peak periods. Appendix B contains plots of traffic movements, comparing base and do minimum flows.

4.3 With-Intervention Case

The highway network operation has been assessed in the With Intervention 'Do Something' scenario using the methodology set out in chapter 2.

The change in rail and highway trips are shown in Table 4.6, which take into account increased rail demand at both new and existing stations. This takes the results of demand forecasts set out for new stations and existing stations in Chapter 3 and illustrates demand by GBATS5 model period (AM peak, inter-peak and PM peak), noting that the initial forecasts are all annual figures.

To calculate period demands consistent with the inputs and outputs for GBATS4 model periods, MOIRA hourly usage profiles have been used. There are several different sets of profiles for different types of journeys, providing individual 24-hour demand based on station origin and destination type and journey time (for instance, very long distance journeys of greater than 6 hours duration tend to begin between 10:00 and 12:00, whereas local journeys up to 1 hour duration are more likely to take place in the peak hour of 08:00-09:00). Annual demand forecasts have been converted to daily figures, also using a MOIRA derived factor, and split into time period, using the gravity model distribution to allocate trip journey time, which alongside allocating stations to categories, subsequently determines the MOIRA profile to use for a particular movement.

The proportion of additional rail trips that are forecast to switch from highway have been identified from the GBATS4 multi-modal assessment results, which vary by time period. These have been applied to the AM peak, inter-peak and PM peak rail demand figures (the resulting changes in highway trips are also shown in Table 4.6).

Table 4.6: Change in rail and highway trips

Change in rail/car demand (from do minimum)	2021				2036			
	Annual	Average day			Annual	Average day		
		AM	IP	PM		AM	IP	PM
Existing stations	492,700	370	60	370	816,100	610	100	610
Portishead	321,000	240	40	240	433,500	330	50	320
Pill	53,500	40	10	40	72,300	50	10	50
TOTAL	781,900	650	110	650	1,295,100	990	160	990
Approx. reduction in car trips		380	20	180		580	30	280

Table 4.7 shows model summary statistics from across the model area of GBATS4, with changes from 2021 and 2036 do minimum scenarios to MetroWest Phase 1 scheme in Tables 4.8 and 4.9. Whereas changes from the 2013 base to the 2021 do minimum and 2036 do minimum are generally reflective of worsening traffic conditions, particularly in the 2036 do minimum, Tables 4.8 and 4.9 indicate that changes as a result of MetroWest Phase 1 are mostly improvements to traffic. However, the scale of impact is much lower than that modelled between the base and do minima, with reductions in highway trips of around 0.5% feeding through to similar order changes in the other metrics (around 1% improvements in peak period travel times and average vehicle speeds being the most notable). Appendix B contains plots of traffic movements, comparing the scheme and do minimum flows.

Table 4.7: MetroWest Phase 1 scheme effects – GBATS4 model statistics

Network Statistics		2021 OBC scheme			2036 OBC scheme		
	units	AM	IP	PM	AM	IP	PM
TOTALS – all modelled area, for hour modelled							
Delay	pcu.hrs/hr	582	325	567	823	538	838
Travel time	pcu.hrs/hr	27,957	19,777	27,921	32,790	23,399	32,401
Travel distance	pcu.kms/hr	1.193m	0.958m	1.221m	1.331m	1.116m	1.359m
Trips loaded	pcu/hr	129,583	111,493	128,517	146,360	129,251	144,266
AVERAGES – per modelled vehicle							
Travel time	mins	12.9	10.6	13.0	13.4	10.9	13.5
Distance	kms	9.2	8.6	9.5	9.1	8.6	9.4
Speed	kph	42.6	48.4	43.7	40.6	47.7	41.9

Table 4.8: MetroWest Phase 1 scheme effects – GBATS4 model statistics - CHANGES

Network Statistics		2021 OBC scheme			2036 OBC scheme		
	units	AM	IP	PM	AM	IP	PM
TOTALS – all modelled area, for hour modelled							
Delay	pcu.hrs/hr	-7.7	-0.7	-5.7	-4.1	-	-2.4
Travel time	pcu.hrs/hr	-226.0	-17.8	-124.1	-439.5	-31.5	-407.0
Travel distance	pcu.kms/hr	-6,041.0	-623.4	-3,357.8	-4,498.0	-8.0	-1,945.7
Trips loaded	pcu/hr	-566.7	-40.0	-260.1	-461.0	-7.2	-146.4

Table 4.8: MetroWest Phase 1 scheme effects – GBATS4 model statistics - CHANGES

Network Statistics	units	**2021 OBC scheme** AM	IP	PM	**2036 OBC scheme** AM	IP	PM
AVERAGES – per modelled vehicle							
Travel time	mins	-0.048	-0.006	-0.031	-0.1374	-0.014	-0.1554
Distance	kms	-0.006	-0.003	-0.007	-0.0021	0.0004	-0.0039
Speed	kph	0.2	-	0.1	0.4	0.1	0.4

Note: Negative changes to travel times, travel distances and trips loaded reflect improvements in conditions on the highway network. Similarly, positive changes to speeds are also an improvement

Table 4.9: MetroWest Phase 1 scheme effects – GBATS4 model statistics - % CHANGES

Network Statistics	units	**2021 Do Min to OBC scheme** AM	IP	PM	**2036 Do Min to OBC scheme** AM	IP	PM
TOTALS – all modelled area, for hour modelled							
Delay	pcu.hrs/hr	-1.3%	-0.2%	-1.0%	-0.5%	-	-0.3%
Travel time	pcu.hrs/hr	-0.8%	-0.1%	-0.4%	-1.3%	-0.1%	-1.2%
Travel distance	pcu.kms/hr	-0.5%	-0.1%	-0.3%	-0.3%	-0.0%	-0.1%
Trips loaded	pcu/hr	-0.4%	-	-0.2%	-0.3%	-0.0%	-0.1%
AVERAGES – per modelled vehicle							
Travel time	mins	-0.4%	-0.1%	-0.2%	-1.0%	-0.1%	-1.1%
Distance	kms	-0.1%	-0.03%	-0.1%	-0.0%	-	-0.0%
Speed	kph	0.5%	-	0.2%	1.0%	0.2%	1.0%

Note: Negative changes to travel times, travel distances and trips loaded reflect improvements in conditions on the highway network. Similarly, positive changes to speeds are also an improvement

4.4 Highway Benefits Analysis

Highway benefits have been identified through TUBA based on results of the highway modelling reported above. TUBA version 1.9.9 has been used, which incorporates the latest advice into the use of values of time that vary with trip distance.

Table 4.10 shows annualisation factors employed, which take into account relative congestion levels in peak and 'shoulder' hours rather than purely on traffic counts. These based on the GBATS framework, which have not been recently reviewed. They are set out in the NFHP DfT Engagement Annualisation Factors Review, August 2011 supplementary document. This document is available upon request.

Table 4.10: TUBA annualisation factors

Time Period	Modelled Hour to Period Conversion Factor	Number of Occurrences per Year	Annualisation Factors	Comments
AM	2.55	253	645.15	Conversion based on AM peak hour
IP	6	253	1518	Conversion based on IP average hour
PM	2.56	253	647.68	Conversion based on PM peak hour
OP	0.69	253	174.57	Conversion based on IP average hour
WE	6.07	56	339.92	Conversion based on IP average hour

Table 4.11 gives the TUBA highway benefits identified. Appendix C presents the decongestion-related inputs in TEE format.

Table 4.11: TUBA highway benefits

Highway benefits	(£'000s)
Commuting / Other user benefit	£27,857
Business user benefit	£22,301
Wider public finances (Indirect taxation revenues)	-£12,678
Greenhouse gases	£251

Figure 4.1 presents the spatial distribution of highway benefits from the scheme based on trip origins. This is consistent with the areas expected to benefit from MetroWest Phase 1.

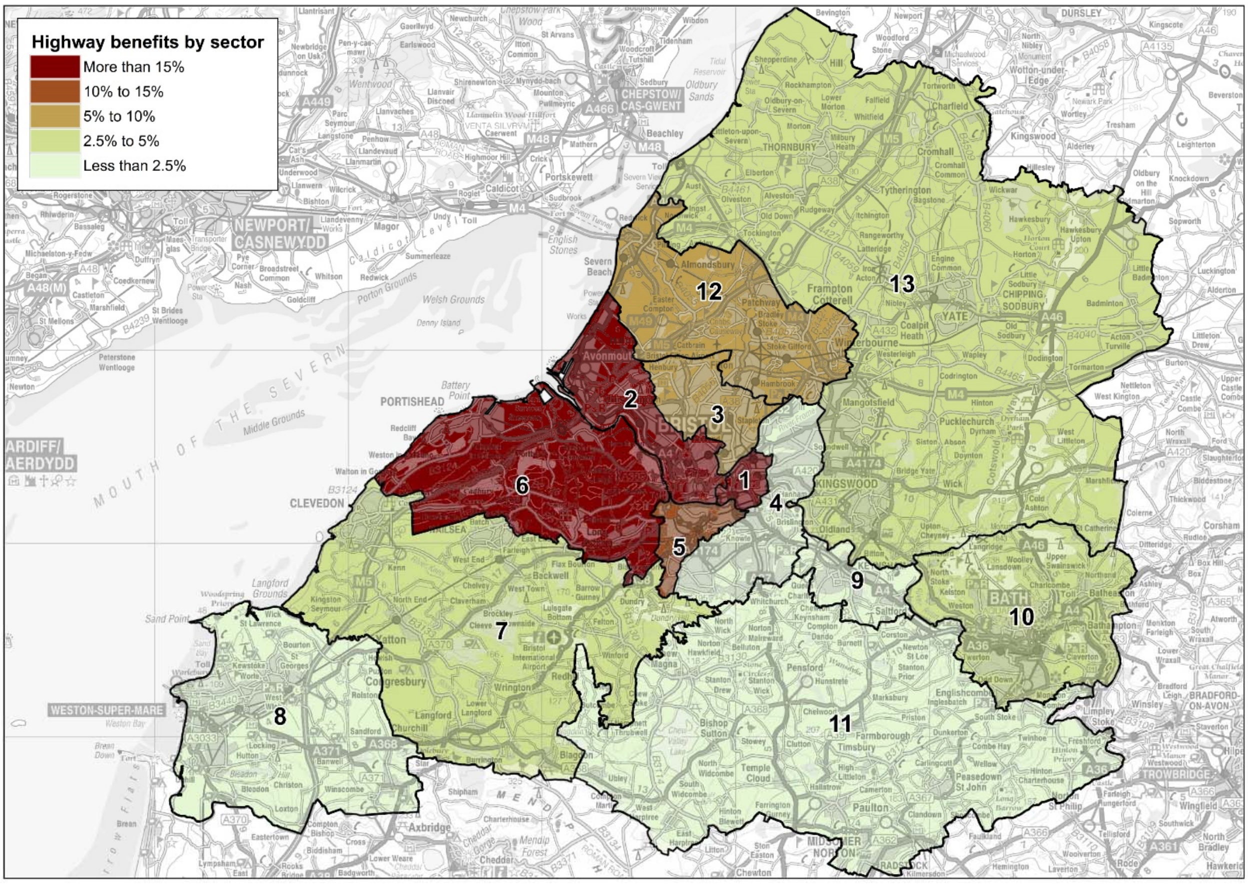


Figure 4-1: Spatial distribution of highway benefits – based on origin sector

SECTION 5

Summary

5.1 Results

A methodology has been employed that makes best use of approaches accepted by the rail industry, in the form of a rail demand model, and the GBATS4 multi-modal model. The methodology is in accordance with both WebTAG and Guide to Railway Investment Projects (GRIP) demand forecasting requirements.

This report has presented:

- Rail demand forecasts for both existing and new stations;
- Highway network impacts; and
- Highway user benefits.

Overall, MetroWest Phase 1 could add a net total of over 950,000 journeys in 2021 (almost 1.3m in 2036). Service improvements at existing stations are forecast to generate over 600,000 new rail trips in 2021, rising to over 800,000 in 2036. At new stations, demand forecasts indicate that around 320,000 passengers would use the proposed station at Portishead in 2021, rising to over 430,000 by 2036. Pill station generates over 53,000 users in 2021, and over 72,000 in 2036. Benchmarking indicates that the demand forecast for Portishead and Pill is in line with expectations for stations of their size and catchment, with the services provide. With an hourly service, while initially there is sufficient capacity, there is however scope for crowding from 2030 onwards. This could be alleviated through operator initiatives to distribute demand across the day if services to Portishead remain at 1 train per hour. More pertinently though, if proposals to run ‘infill’ peak time services are achieved, this would provide enhanced capacity and more closely spaced peak services. Further investigations are being undertaken into introducing ‘infill’ services that would provide two departures during the peak hour, at broadly 45 minute intervals.

Note though that the forecast growth rates, and the resulting forecasts of demand and revenue, assumed can be considered comparatively conservative, in that they do not explicitly take into the potential for a new Great Western franchise to generate new demand, or furthermore take account the opportunity for initiatives such as smart ticketing to generate new demand, particularly at off-peak times.

Highway network impacts show that total car-km on the network (modelled in GBATS4) could reduce by over 4,000 in the AM peak, and around 2,000 in the PM peak with smaller reductions in the inter-peak (values are similar in 2021 and 2036 as a result of the congested network). Combining the mode results over time results in a net present value of highway user benefits of some £50.1m. A net reduction in tax revenues, and consequent impact on fuel duty paid to the exchequer, of around £12.7m is expected due to reduced fuel consumption.

The final combined economic appraisal results are presented in the MetroWest Phase 1 OBC Economic Assessment Report, and Outline Business Case Economic Case chapter.

Appendix A
Financial profiles

Financial Profile – OBC scheme, showing the effects of operating cost risks

FIRST 3 YEARS' OPERATION >>>	no op cost risk	incl mobilisation	50% GWR op cost risk	incl mobilisation	100% GWR op cost risk	incl mobilisation	PBC Scheme - Option 5B
Revenue	£14,505,382	£14,505,382	£14,505,382	£14,505,382	£14,505,382	£14,505,382	£16,071,747
Operating cost	£15,079,376	£16,958,235	£16,574,409	£18,702,962	£18,069,441	£20,447,688	£21,368,397
Surplus / Subsidy	-£573,994	-£2,452,852	-£2,069,027	-£4,197,579	-£3,564,059	-£5,942,306	-£5,296,649

costs and revenues are nominal values for the years indicated, including demand growth and real-terms increases in cost elements and fares

OBC Scheme : no operating cost risk elements included

initial	3-yr total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	£14,505,382	-	-	-	-	£4,385,200	£4,830,408	£5,289,775	£5,627,691	£5,981,376	£6,354,164	£6,746,866	£7,160,311	£7,595,351	£8,052,854
Operating Cost	£15,079,376	-	-	-	-	£4,889,940	£5,023,130	£5,166,307	£5,320,182	£5,485,542	£5,656,618	£5,833,627	£6,016,795	£6,206,357	£6,402,556
Surplus / Subsidy	-£573,994	-	-	-	-	-£504,740	-£192,722	£123,468	£307,509	£495,835	£697,547	£913,239	£1,143,516	£1,388,995	£1,650,298

with mobilisation	3-yr total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	£14,505,382	-	-	-	-	£4,385,200	£4,830,408	£5,289,775	£5,627,691	£5,981,376	£6,354,164	£6,746,866	£7,160,311	£7,595,351	£8,052,854
Operating Cost	£16,958,235	-	-	£331,463	£1,547,395	£4,889,940	£5,023,130	£5,166,307	£5,320,182	£5,485,542	£5,656,618	£5,833,627	£6,016,795	£6,206,357	£6,402,556
Surplus / Subsidy	-£2,452,852	-	-	-£331,463	-£1,547,395	-£504,740	-£192,722	£123,468	£307,509	£495,835	£697,547	£913,239	£1,143,516	£1,388,995	£1,650,298

