Welsh Government

M4 Corridor around Newport - Motorway to the South of Newport

Traffic Forecasting Report

14-9230

Issue | July 2014

Job number 117300

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1 Introduction

1.1 Scheme Background

The M4 in South Wales forms part of the Trans-European Transport Network (TEN-T), which provides connections throughout Europe by road, rail, sea and air. The M4 plays a key strategic role in connecting South Wales with the rest of Europe, providing links to Ireland via the ports in South West Wales and England, and mainland Europe to the east. It is a key east-west route being the main gateway into South Wales and also one of the most heavily used roads in Wales.

The M4 is critical to the Welsh economy as it facilitates the transport of goods, links people to jobs and employment sites, and serves the Welsh tourism industry. Cardiff, Newport and Swansea have ambitious regeneration strategies and Monmouthshire County Council is developing areas around Junction 23A of the M4. Rhondda Cynon Taff has important gateways onto the motorway at Junctions 32 and 34. Bridgend is served by M4 Junctions 35 and 36. Neath Port Talbot straddles the motorway and gets important access from Junctions 38 to 43. Congestion on the M4 causing unreliable journey times and reduced service levels will therefore hinder economic development in South Wales.

The M4 between Junctions 28 and 24 was originally designed as the ‘Newport Bypass’ with further design amendments in the 1960s to include the first motorway tunnels to be built in the UK.

The M4 Motorway between Magor and Castleton does not meet modern motorway design standards. This section of the M4 has many lane drops and lane gains, resulting in some two-lane sections, an intermittent hard shoulder and frequent junctions.

It is often congested, especially during weekday peak periods resulting in slow and unreliable journey times and stop-start conditions with incidents frequently causing delays.

This is why problems with congestion and unreliable journey times have been a fact of life on the M4 around Newport for many years. The motorway and surrounding highway network does not cope with sudden changes in demand or operation, for example as a result of accidents or extreme weather events. These issues are worse at times of peak travel (rush hour) and have worsened as the number of users on the network has increased.

Since 1991, much assessment and consultation has been undertaken to develop a preferred solution to the problems on the motorway around Newport. A detailed history is documented in the M4 Corridor around Newport WelTAG[1] Stage 1 (Strategy Level) Appraisal Report[2]. This included the adoption of a revised TR111 route[3] in April 2006, which remains protected for planning purposes. The

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[1] Welsh Transport Planning and Appraisal Guidance, available at http://wales.gov.uk/topics/transport/publications/weltag/?lang=en

[2] Welsh Government, M4 Corridor around Newport, WelTAG Appraisal Report Stage 1 (Strategy Level), Arup, June 2013, available at www.m4newport.com

[3] Once a preferred route is announced, Welsh Government serves a statutory notice (TR111) on the local planning authorities requiring the line to be protected from development. This is enacted

alignment of this proposed new section of motorway has been developed following extensive consultation, investigation and analysis. The aim is to minimise the impact on the environment, whilst fully meeting motorway design and safety standards. A draft Plan has been developed for the M4 Corridor around Newport. The main element of the draft Plan is a new section of motorway to the south of Newport (the Black Route) which largely follows this TR111 alignment. A more detailed description of the scheme is provided in Chapter 5, whilst Figure 1.1 shows the proposed new section of motorway to the south of Newport.

1.2 Objective of this Report

The main objective of this Traffic Forecasting Report is to document the development of the future year traffic models, including the methods and assumptions adopted and to demonstrate that these are consistent with best practice guidance.

This report also presents the future year traffic forecasts, which will inform the operational, economic and environmental evaluations of the new section of motorway to the south of Newport. Evaluation is undertaken through comparison of a 'Do Something' case (the future year scenario with the motorway south of Newport) against a 'Do Minimum' case (the future year scenario without the new section of motorway south of Newport).