OBC Scheme : 50% GWR operating cost risks included

initial	3-yr total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	£14,505,382	-	-	-	-	£4,385,200	£4,830,408	£5,289,775	£5,627,691	£5,981,376	£6,354,164	£6,746,866	£7,160,311	£7,595,351	£8,052,854
Operating Cost	£16,574,409	-	-	-	-	£5,372,299	£5,521,040	£5,681,070	£5,853,201	£6,038,333	£6,229,970	£6,428,363	£6,633,772	£6,846,466	£7,066,728
Surplus / Subsidy	-£2,069,027	-	-	-	-	-£987,099	-£690,632	-£391,295	-£225,510	-£56,956	£124,194	£318,503	£526,540	£748,885	£986,126

with mobilisation	3-yr total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	£14,505,382	-	-	-	-	£4,385,200	£4,830,408	£5,289,775	£5,627,691	£5,981,376	£6,354,164	£6,746,866	£7,160,311	£7,595,351	£8,052,854
Operating Cost	£18,702,962	-	-	£389,383	£1,739,170	£5,372,299	£5,521,040	£5,681,070	£5,853,201	£6,038,333	£6,229,970	£6,428,363	£6,633,772	£6,846,466	£7,066,728
Surplus / Subsidy	-£4,197,579	-	-	-£389,383	-£1,739,170	-£987,099	-£690,632	-£391,295	-£225,510	-£56,956	£124,194	£318,503	£526,540	£748,885	£986,126

OBC Scheme : 100% GWR operating cost risks included

initial	3-yr total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	£14,505,382	-	-	-	-	£4,385,200	£4,830,408	£5,289,775	£5,627,691	£5,981,376	£6,354,164	£6,746,866	£7,160,311	£7,595,351	£8,052,854
Operating Cost	£18,069,441	-	-	-	-	£5,854,657	£6,018,951	£6,195,833	£6,386,220	£6,591,124	£6,803,323	£7,023,100	£7,250,749	£7,486,576	£7,730,901
Surplus / Subsidy	-£3,564,059	-	-	-	-	-£1,469,457	-£1,188,543	-£906,058	-£758,529	-£609,747	-£449,158	-£276,234	-£90,437	£108,775	£321,953

with mobilisation	3-yr total	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	£14,505,382	-	-	-	-	£4,385,200	£4,830,408	£5,289,775	£5,627,691	£5,981,376	£6,354,164	£6,746,866	£7,160,311	£7,595,351	£8,052,854
Operating Cost	£20,447,688	-	-	£447,303	£1,930,944	£5,854,657	£6,018,951	£6,195,833	£6,386,220	£6,591,124	£6,803,323	£7,023,100	£7,250,749	£7,486,576	£7,730,901
Surplus / Subsidy	-£5,942,306	-	-	-£447,303	-£1,930,944	-£1,469,457	-£1,188,543	-£906,058	-£758,529	-£609,747	-£449,158	-£276,234	-£90,437	£108,775	£321,953

PBC Scheme - Option 5B

	3-yr total	2017	2018	2019	2020	2021	2022
Revenue	£16,071,747	-	-	£4,971,196	£5,354,562	£5,745,990	£6,154,918
Operating Cost	£21,368,397	-	-	£6,825,409	£7,123,123	£7,419,865	£7,729,389
Surplus / Subsidy	-£5,296,649	-	-	-£1,854,213	-£1,768,562	-£1,673,875	-£1,574,472

costs and revenues are nominal values for the years indicated, including demand growth and real-terms increases in cost elements and fares

Appendix B
Saturn highway plots

Saturn highway plots

- Figure B1 – AM Peak Change from 2013 Base to the 2021 Do Minimum
- Figure B2 – AM Peak Change from 2013 Base to the 2036 Do Minimum
- Figure B3 – AM Peak Change from 2021 Do Minimum to the 2021 Scheme scenario
- Figure B4 – AM Peak Change from 2036 Do Minimum to the 2036 Scheme scenario
- Figure B5 – IP Change from 2013 Base to the 2021 Do Minimum
- Figure B6 – IP Change from 2013 Base to the 2036 Do Minimum
- Figure B7 – IP Change from 2021 Do Minimum to the 2021 Scheme scenario
- Figure B8 – IP Peak Change from 2036 Do Minimum to the 2036 Scheme scenario
- Figure B9 – PM Peak Change from 2013 Base to the 2021 Do Minimum
- Figure B10 – PM Peak Change from 2013 Base to the 2036 Do Minimum
- Figure B11 – PM Peak Change from 2021 Do Minimum to the 2021 Scheme scenario
- Figure B12 – PM Peak Change from 2036 Do Minimum to the 2036 Scheme scenario
- Figure B13 – AM Peak Base year – congestion at nodes (delays per second)
- Figure B14 – AM Peak 2021 – Do Minimum – congestion at nodes (delays per second)
- Figure B15 – AM Peak 2021 – Scheme scenario – congestion at nodes (delays per second)
- Figure B16 – AM Peak 2036 – Do Minimum – congestion at nodes (delays per second)
- Figure B17 – AM Peak 2036 – Scheme scenario – congestion at nodes (delays per second)
- Figure B18 – IP Peak Base year – congestion at nodes (delays per second)
- Figure B19 – IP Peak 2021 – Do Minimum – congestion at nodes (delays per second)
- Figure B20 – IP Peak 2021 – Scheme scenario – congestion at nodes (delays per second)
- Figure B21 – IP Peak 2036 – Do Minimum – congestion at nodes (delays per second)
- Figure B22 – IP Peak 2036 – Scheme scenario – congestion at nodes (delays per second)
- Figure B23 – PM Peak Base year – congestion at nodes (delays per second)
- Figure B24 – PM Peak 2021 – Do Minimum – congestion at nodes (delays per second)
- Figure B25 – PM Peak 2021 – Scheme scenario – congestion at nodes (delays per second)
- Figure B26 – PM Peak 2036 – Do Minimum – congestion at nodes (delays per second)
- Figure B27 – PM Peak 2036 – Scheme scenario – congestion at nodes (delays per second)

FIGURE B1

AM Peak Change from 2013 Base to the 2021 Do Minimum

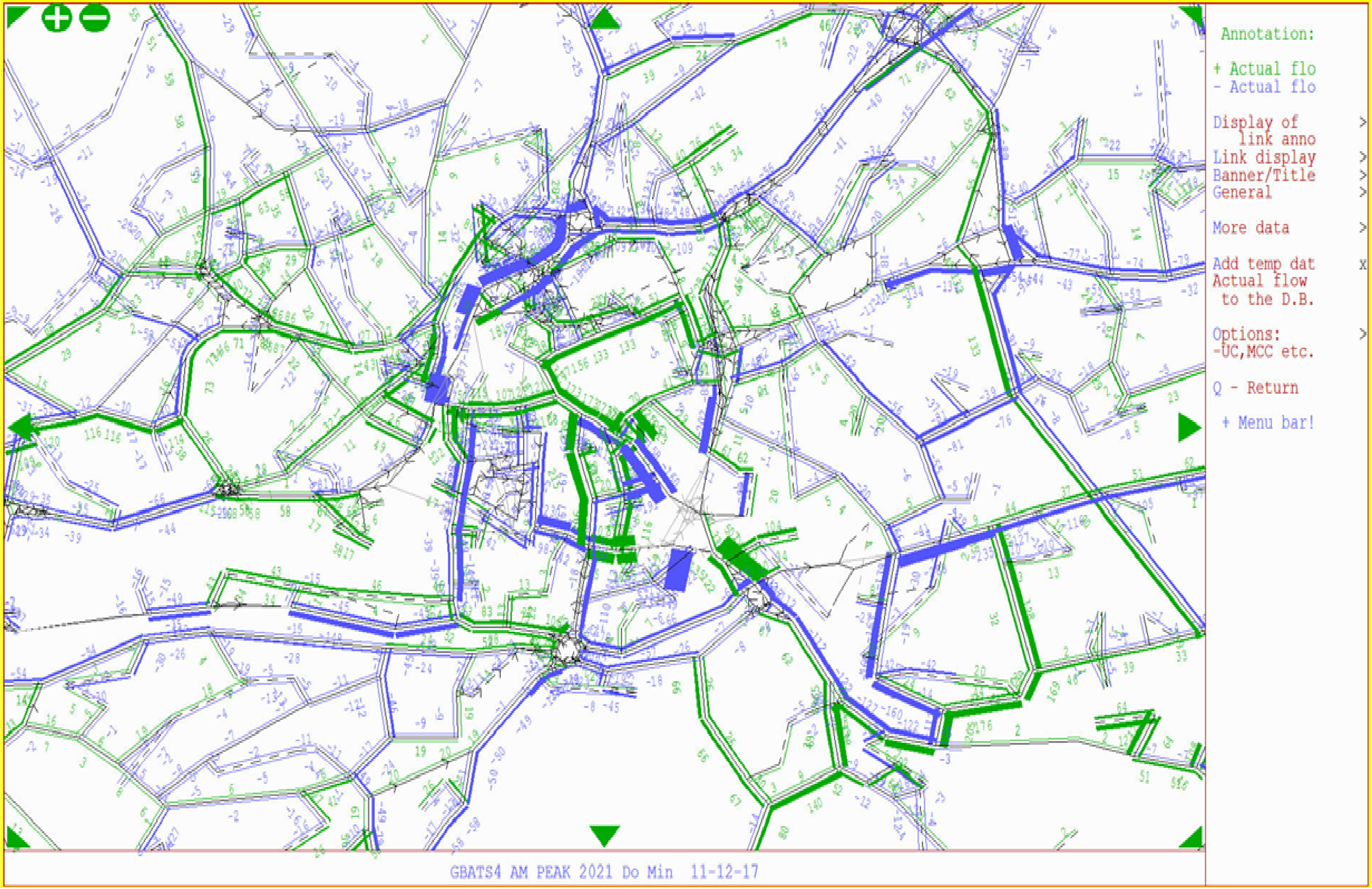


FIGURE B2

AM Peak Change from 2013 Base to the 2036 Do Minimum

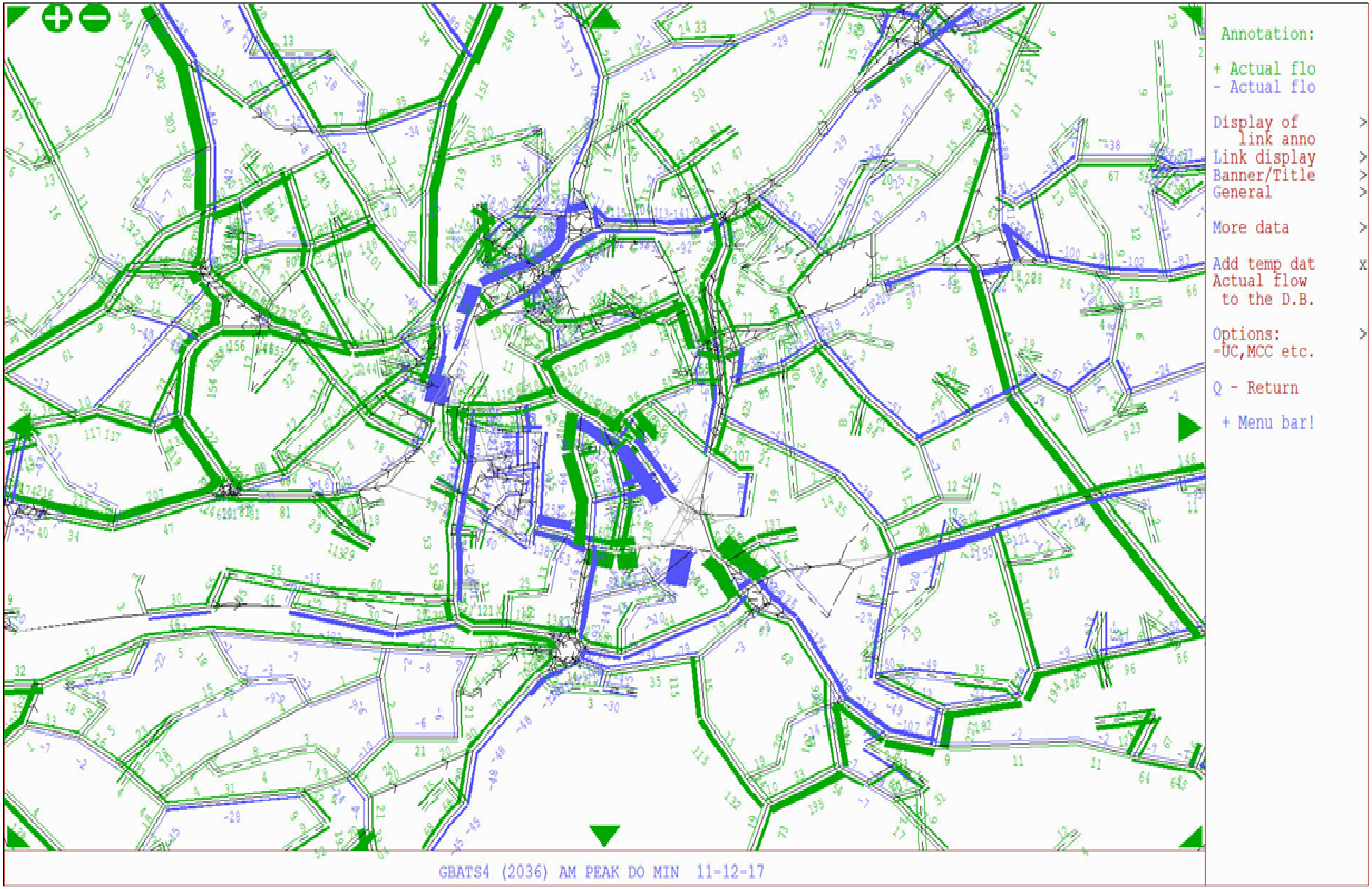


FIGURE B3

AM Peak Change from 2021 Do Minimum to the 2021 Scheme scenario

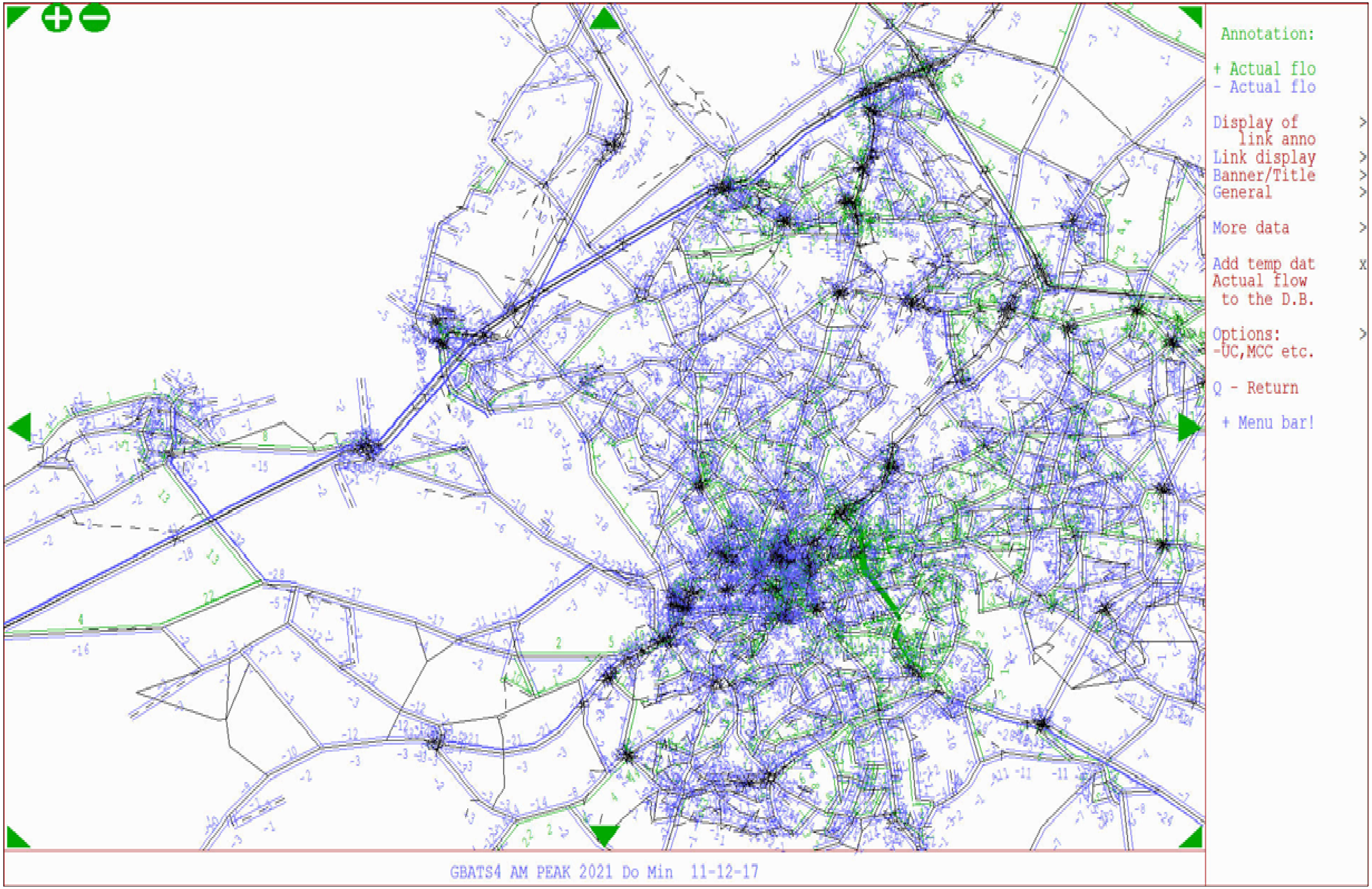


FIGURE B4

AM Peak Change from 2036 Do Minimum to the 2036 Scheme scenario

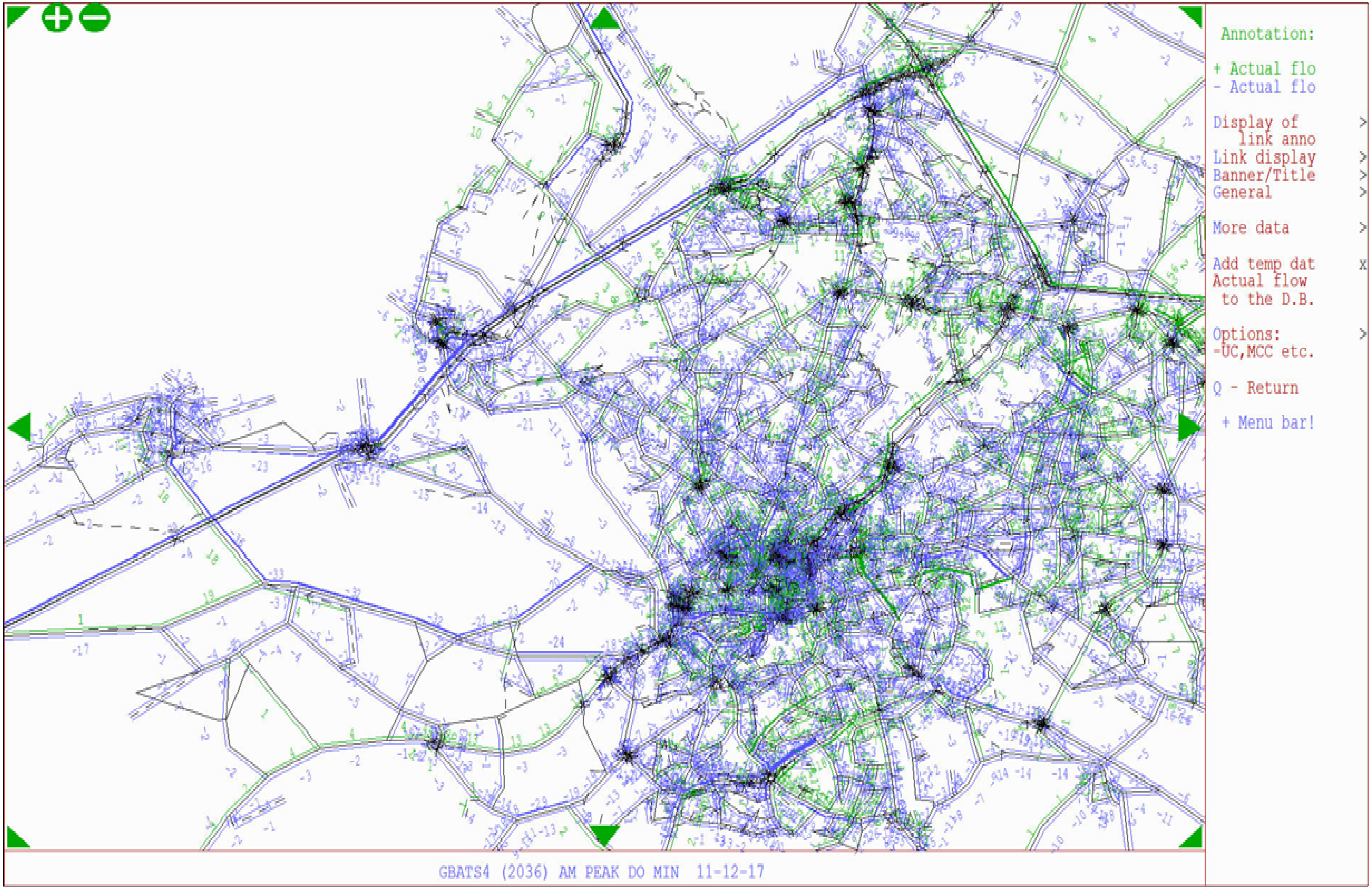


FIGURE B5

IP Change from 2013 Base to the 2021 Do Minimum

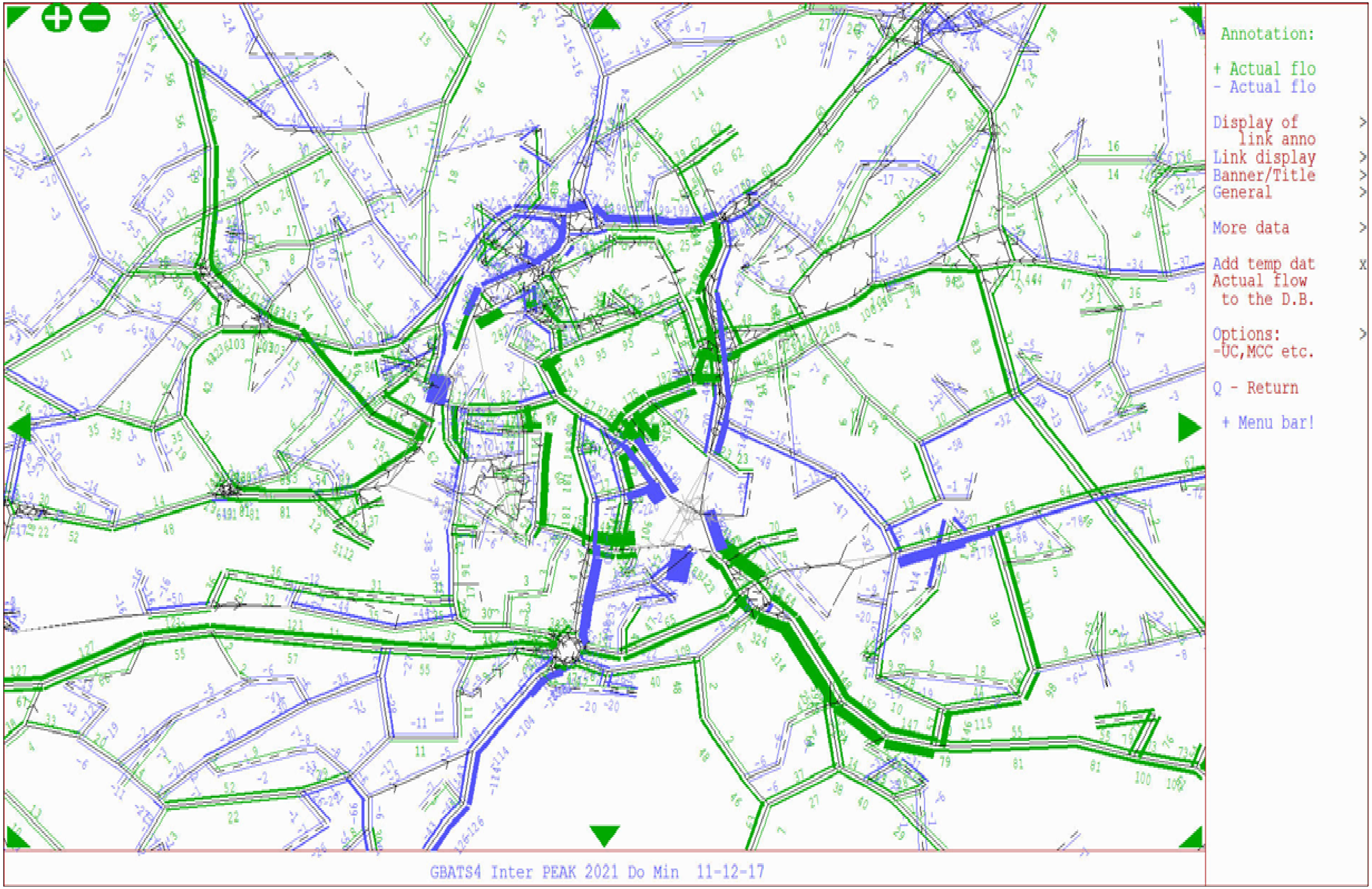


FIGURE B6

IP Change from 2013 Base to the 2036 Do Minimum