1.3 Report Structure

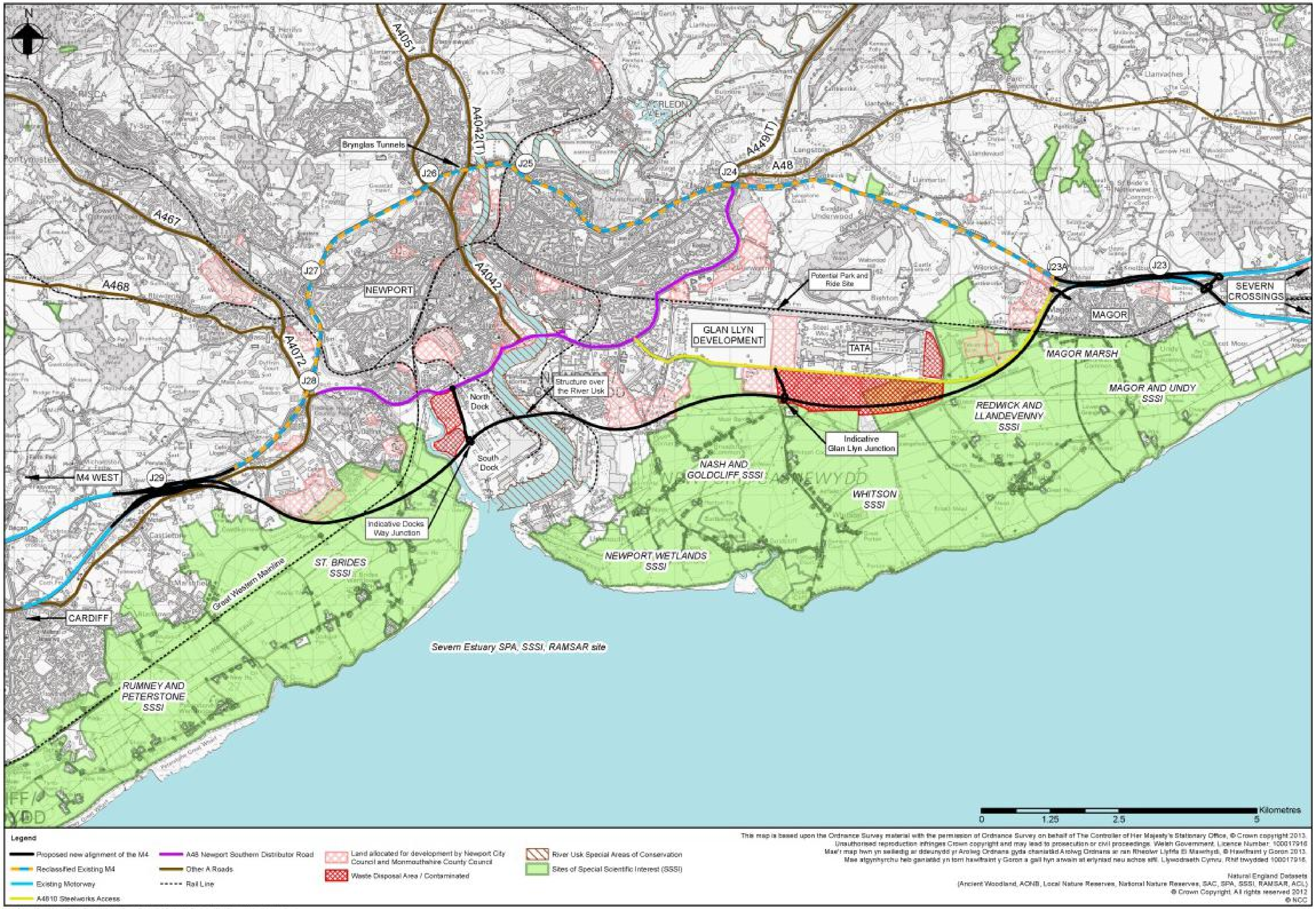
This report details the development of and output from the forecast year traffic models.

Following this introduction the report is structured as follows:

- Chapter 2 describes the technical model details;
- Chapter 3 provides an overview of the modelling of future year travel;
- Chapter 4 provides details of the reference case forecasts;
- Chapter 5 describes the future year highway networks;
- Chapter 6 describes the variable demand modelling;
- Chapter 7 provides in-depth information on the forecast assignments; and
- Chapter 8 summarises the main points of the report.

under Article 19 of The Town & Country Planning (Development Management Procedure) (Wales) Order 2012.

Figure 1.1 Proposed New Section of Motorway to the South of Newport



2 Overview of Traffic Model

2.1 Introduction

This report presents forecasts of future year traffic flows to enable the operational, economic and environmental assessments of the new section of motorway to the south of Newport to be undertaken. It also provides a description of the methods and assumptions used in preparing the forecasts.

The basis for forecasting is the M4 Corridor around Newport 2012 base year traffic model which has been validated in accordance with the Design Manual for Roads and Bridges (DMRB)[4] and WebTAG Unit 3.19[5]. The development and the validation of the base year traffic model has been detailed in the Local Model Validation Report (LMVR)[6].

Both the base year and the forecast year traffic models use the SATURN modelling suite (Simulation and Assignment of Traffic in Urban Road Networks).

Two future years have been defined for the traffic forecasting in accordance with guidance, namely the assumed year of scheme opening, 2022, and a design year which is the fifteenth year after scheme opening, 2037.

A large number of web-based Transport Analysis Guidance (WebTAG) documents are made available by the Department for Transport (DfT) (www.gov.uk/transport-analysis-guidance-webtag). TAG Unit M2[7] prescribes the use of Variable Demand Modelling (VDM) in forecasting mode for schemes with a capital cost of more than £5 million. Variable Demand Modelling has therefore been used in the traffic forecasting for the new section of motorway to the south of Newport.

2.2 Modelled Time Periods

Traffic forecasts for three modelled time periods were developed representing a typical weekday:

- AM Peak Hour (08:00-09:00);
- Interpeak Hour (13:00-14:00); and
- PM Peak Hour (17:00-18:00).

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[4] Design Manual for Roads and Bridges, Volume 12, Section 2, Part 1, Traffic Appraisal in Urban Areas, Department for Transport, May 1996
[5] Transport Analysis Guidance, Highway Assignment Modelling, Unit 3.19, Department for Transport, August 2012 This Guidance has since been superseded by TAG Unit M3.1, January 2014.
[6] M4 Corridor Around Newport – Motorway to the South of Newport, Local Model Validation Report, Ove Arup and Partners, June 2014
[7] Transport Analysis Guidance, TAG Unit M2 - Variable Demand Modelling, Department for Transport, January 2014

2.3 User Classes

The following five vehicle types and trip purposes are treated as separate user classes within the traffic model:

- Car – employer's business trips;
- Car – commuter trips;
- Car – other trips;
- Light goods vehicle (LGV); and
- Heavy goods vehicle (HGV).