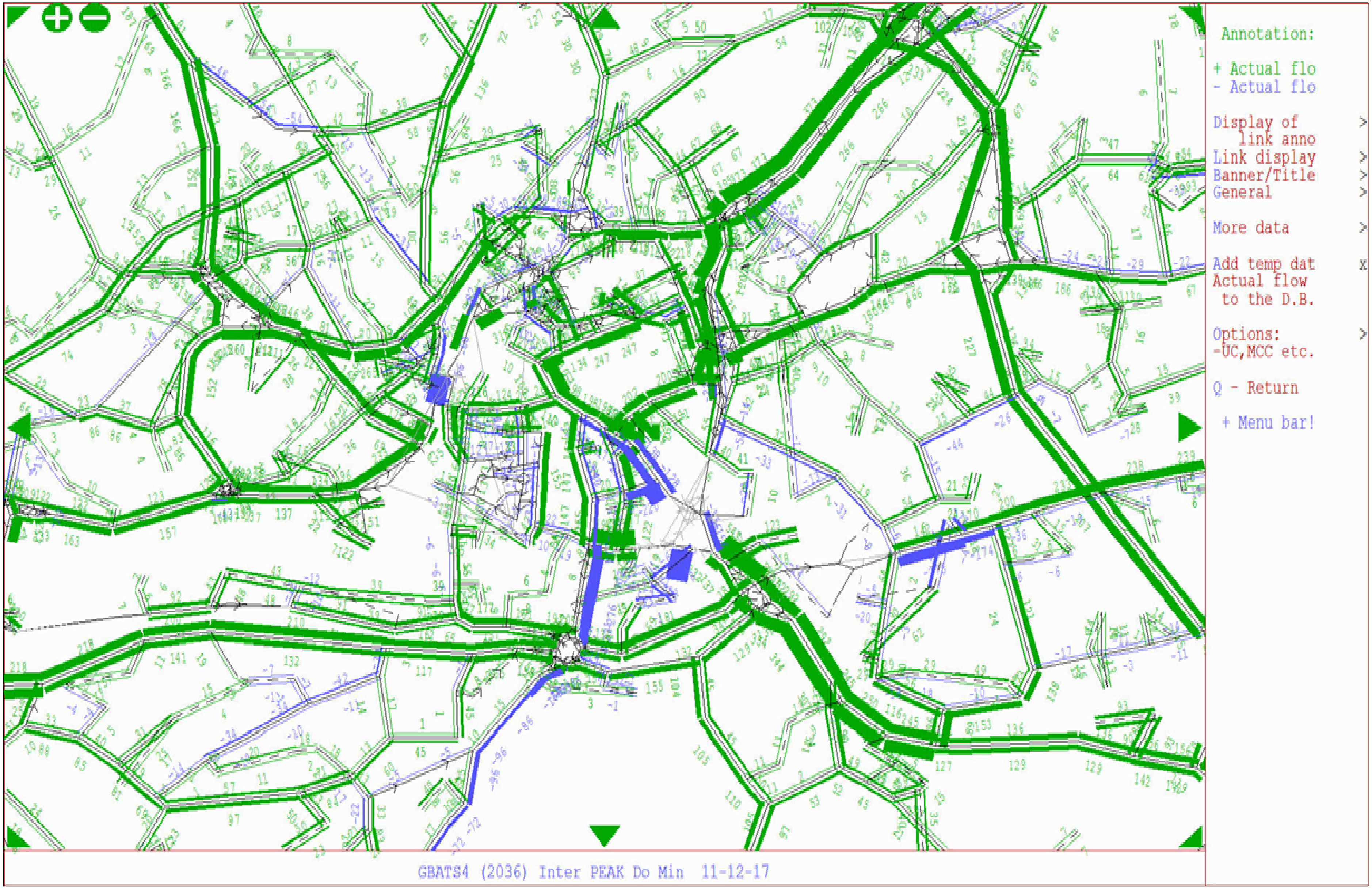


FIGURE B7

IP Change from 2021 Do Minimum to the 2021 Scheme scenario

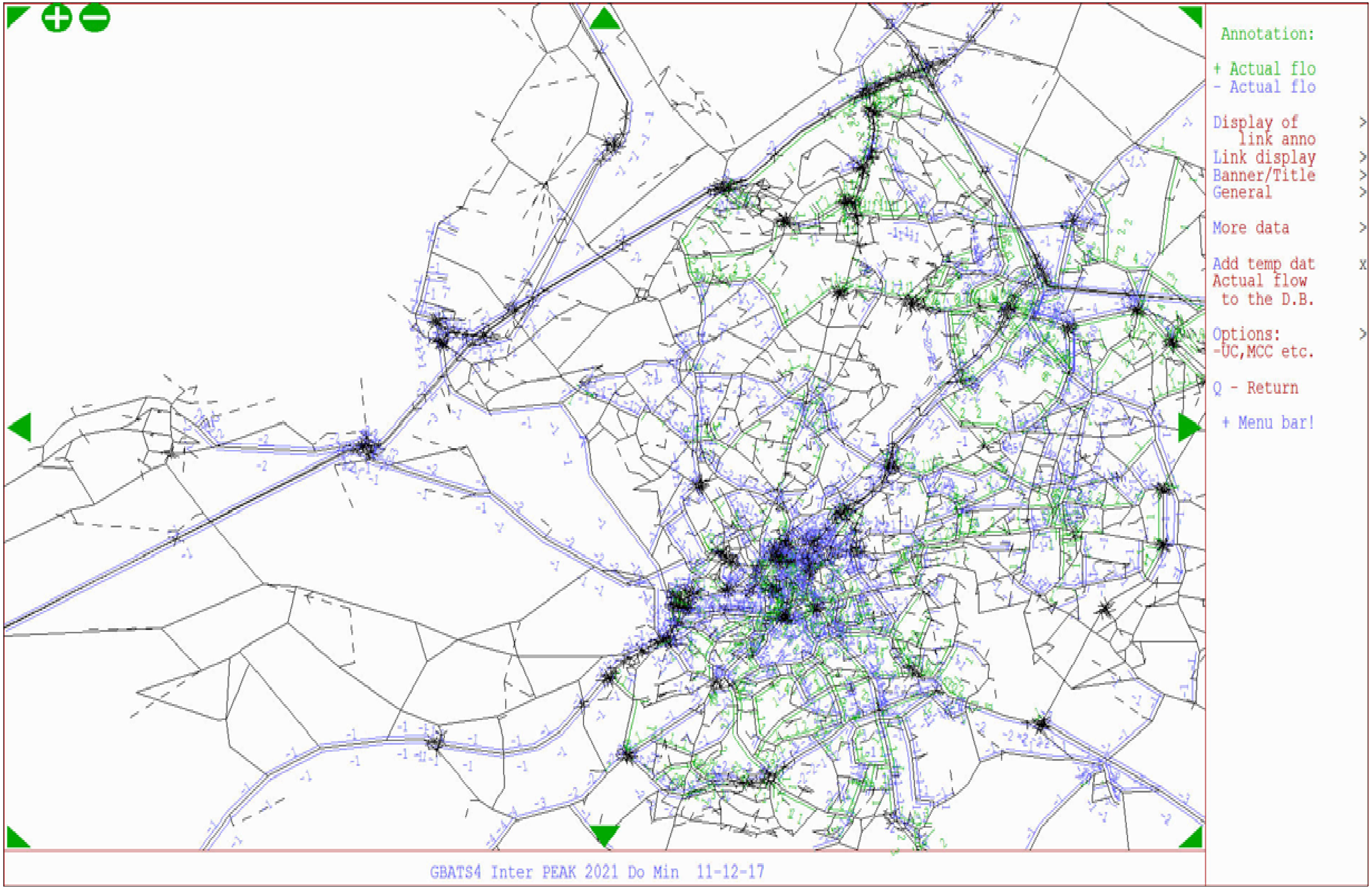


FIGURE B8

IP Peak Change from 2036 Do Minimum to the 2036 Scheme scenario

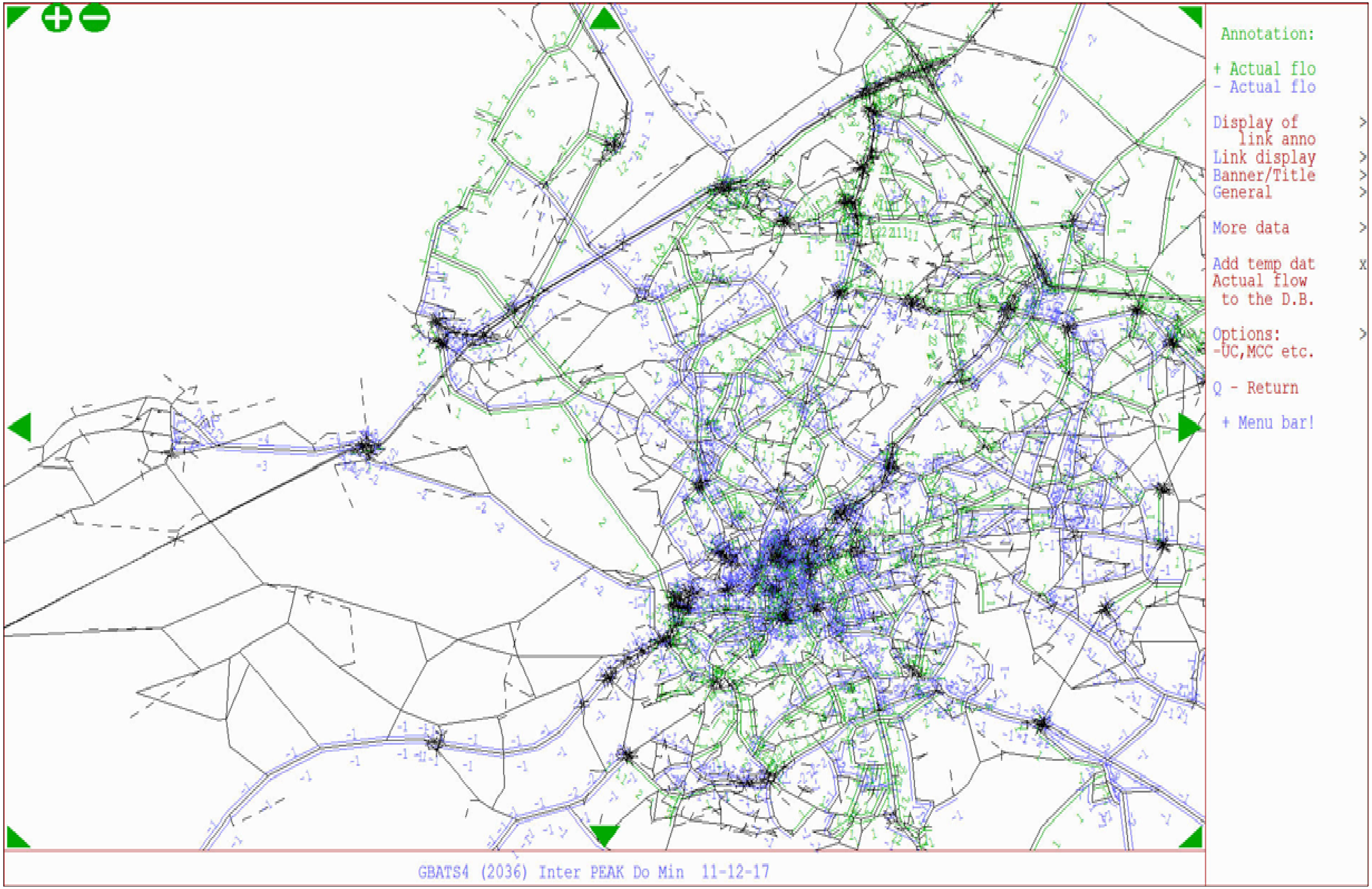


FIGURE B9

PM Peak Change from 2013 Base to the 2021 Do Minimum

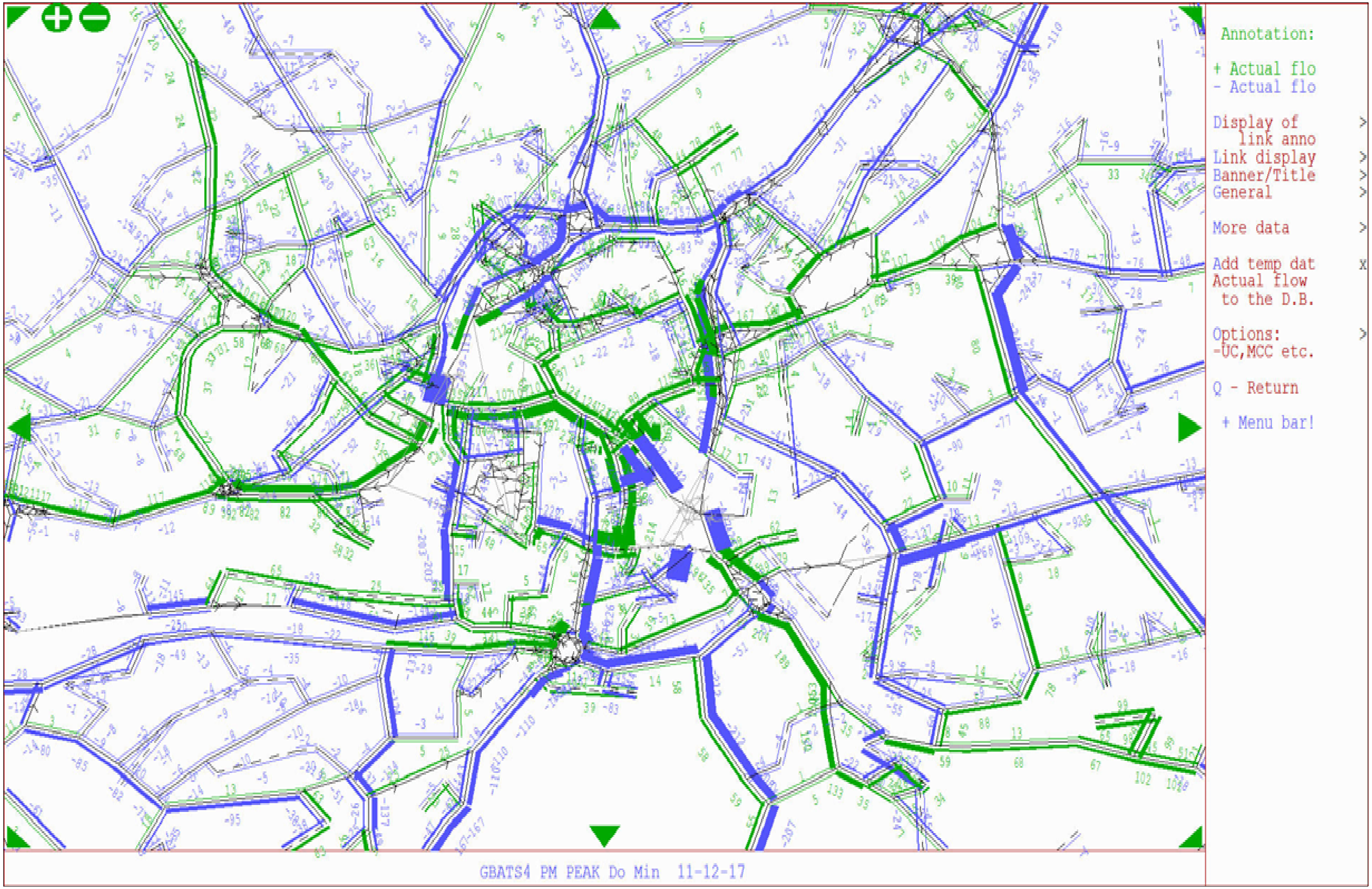


FIGURE B10

PM Peak Change from 2013 Base to the 2036 Do Minimum

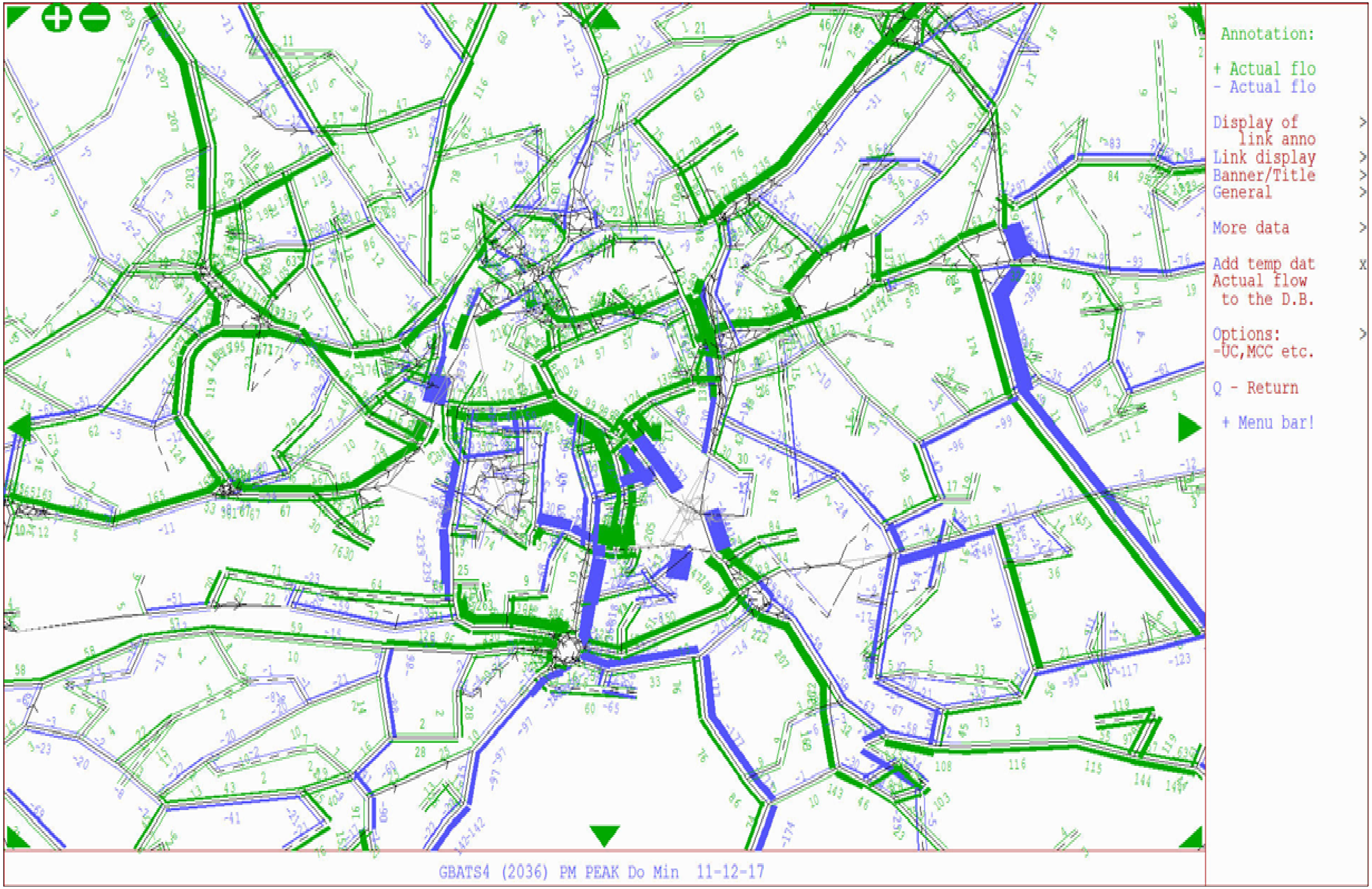


FIGURE B11

PM Peak Change from 2021 Do Minimum to the 2021 Scheme scenario

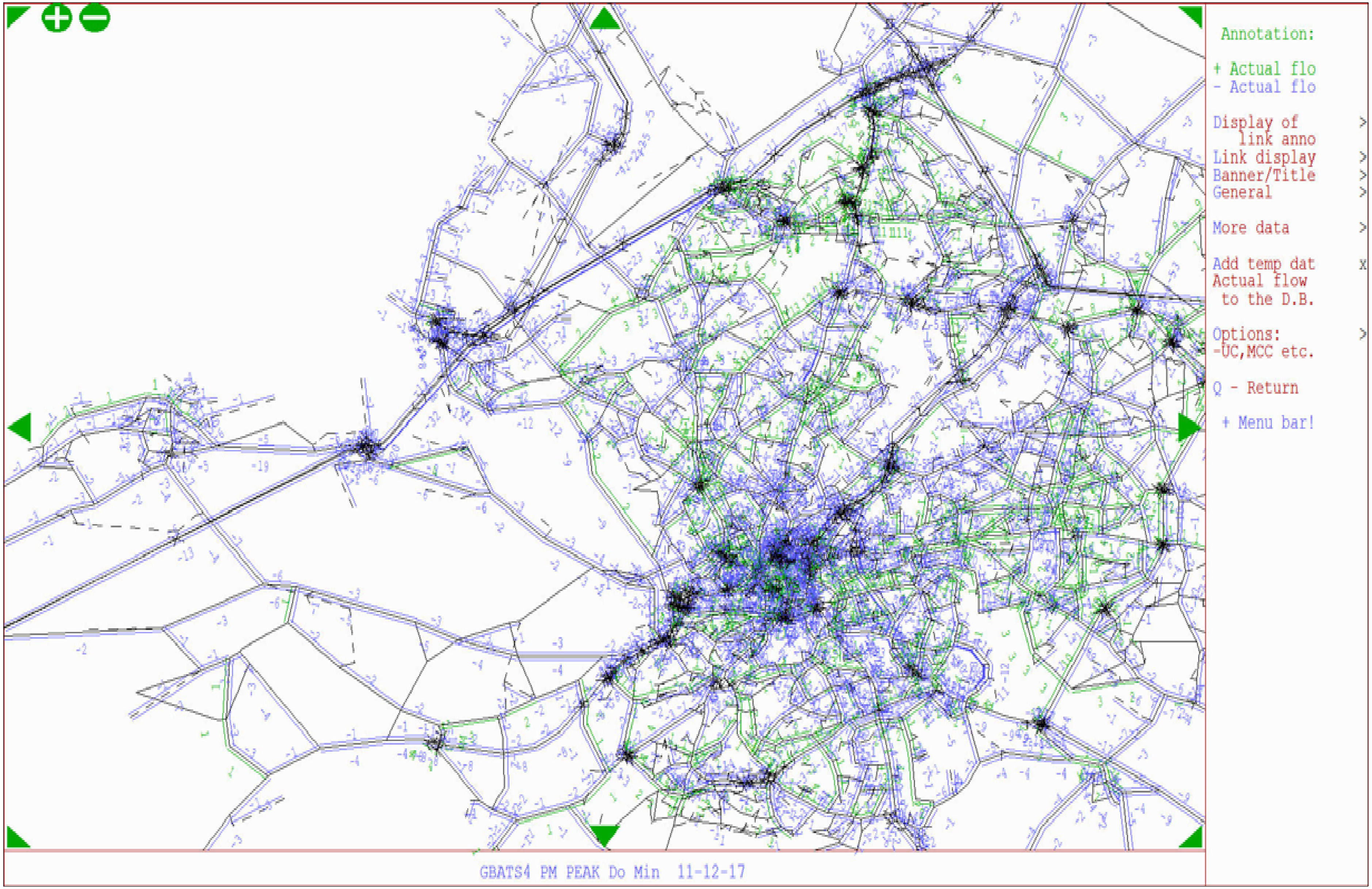


FIGURE B12

PM Peak Change from 2036 Do Minimum to the 2036 Scheme scenario

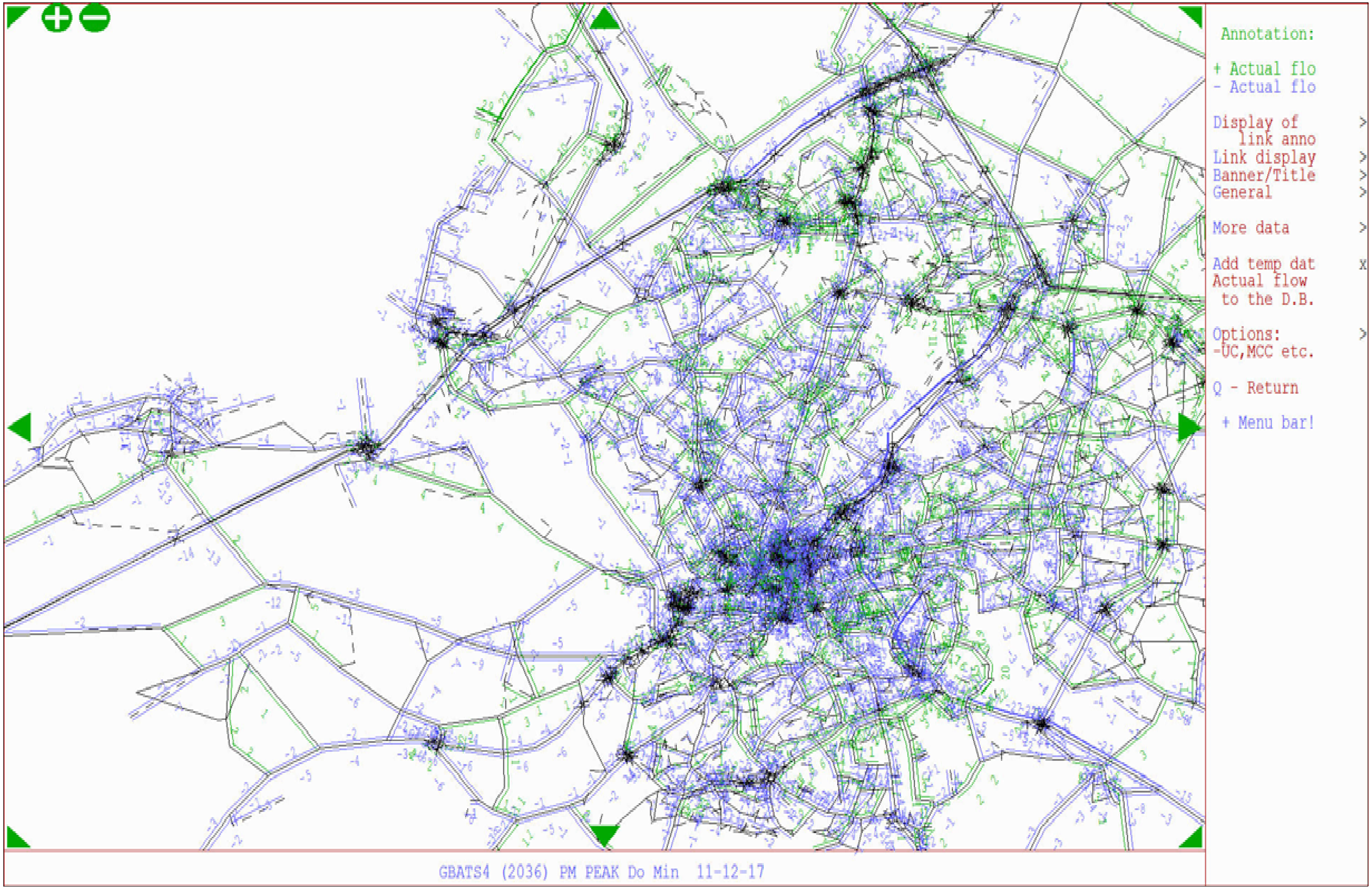


FIGURE B13

AM Peak Base year – congestion at nodes (delays per second)

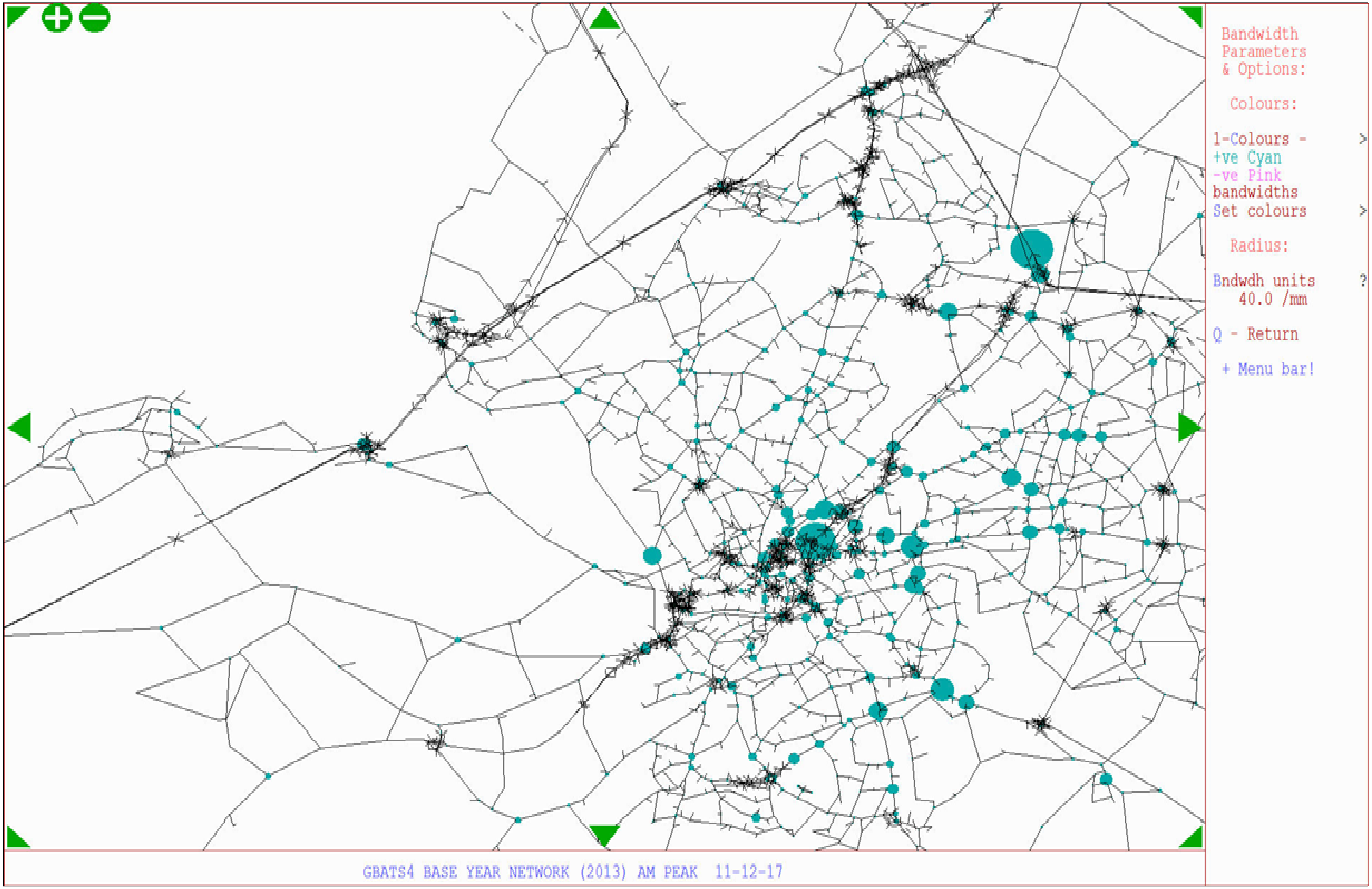


FIGURE B14

AM Peak 2021 – Do Minimum – congestion at nodes (delays per second)

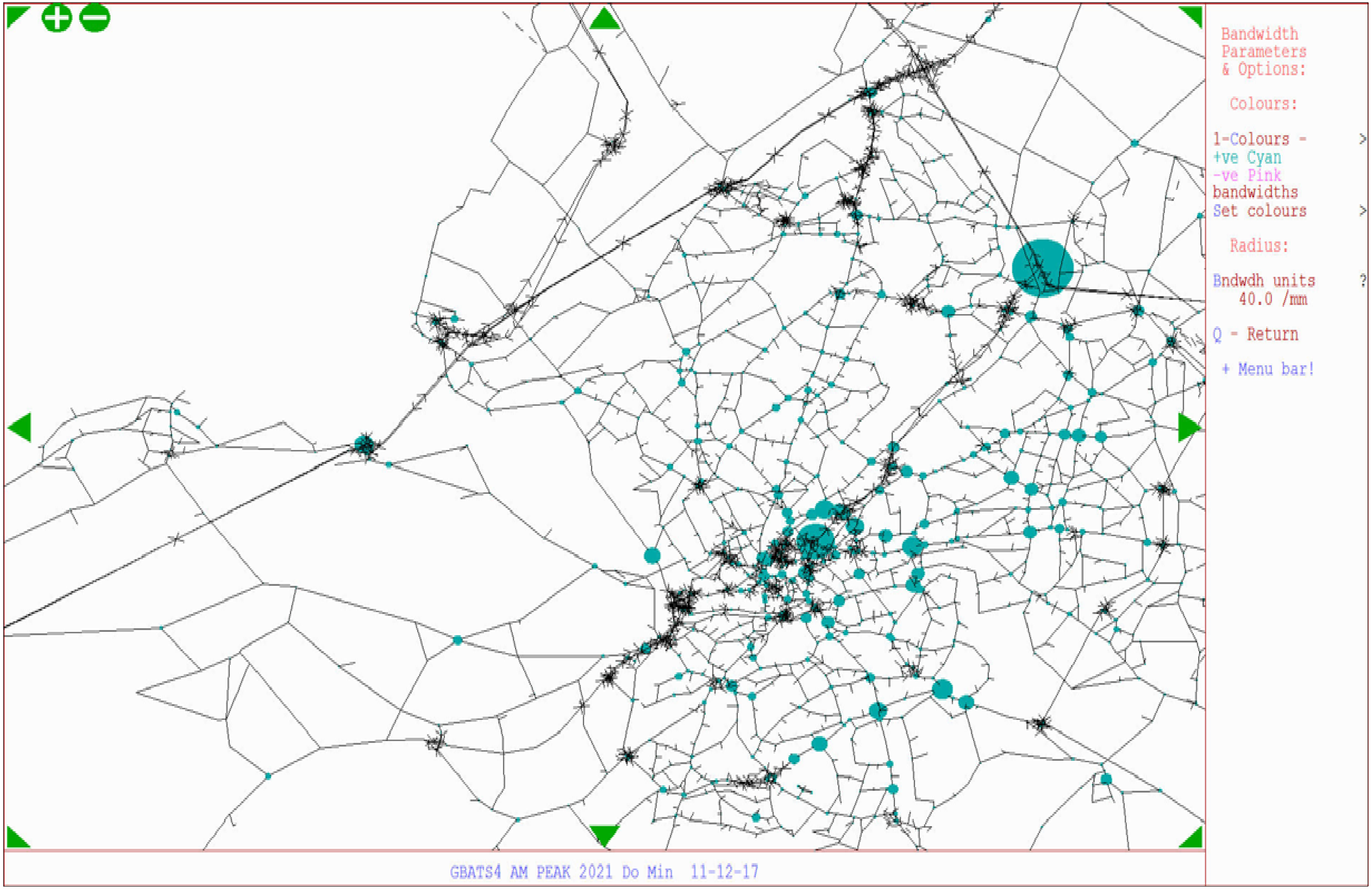


FIGURE B15

AM Peak 2021 – Scheme scenario – congestion at nodes (delays per second)

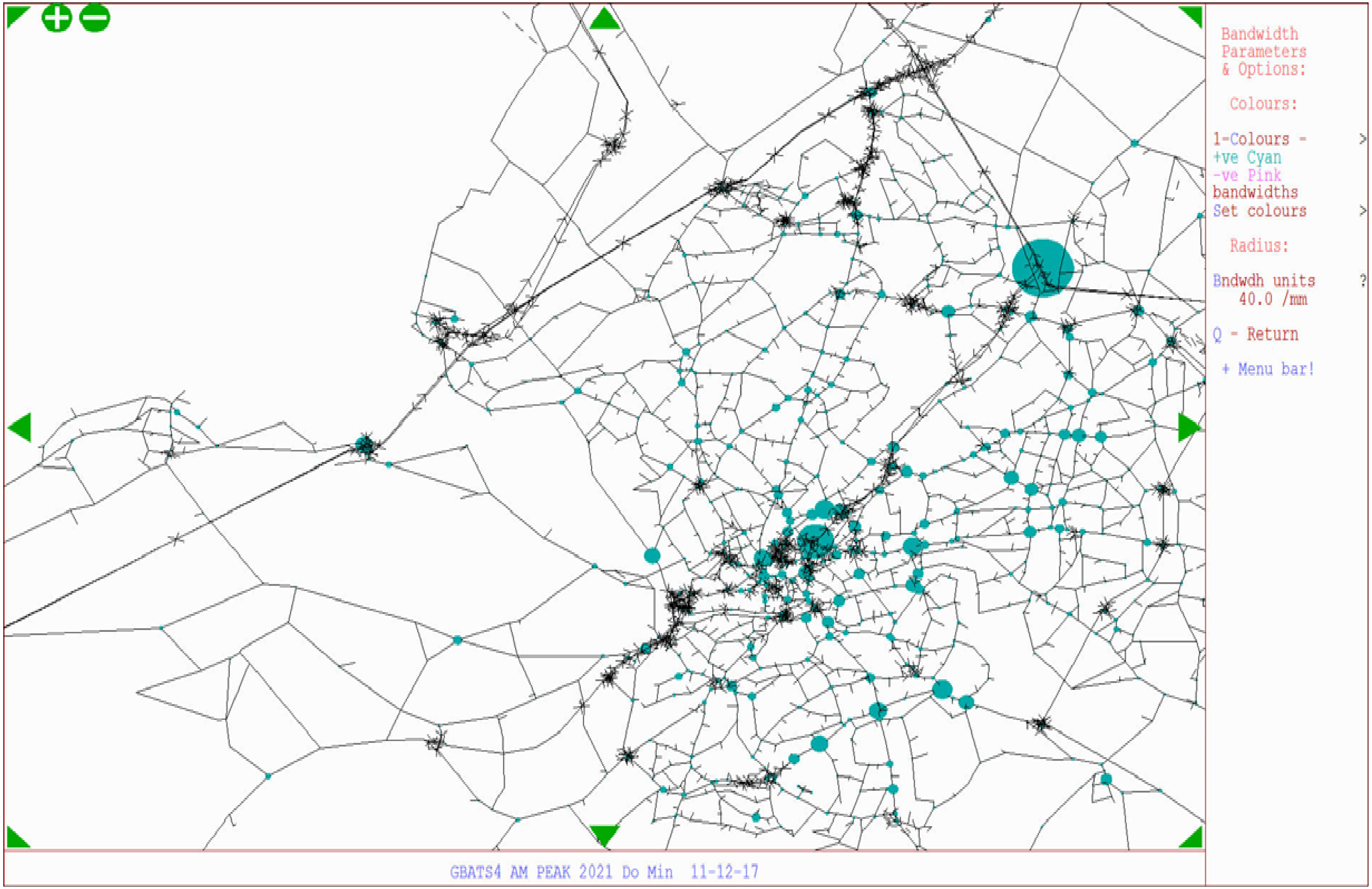


FIGURE B16

AM Peak 2036 – Do Minimum – congestion at nodes (delays per second)