2.4 Assignment Parameters and Technique

The assignment process is an important element as it predicts the routes that drivers will choose taking into account the level of traffic demand and the available road capacity. The assignment technique used for the M4 Corridor around Newport traffic model was the Wardrop equilibrium assignment for multiple user classes. The principle of this assignment is that traffic arranges itself on the network such that the cost of travel on all routes used between each origin and destination is equal to the minimum cost of travel and all unused routes have equal or greater cost.

2.5 Generalised Costs

Travel cost in SATURN is represented by time and distance coefficients, which are expressed in terms of pence per minute (PPM) and pence per kilometre (PPK). The generalised cost of each trip can then be calculated based on these coefficients.

The SATURN assignment procedure uses the generalised time formulation shown below (SATURN Manual 15.24.5):

Generalised Time = Time + (PPK/PPM) * Distance + Toll / PPM.

Where: PPM = pence per minute and PPK = pence per kilometre.

The generalised cost coefficients used in the base model are based on data given in WebTAG Unit 3.5.6[8], which provides values of time, occupancy figures, purpose splits, Gross Domestic Product (GDP) growth rates and vehicle operating costs that are recommended by the Department for Transport (DfT) for use in the economic appraisal of transport projects.

Tables 1 and 2 in Unit 3.5.6 provide monetary values of time in 2010 prices for different transport users, which can be used to derive values of time in an assignment model in terms of pence per minute (PPM). The conversion from 2010 to the modelled years was made in accordance with the forecast annual rates of growth in the value of time set out in Table 3 of Unit 3.5.6. This states that the value of time is assumed to increase in line with income, measured for this purpose as GDP per head.

[8] Transport Analysis Guidance, Values of Time and Vehicle Operating Costs, TAG Unit 3.5.6, Department for Transport, October 2012. This Guidance has since been superseded by TAG Unit A1.3, May 2014.

Similarly Tables 10, 11 and 12 in TAG Unit 3.5.6 provide parameters to calculate fuel costs and Table 15 provides parameters to calculate non-fuel vehicle operating costs. These parameters were used to calculate the fuel costs per kilometre for each user class. In converting fuel costs from 2010 to the modelled years, account was taken of the forecast growth in the cost of fuel and the predicted rate of increase in fuel efficiency, as set out in Tables 13 and 14 of Unit 3.5.6. As noted in the guidance, the non-fuel vehicle operating costs are assumed to remain constant in real terms, and so no adjustment was applied to convert to 2012 values.

When added together, the fuel and non-fuel elements give the total vehicle operating costs in terms of PPK for different transport users. The PPM and PPK parameters then give the overall generalised cost for each of the different user classes. The generalised costs (in 2012 prices) that were used in the forecast models are shown in Table 2.1.

Table 2.1: Base and Forecast Year Generalised Cost Parameter Values

2012	**AM Peak**		**Inter Peak**		**PM Peak**	
	PPM	**PPK**	**PPM**	**PPK**	**PPM**	**PPK**
Car, Employer's Business	56.05	13.56	55.37	13.48	58.41	13.58
Car, Other	14.75	7.82	15.18	7.68	15.62	7.74
Car, Commuting	12.56	7.70	12.77	7.68	12.80	7.67
Light Goods Vehicle	24.34	17.68	23.84	17.89	24.71	17.72
Heavy Goods Vehicle	20.99	44.79	20.71	45.17	20.72	47.38
2022	**AM Peak**		**Inter Peak**		**PM Peak**	
	PPM	**PPK**	**PPM**	**PPK**	**PPM**	**PPK**
Car, Employer's Business	66.95	12.52	66.24	12.81	69.51	12.57
Car, Other	16.72	6.35	17.21	6.30	17.74	6.36
Car, Commuting	14.44	6.28	14.68	6.30	14.73	6.30
Light Goods Vehicle	29.25	16.59	28.64	16.72	29.70	16.61
Heavy Goods Vehicle	25.23	47.40	24.88	47.47	24.90	48.32
2037	**AM Peak**		**Inter Peak**		**PM Peak**	
	PPM	**PPK**	**PPM**	**PPK**	**PPM**	**PPK**
Car, Employer's Business	88.60	11.88	87.82	11.44	91.53	11.84
Car, Other	20.46	5.34	21.04	5.17	21.78	5.31
Car, Commuting	18.02	5.28	18.29	5.17	18.39	5.27
Light Goods Vehicle	39.01	15.64	38.20	15.80	39.61	15.74
Heavy Goods Vehicle	33.64	50.74	33.19	49.37	33.21	50.63

2.6 Annualisation Factors

In order to carry out environmental assessments, model data needs to be converted from peak hour to 18 hour traffic volumes. In addition, 24 hour traffic flows are required for reporting purposes. Historic Automatic Traffic Counter (ATC) data along the M4 corridor in the study area were used to derive a number of factors allowing the calculation of Annual Average Weekday Traffic (AAWT) and Annual Average Daily Traffic (AADT). The factors are given in Table 2.2.

Table 2.2: Annualisation Factors

Peak Hour to Peak Period			12 Hour (07:00-19:00) to AAWT	AAWT to 18 hr (06:00-24:00)	AAWT to AADT
AM	Interpeak	PM			
2.81	6.08	2.81	1.226	0.921	0.931

2.7 Geographical Coverage of Traffic Model

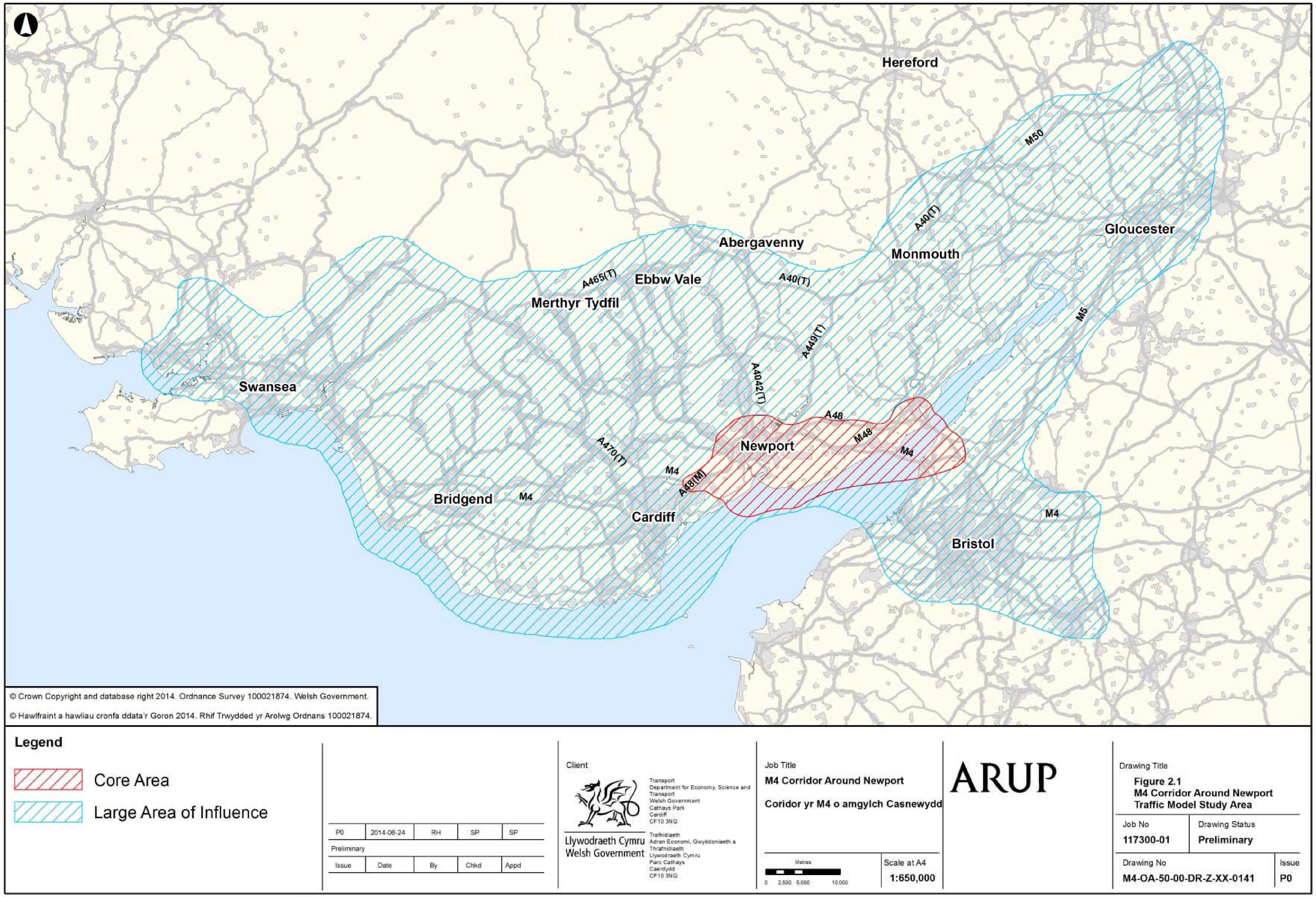
For the purposes of preparing traffic forecasts for the M4 Corridor around Newport, a core area covers the M4 between J30 in the west and J21 in the east, including junctions 29 and 23 that are the western and eastern ends respectively of the proposed new section of motorway. Within this core area are key roads/corridors of interest including:

- the existing M4 and proposed new section of motorway to the south of Newport;
- the M48 motorway;
- access routes to the existing M4 and M48 motorways from Cardiff, Newport, Chepstow and the hinterland north of Newport;
- the corridors on the east and west banks of the River Usk that could connect Central Newport to the new section of motorway via intermediate junction(s); and
- east / west routes through Newport via Newport Bridge, George Street Bridge and the Southern Distributor Road (SDR).

The core area is modelled at a high level of detail (SATURN simulation network). Outside this core area is a large area-of-influence where changes in traffic flow may be experienced following opening of the new section of motorway to the south of Newport. This extends to Skewen (M4 J43) in the west, the A465 Heads of the Valleys Road and M50 in the north, and the M5 J8 to 18a in the east. The area-of-influence is modelled at a lower level of detail (SATURN buffer network).

The study area is shown in Figure 2.1.

Figure 2.1 M4 Corridor Around Newport Study Area



2.8 Zone System

The future year zone system replicates that for the base year traffic model, which includes zones reserved for new development proposals in future years. Development zones were added to the base model where a new development is expected to have a different land use from the existing zone, or the new development traffic would load onto the surrounding network at a different point to the existing zone.