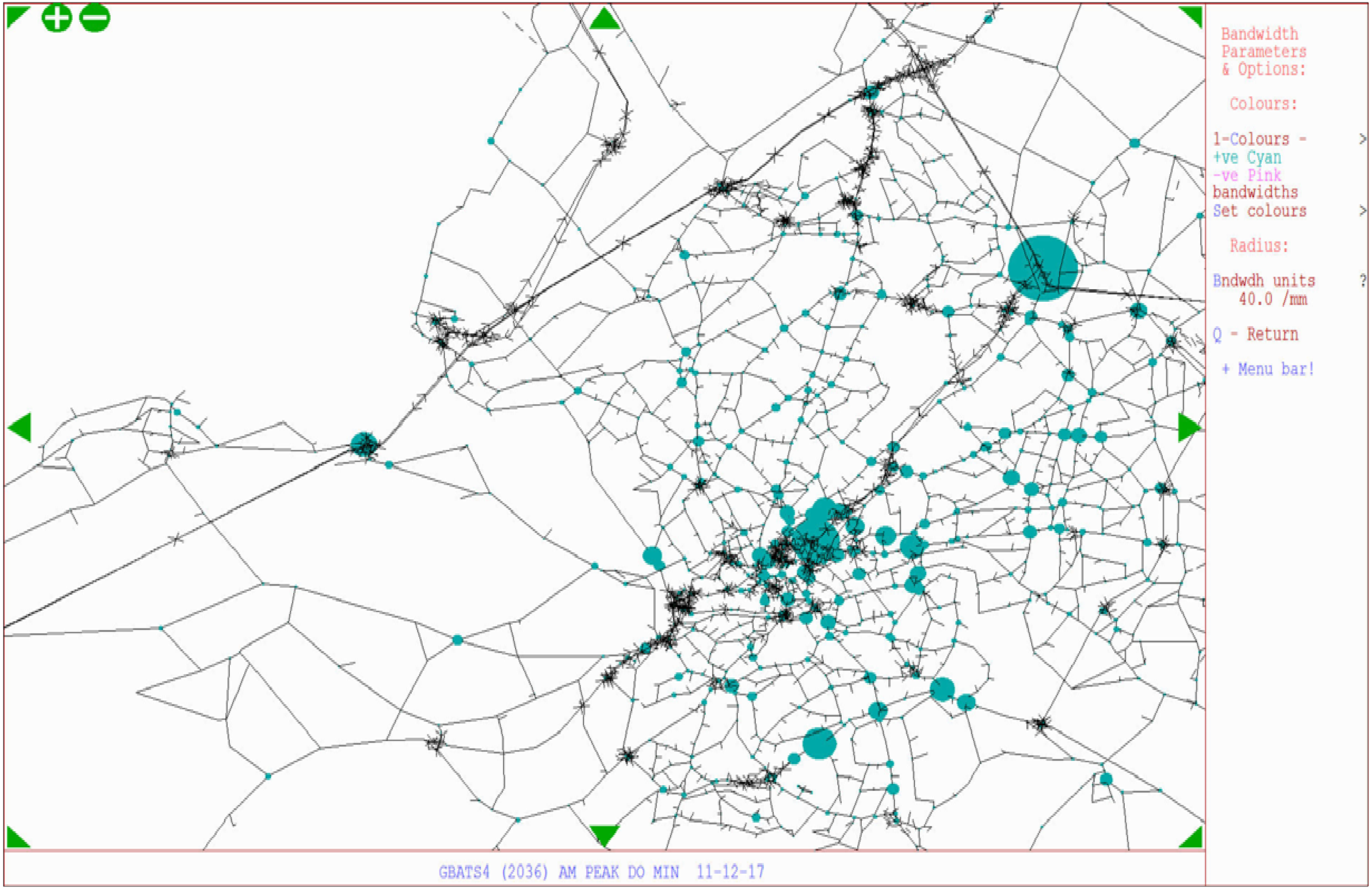


FIGURE B17

AM Peak 2036 – Scheme scenario – congestion at nodes (delays per second)

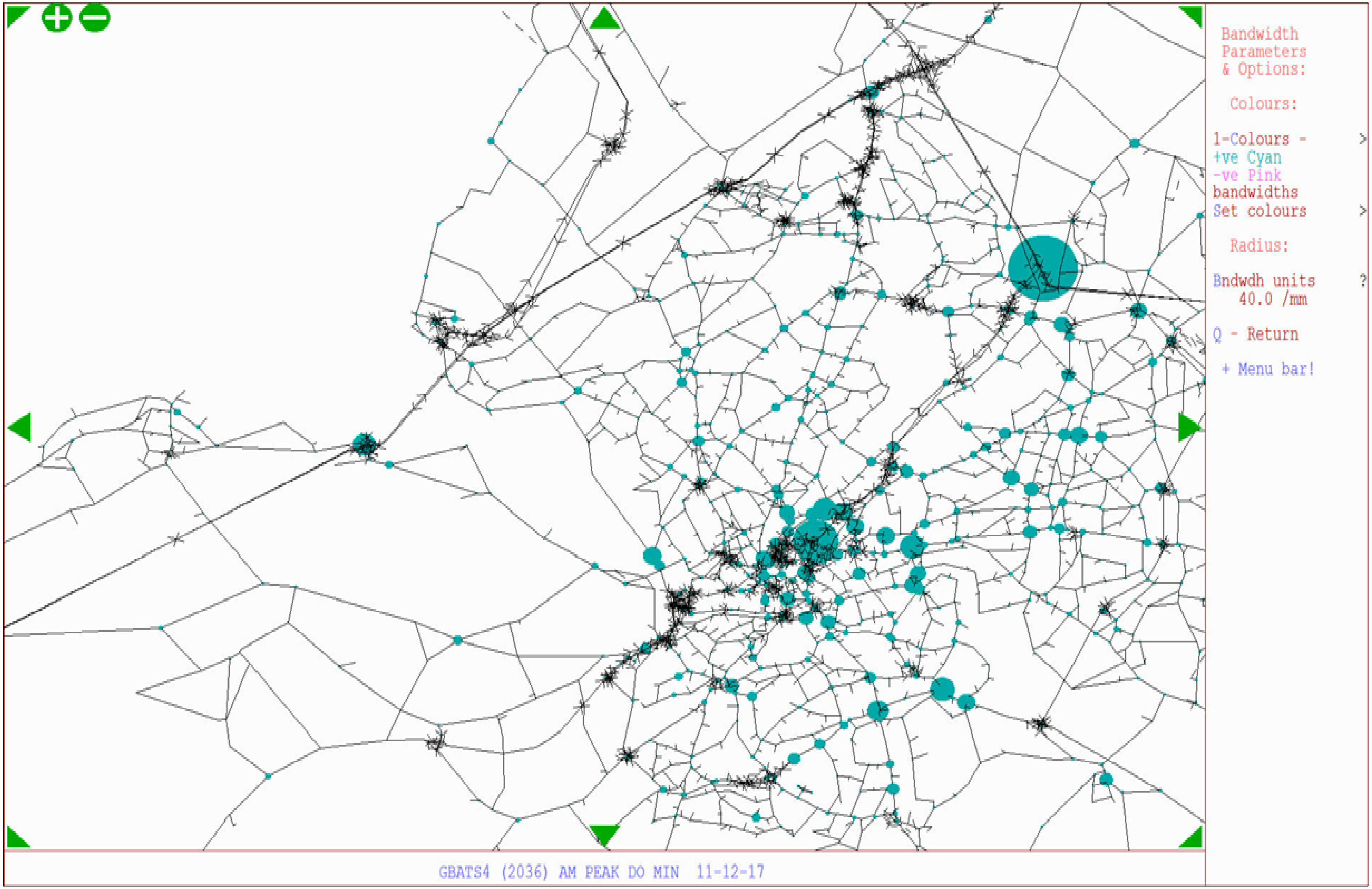


FIGURE B18

IP Peak Base year – congestion at nodes (delays per second)

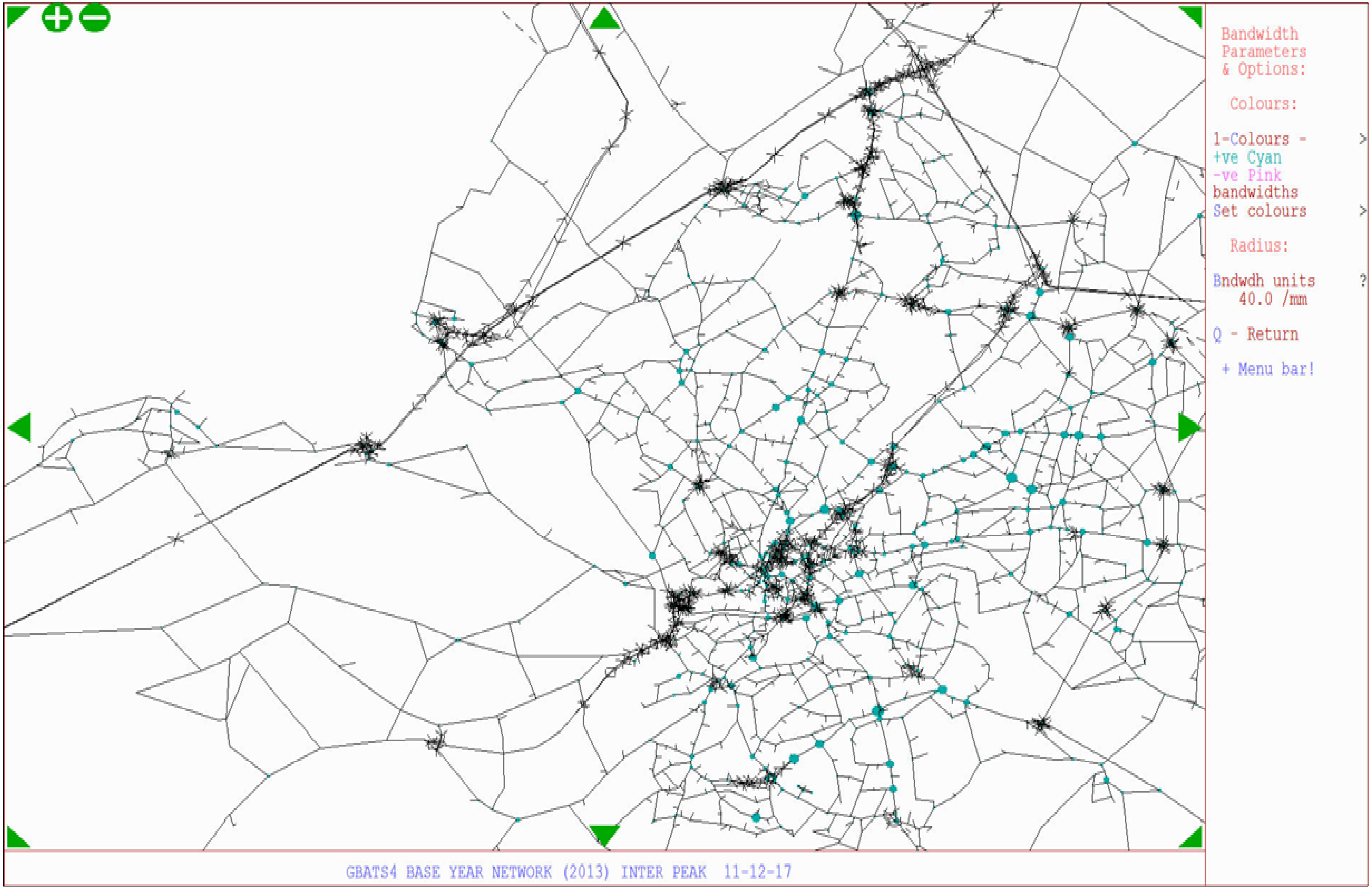


FIGURE B19

IP Peak 2021 – Do Minimum – congestion at nodes (delays per second)

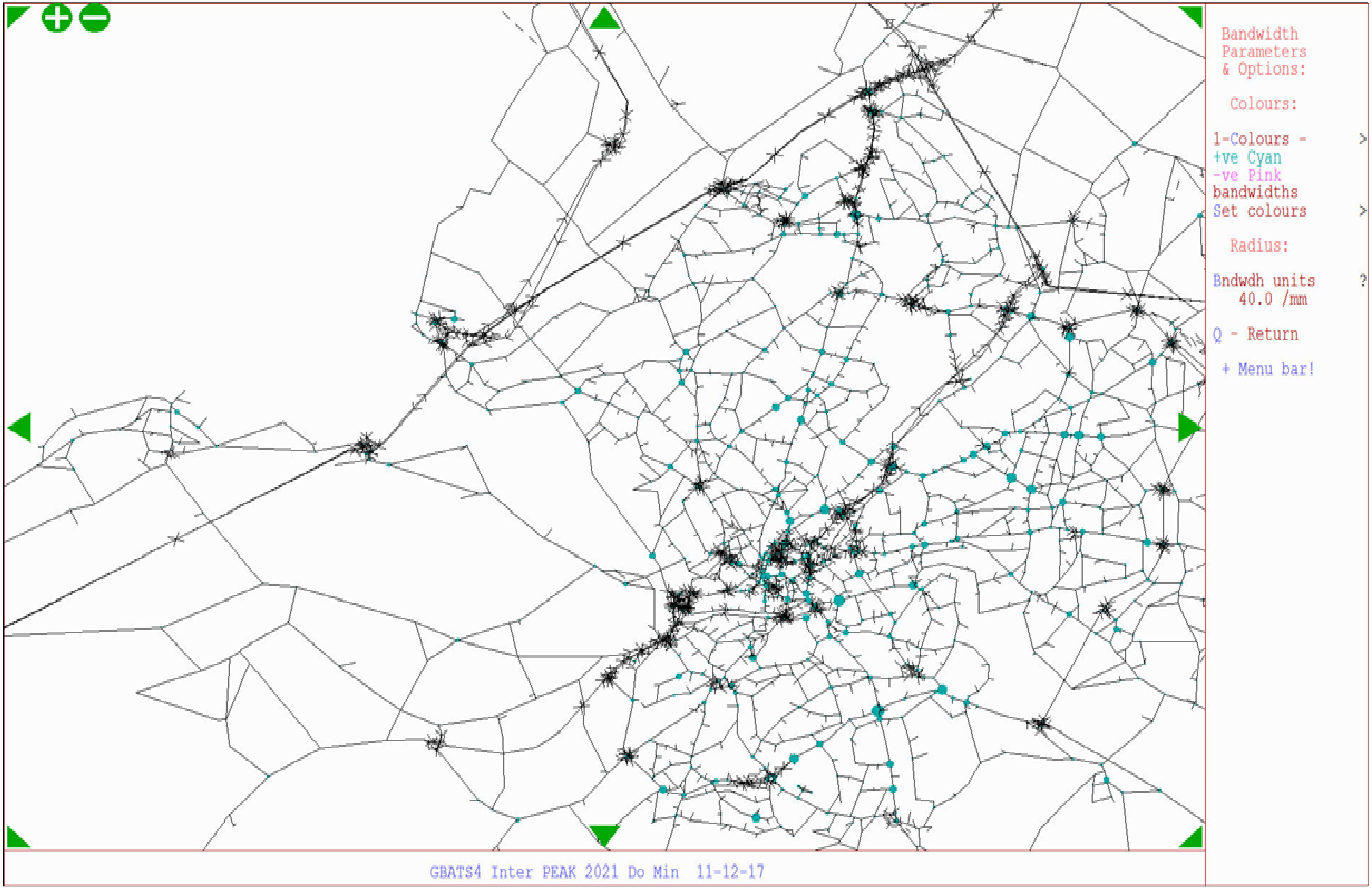


FIGURE B20

IP Peak 2021 – Scheme scenario – congestion at nodes (delays per second)