In total, there are 443 zones in the forecast model. Figures 2.2 to 2.4 show the M4 Corridor around Newport traffic model zones.

Figure 2.2 UK Zone Plan

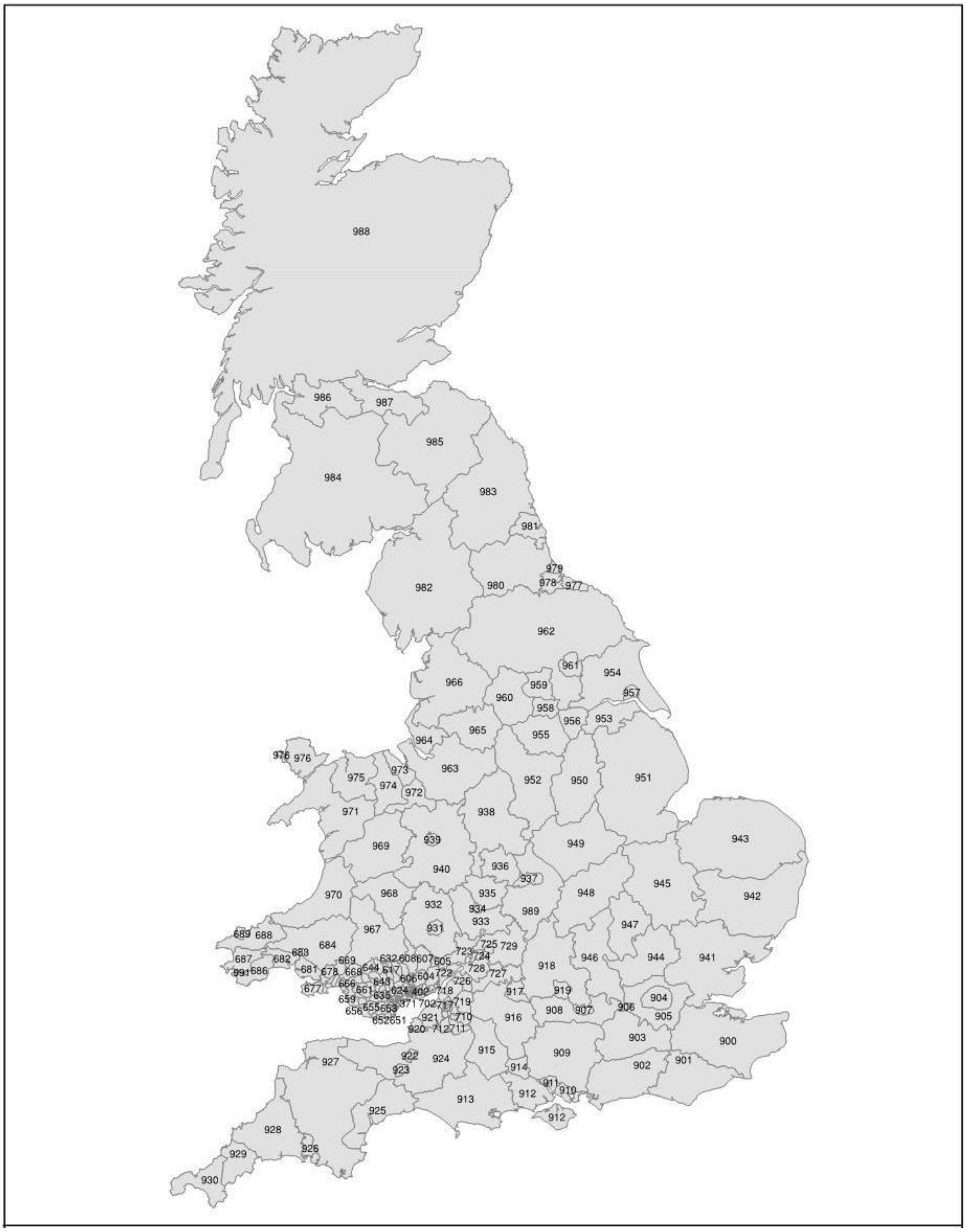


Figure 2.3 South East Wales Zone Plan

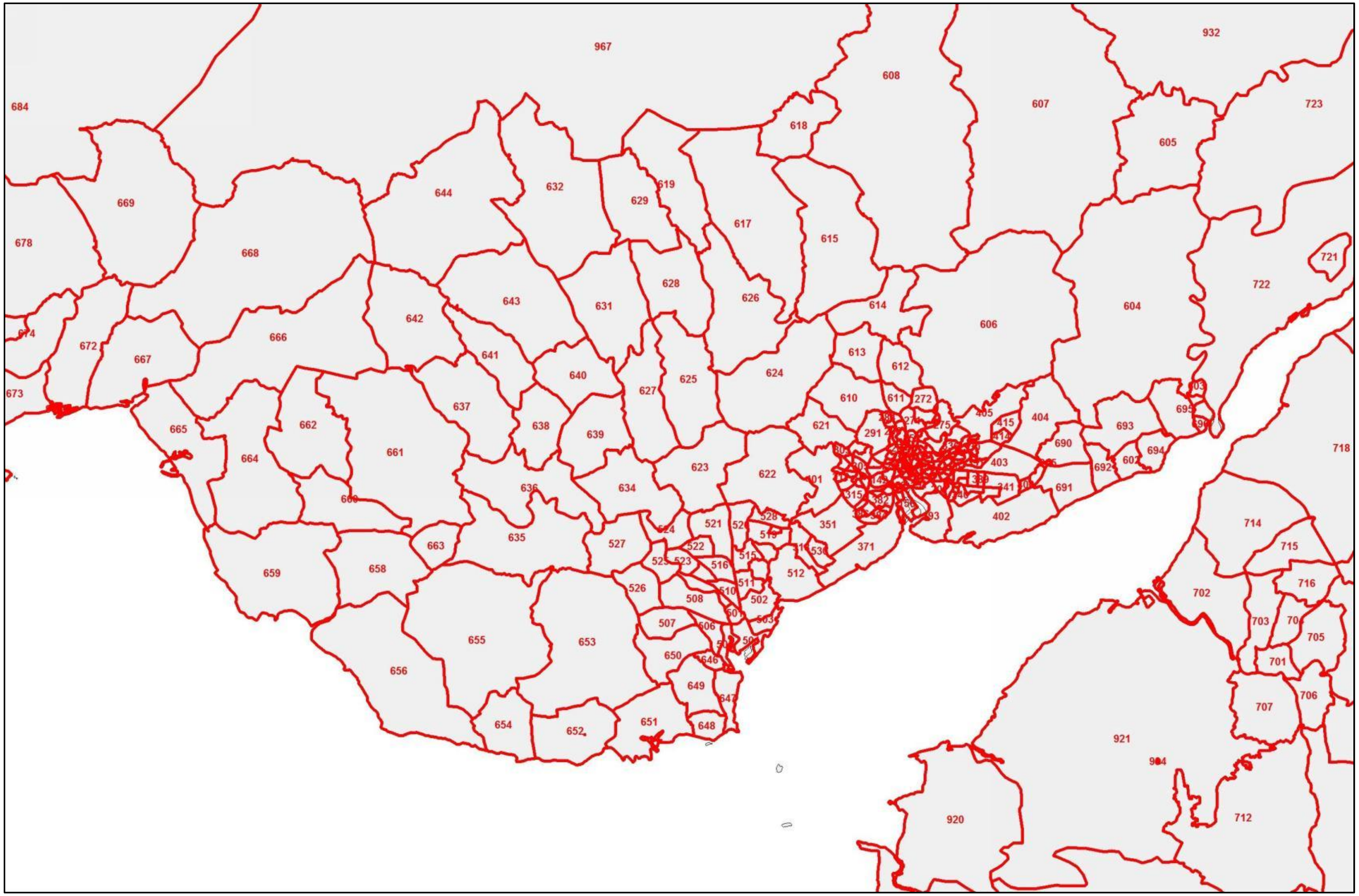
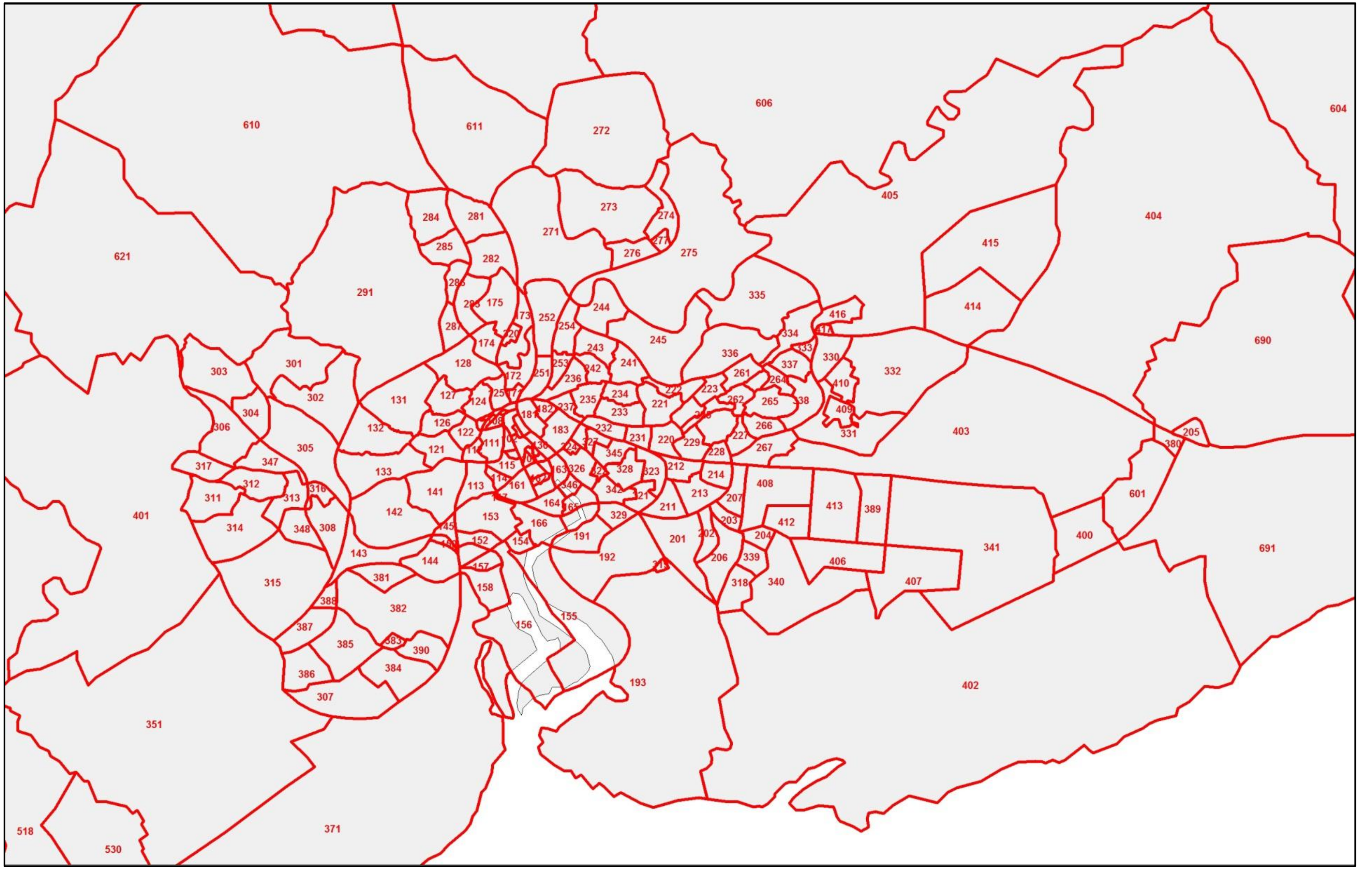