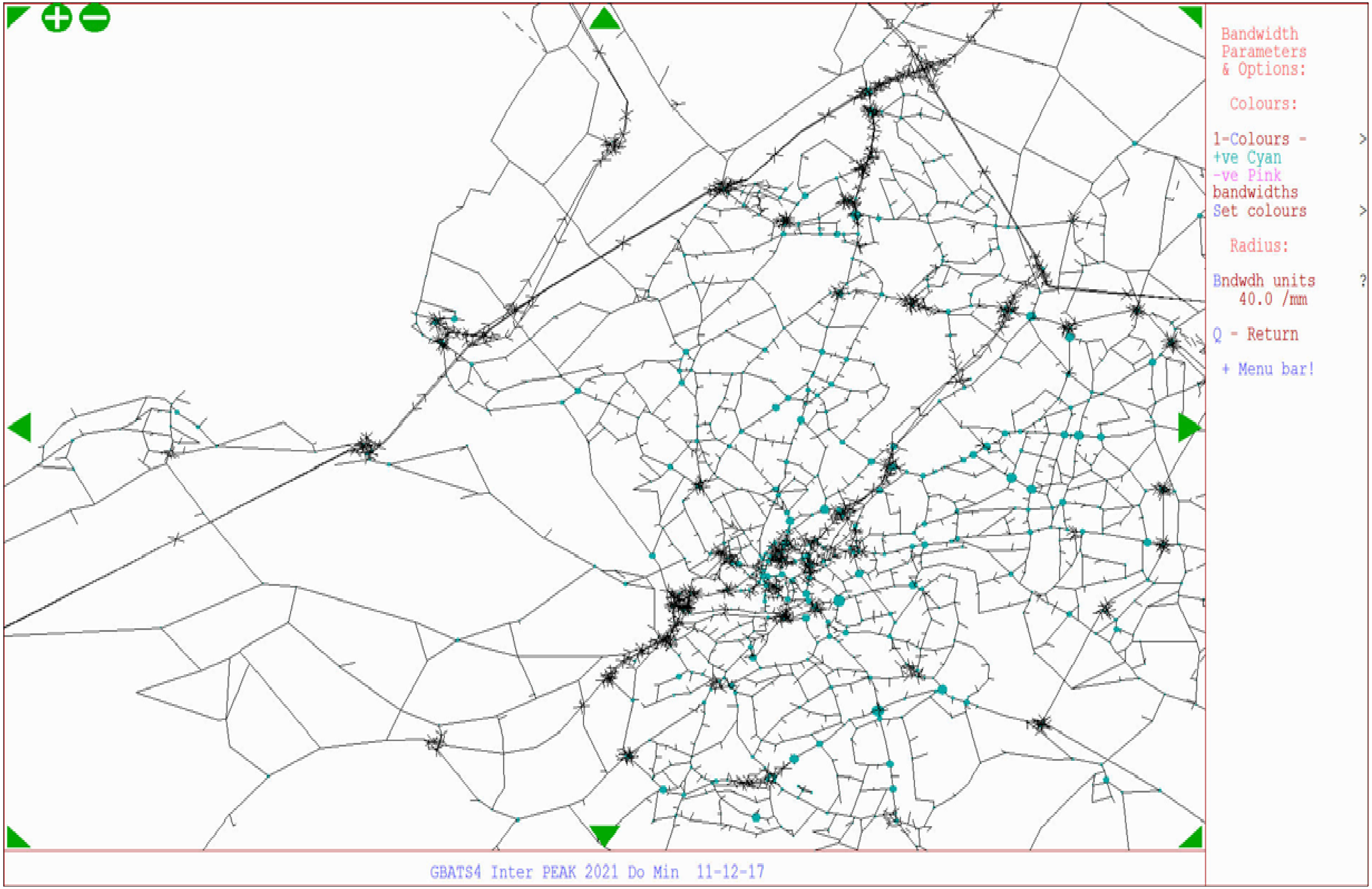


FIGURE B21

IP Peak 2036 – Do Minimum – congestion at nodes (delays per second)

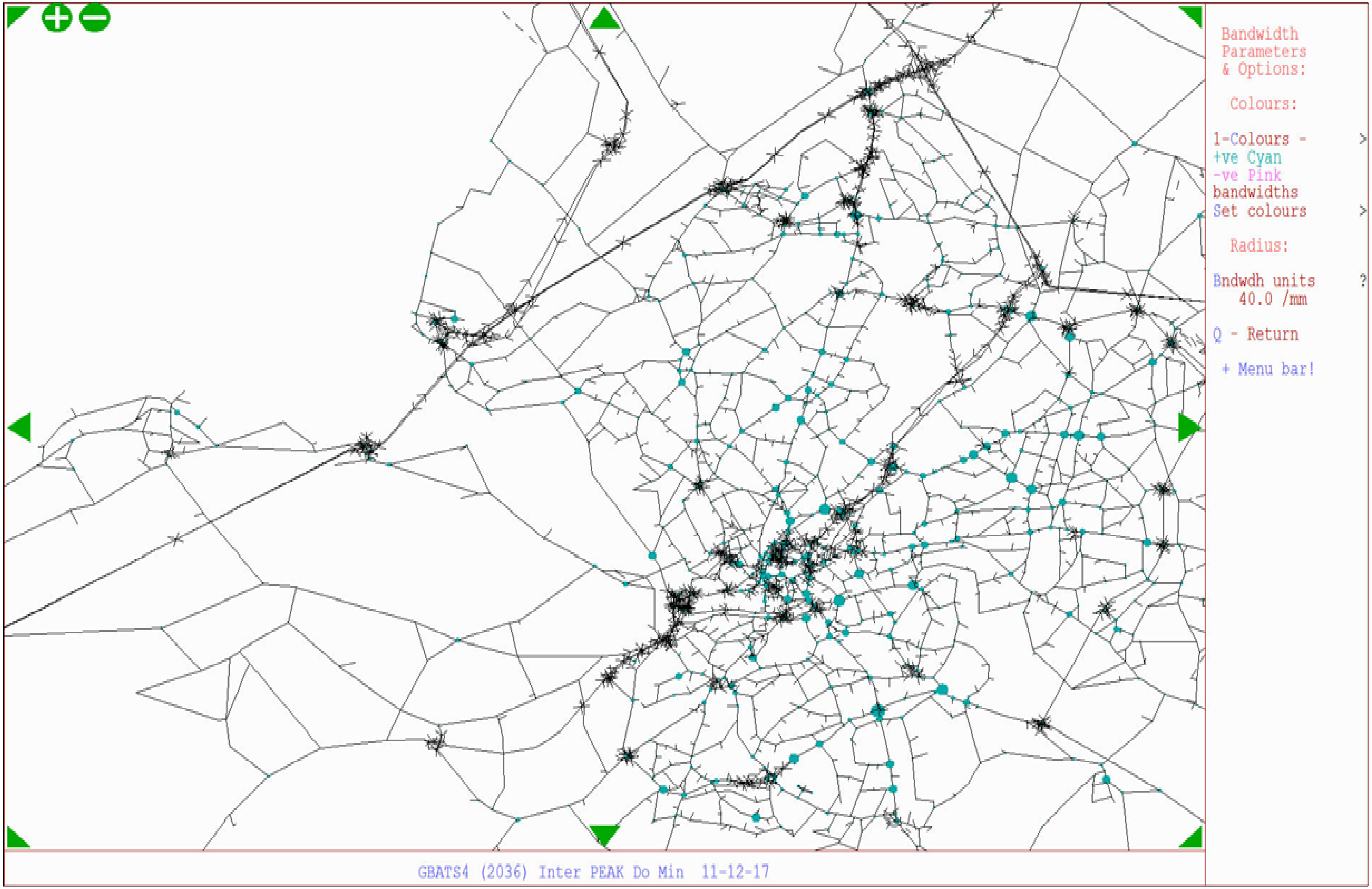


FIGURE B22

IP Peak 2036 – Scheme scenario – congestion at nodes (delays per second)

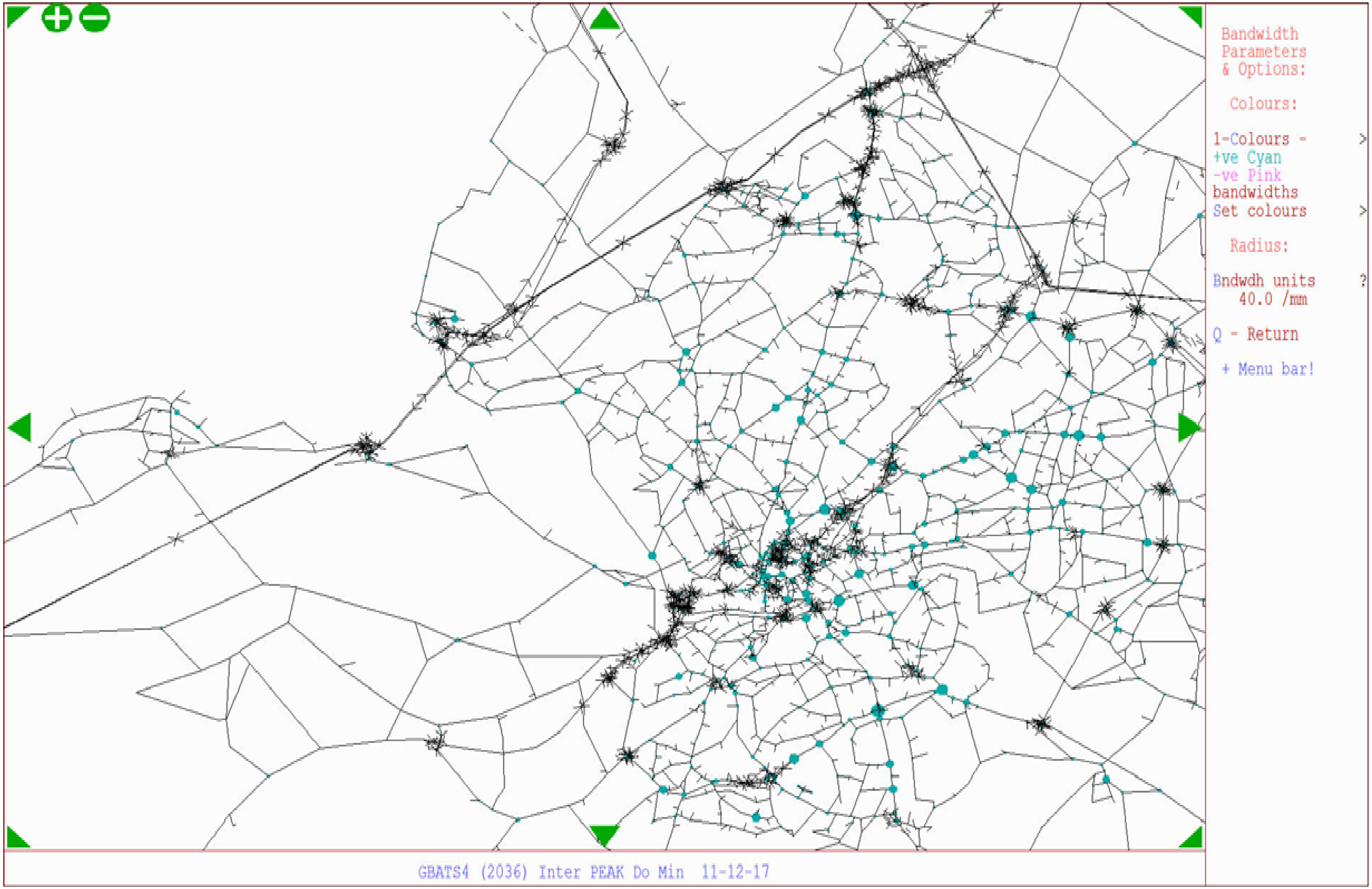


FIGURE B23

PM Peak Base year – congestion at nodes (delays per second)

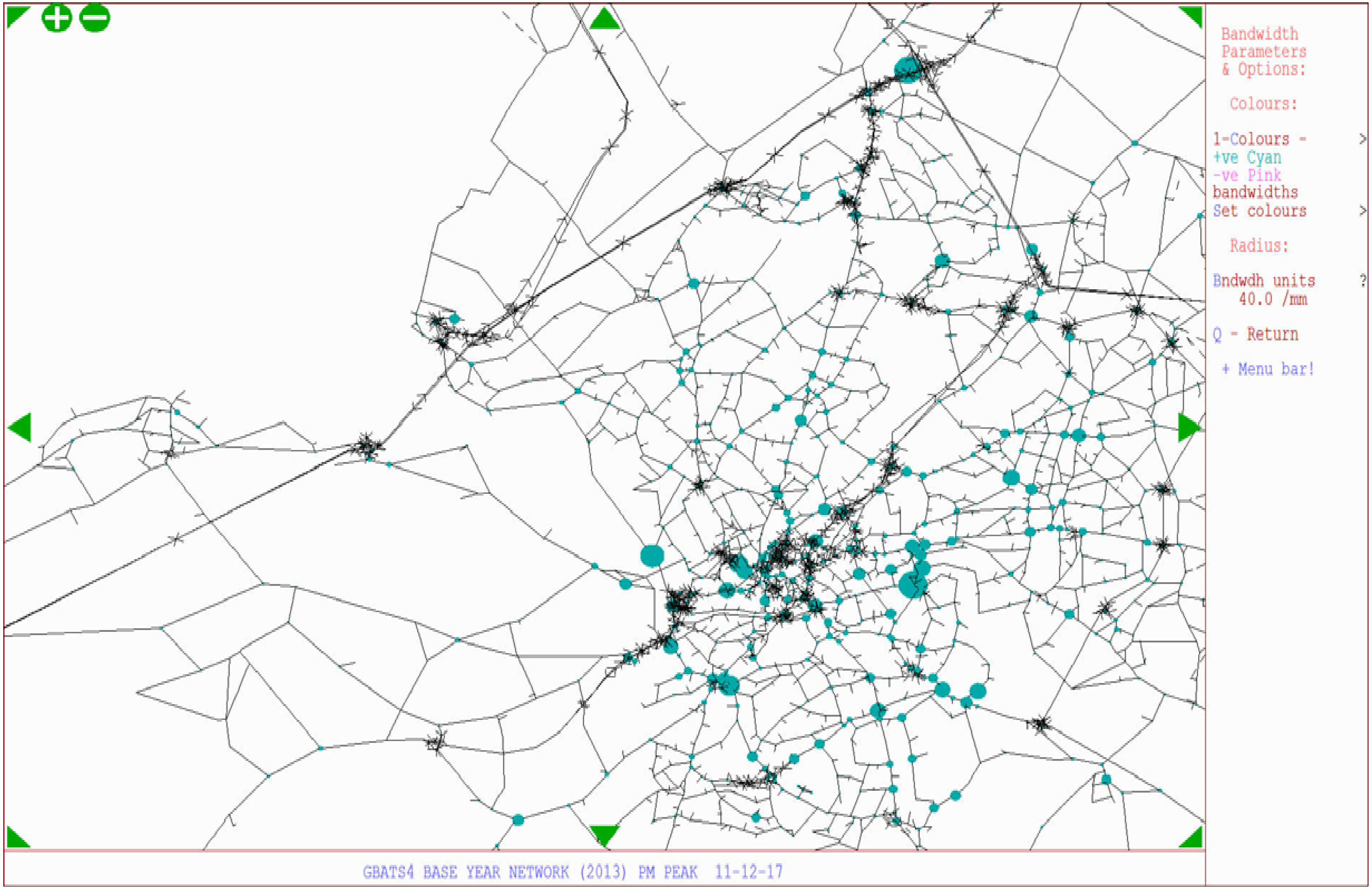


FIGURE B24

PM Peak 2021 – Do Minimum – congestion at nodes (delays per second)