Figure 2.4 Newport Area Zone Plan



2.9 Overview of the Forecasting Methodology

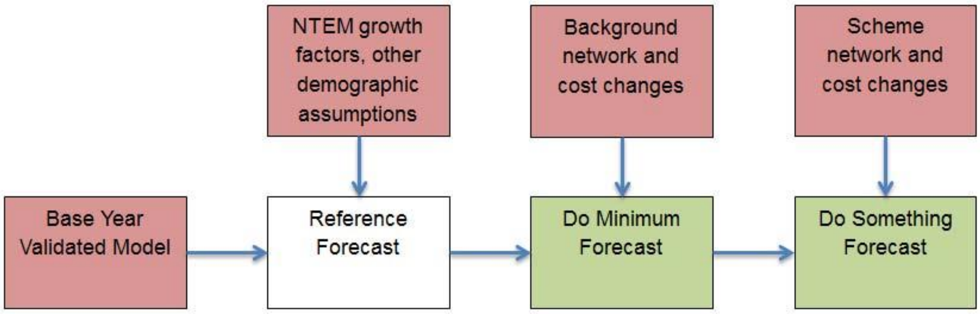
The traffic forecasts take account of predicted changes over time, both in terms of changes to the transport network (supply) and changes in travel demand. The underlying assumptions which have fed into the traffic forecasts are detailed in the following chapters.

3 Forecasting and Modelling Future Year Travel

3.1 Overview of Demand Forecasting Procedure

Figure 1 of *TAG Unit M4 Forecasting and Uncertainty* describes the methodology to be followed to produce a set of forecasts. This figure is reproduced as Figure 3.1.

Figure 3.1 Basic approach to forecasting using a transport model



The Reference Case matrices, and the reference forecast is the starting point for the VDM process necessary to develop the Do Minimum and Do Something forecasts. This chapter describes the NTEM growth and other demographic assumptions used to develop the reference forecasts.

3.2 National Trip End Model

The National Trip End Model (NTEM) has been developed by the DfT and provides a set of predictions for growth in travel demand at trip end level for a range of different modes: walk, bicycle, car drivers, car passengers, bus and train. The results from NTEM are available through an interface called the Trip End Model Presentation Program (TEMPRO). Version 6.2 of TEMPRO, issued in 2011, represents the definitive version as defined by the DfT, and has been used to create the forecasts outlined in this report.

NTEM starts from the basis that each one way trip made has two trip ends; an origin and a destination trip end. Trips are categorised as either home based (HB), where one of the trip ends is at the place of residence; or non-home based (NHB). NTEM splits these further into 20 trip destination purposes such as work trips, shopping trips, education trips, and so on.

Within NTEM, Great Britain is broken down into a range of NTEM zones, which are groups of 2001 Census wards. These are, in general, a level below district level. Authorities are generally split into named urban zones and rural district remainders.

NTEM is also able to produce datasets for different forecast years and for six different time periods:

- Weekday AM peak;

- Weekday interpeak;
- Weekday PM peak;
- Weekday Off peak;
- Saturday (all day); and
- Sunday (all day).

Only one set of factors is provided in TEMPRO, representing the central growth case of what is likely to happen to travel demand in the future based on the assumptions input to NTEM. The factors are based on predicted demographic changes and do not take account of the level of congestion or other factors (such as traffic restraint measures) which may limit the potential for all the demand to use the network without an unrealistic deterioration in travel conditions.

NTEM was used to produce demand matrices for the car user classes in the two forecast years. Correspondence between the model zones and NTEM areas was made at the finest level practicable. Within the core of the study area, model zones were allocated to the NTEM zones, while model zones further out were allocated to local authority zones or regions as appropriate. TEMPRO was used to extract origin/destination growth factors of demand for the forecast years from NTEM for the relevant NTEM areas in the AM peak, interpeak and PM peak time periods for the following model user classes:

- Car – Employers’ Business trips;
- Car – Other trips; and
- Car – Commuter trips.