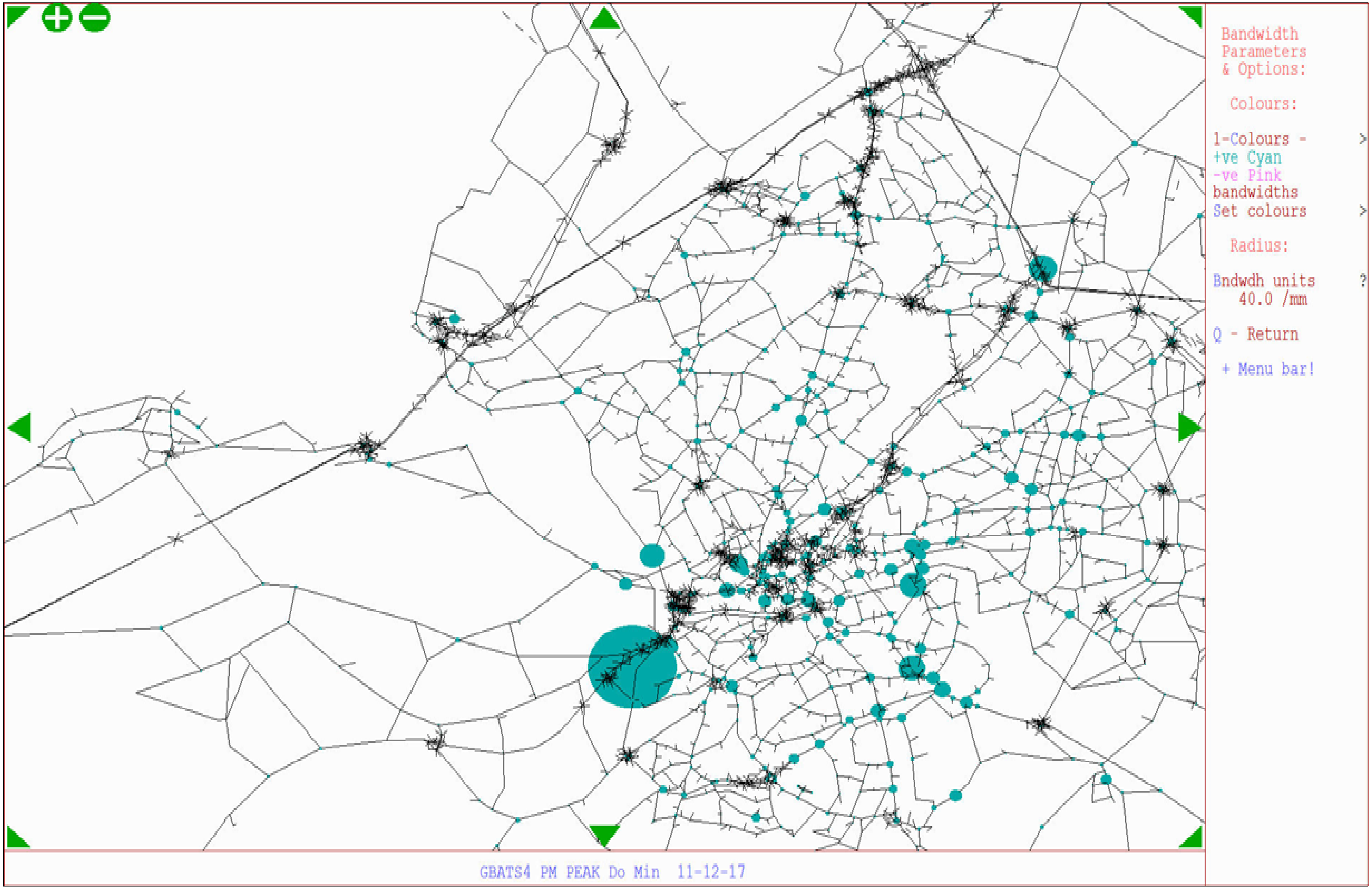


FIGURE B25

PM Peak 2021 – Scheme scenario – congestion at nodes (delays per second)

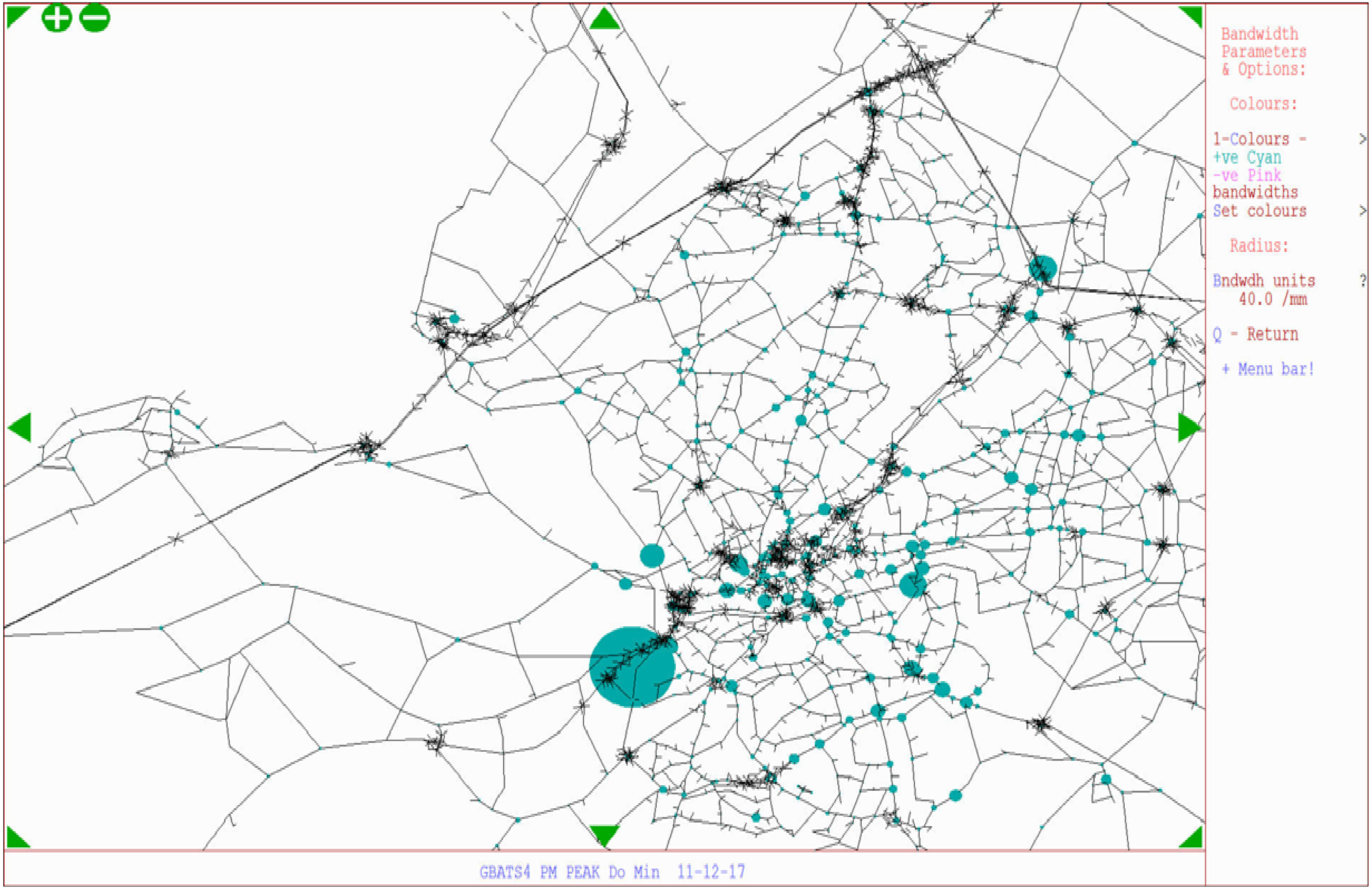


FIGURE B26

PM Peak 2036 – Do Minimum – congestion at nodes (delays per second)

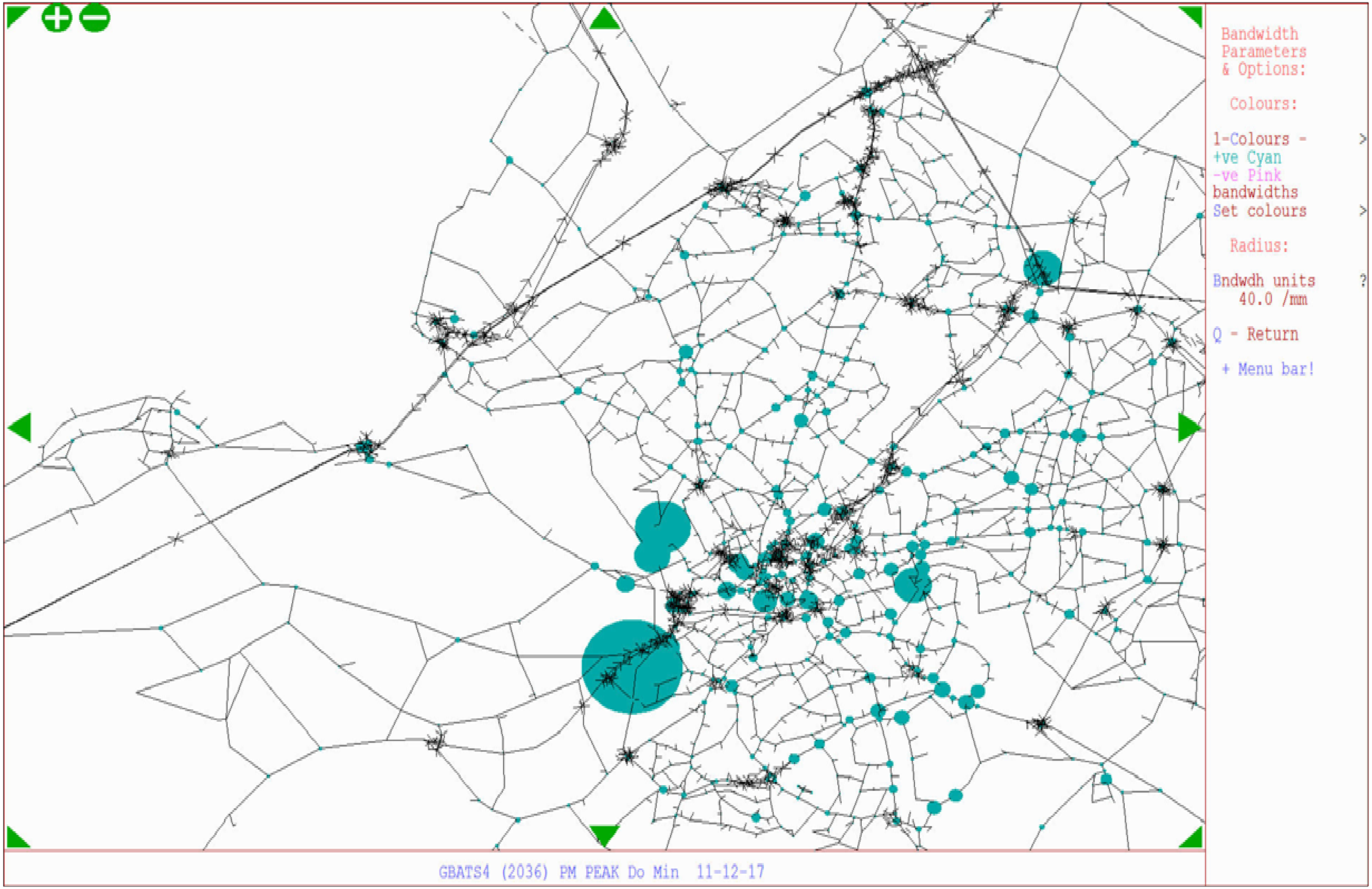
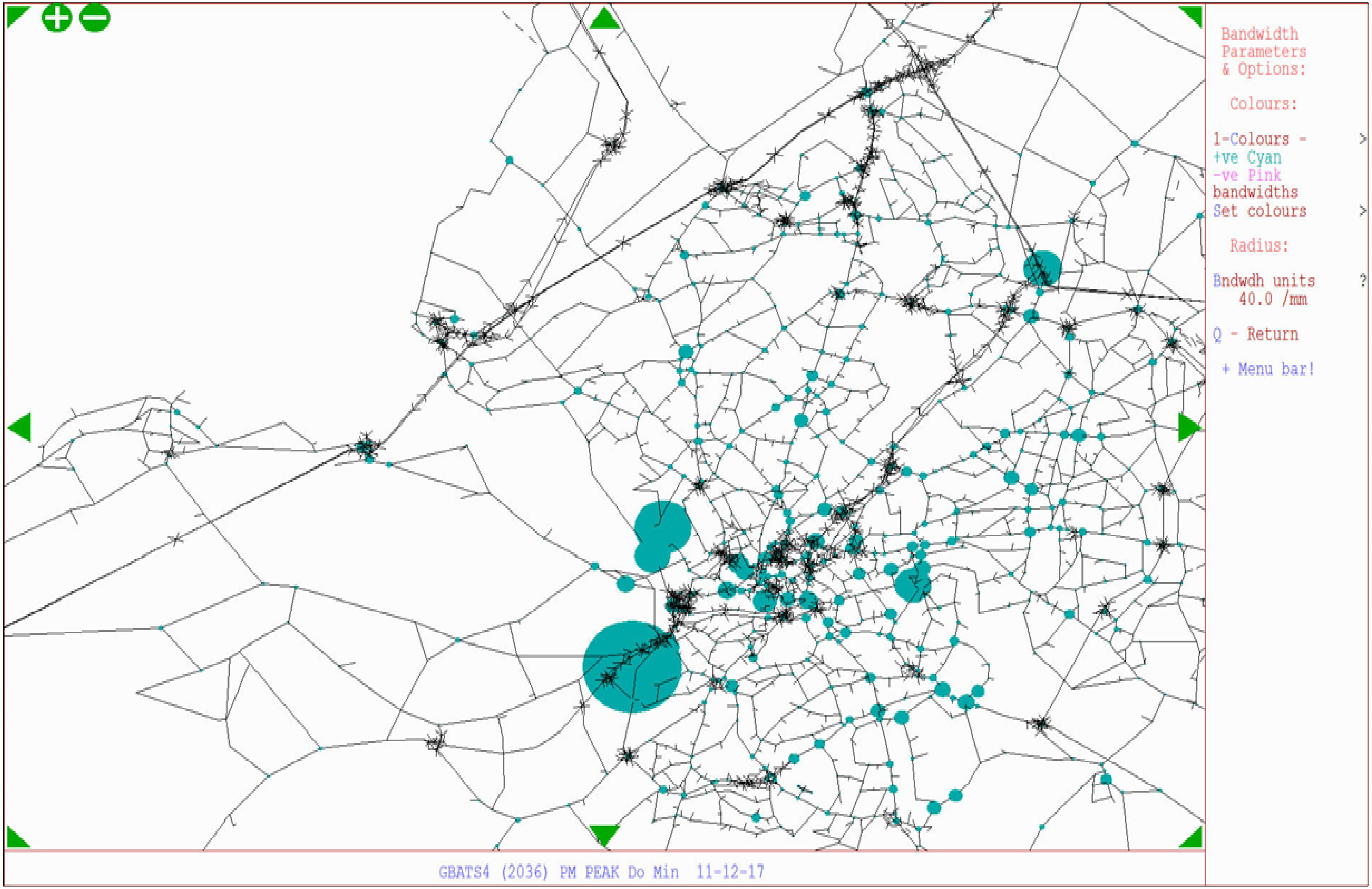


FIGURE B27

PM Peak 2036 – Scheme scenario – congestion at nodes (delays per second)



Appendix C
TEE Table TUBA Highway Benefits

MetroWest Phase 1

Economic Efficiency of the Transport System (TEE)

Consumer - Commuting user benefits	**All Modes**	**Road**	
Travel Time	25,901	25,901	
Vehicle operating costs	1,956	1,956	
User charges	0	0	
During Construction & Maintenance	0	0	
NET CONSUMER - COMMUTING BENEFITS	**27,857**	**27,857**	
Consumer - Other user benefits	**All Modes**	**Road**	
Travel Time	0	0	
Vehicle operating costs	0	0	
User charges	0	0	
During Construction & Maintenance	0	0	
NET CONSUMER - OTHER BENEFITS	**0**	**0**	
Business	All Modes	Personal	Freight
Travel Time	19,305	3,678	15,626
Vehicle operating costs	2,996	706	2,290
User charges	0	0	0
During Construction & Maintenance	0	0	0
Subtotal	**22,301**	**4,385**	**17,916**
Private Sector Provider Impacts			
Revenue	0	0	
Operating costs	0	0	
Investment costs	0	0	
Grant/subsidy	0	0	
Subtotal	**0**	**0**	
Other business Impacts			
Developer contributions	0	0	
NET BUSINESS IMPACT	**22,301**		
TOTAL			
Present Value of Transport Economic Efficiency Benefits (TEE)	**50,158**		

Benefits appear as positive numbers, while costs appear as negative numbers.

All entries are present values discounted to 2010, in 2010 prices

Highways only