For a fixed demand approach, WebTAG[9] makes provision for an additional global factor to take account of two further variables, income adjustment and fuel price variability. However, it also advises that a model which accounts for variable demand, as is the case with the M4 Corridor around Newport model, invalidates the use of these additional variables, as these effects are modelled explicitly within the variable demand process. Consequently, the NTEM car growth factors produced were not expanded to include the income and fuel price factors, but were applied directly to the equivalent zone trip ends within the 2012 base matrices for car trips.

Further details of the NTEM traffic growth factors are given in Appendix A.

3.3 National Transport Model

The National Trip End Model does not produce growth factors for trips made by goods vehicles, and WebTAG Unit M4 advises that for modelling other vehicle types in highway models, growth factors from the National Transport Model (NTM) may be used. This incorporates the Great Britain Freight Model which expands base heavy goods vehicle (HGV) data by modelling the effects of macroeconomic variables and changes in generalised cost, while light goods vehicle (LGV) traffic is projected using a separate time series model related to changes in the Gross Domestic Product (GDP) and fuel price.

NTM provides estimates for the growth in road traffic between 2003 and 2035. The available data gives growth factors for light good vehicles (LGVs),

[9] Transport Analysis Guidance, TAG Unit M4, Forecasting and Uncertainty, Department for Transport, May 2014

articulated heavy vehicles and rigid heavy vehicles. The NTM growth factors were adjusted by the NTEM ratio of growth in the study area to national growth, in order to reflect the differential change in economic activity in the study area compared to other parts of the country.

The resulting NTM central growth factors for the change in vehicle-kilometres for LGVs and HGVs in Wales are shown in Table 3.1.

Table 3.1: Goods Vehicle Growth Factors from NTM

User Class	2012 to 2022	2012 to 2037
LGV	1.276	1.811
HGV	1.068	1.267

3.4 Uncertainty in Forecasting

An Uncertainty Log relating to the M4 Corridor around Newport is given in Appendix B. The following sections provide details of how local uncertainty in travel demand and supply has been addressed in the forecasting process.

3.4.1 Developments Explicitly Included in Forecast Matrices

Information regarding the detailed proposals and planning status of future developments in the study area was obtained from the local planning authorities in Newport and Monmouthshire. This takes on board information contained in:

- the Newport Local Development Plan, placed on deposit in April 2012, with consultation due to be completed in November 2012; and
- the Monmouthshire Local Development Plan, which was placed on deposit in September 2011 and subsequently adopted in February 2014.

Each proposed development was considered in turn and classified in accordance with Table A2 of WebTAG Unit M4. Those developments which were the subject of a planning application or had been approved were classified as ‘more than likely’ and ‘near certain’ and were therefore taken into account in the future year reference matrices.

The land use and quantum of each development was used to determine the total number of trips generated by each development. These were estimated using the Trip Rate Information Computer System (TRICS) database or, where available, were taken from development specific transport assessments.

The TRICS database contains over 2,100 site locations, 4,700 survey counts and 98 land use sub-categories, and is widely used for trip rate estimates for future year developments. In order to obtain a reasonable representation of future development generated trips, average trip rates were used for the relevant development land uses. The distribution of trips in such cases was based on that from the base year model for nearby ‘reference’ zones with a similar land use.

Table 3.2 lists the development proposals included in the forecast traffic models, together with the assumed proportion completed in each of the modelled forecast years.

Table 3.2: Development Proposals

Development		Land Use	Size	Completion	
				2022	2037
1	Newport City Centre redevelopment, Friars Walk	Mixed use	30,600m^2 retail 2,314m^2 cinema 3,440m^2 restaurants	100%	100%
2	Newport City Spires development, Cambrian Rd	Mixed use	7,430m^2 offices 130-bed hotel 228 flats	100%	100%
3	Gwent Europark	Warehousing	80,000m^2 GFA	100%	100%
4	George St	Offices	7,400m^2 GFA	100%	100%
5	Dumfries Place/Uskway	Offices	3,500m^2 GFA	100%	100%
6	Glebelands	Housing	153 units	-	100%
7	Rodney Parade	Flats	394 units	60%	100%
8	Wales 1 Business Park	Offices	19,600m^2 GFA	100%	100%
9	Crindau Gateway	Mixed use	420 houses 2,000m^2 offices	-	100%
10	Quinn, Duffryn	Employment	700 jobs	-	100%
11	Celtic Springs Business Park	Offices	29,192m^2 GFA	100%	100%
12	East Newport, north of railway line	Housing	1100 units	27%	100%
13	East Newport, south of railway line (Glan Llyn)	Housing	4000 units	8%	100%
14	East Newport, south of railway line (Glan Llyn)	Employment	40 hectares	-	100%
15	Old Town Dock	Housing	760 units	23%	100%
16	Monmouthshire Bank	Housing	545 units	59%	100%
17	Lysaght Institute	Housing	100 units	100%	100%
18	Former Tredegar Park Golf Course	Housing	150 units	100%	100%
19	Hartridge School	Housing	100 units	100%	100%
20	Tatton Rd, Queensway Meadows	Employment	17.2 hectares	-	100%
21	Whiteheads Works	Housing	400 units	60%	100%
22	Former Pirelli Works	Housing	200 units	100%	100%
23	Lysaght Village (Orb Works)	Housing	434 units	74%	100%
24	Newport Docks	Industry	19 hectares	-	100%
25	Quay Point, Magor	Employment	19.6 hectares	-	100%
26	Duffryn	Offices	49,000m^2 GFA	-	100%
27	Former Sainsbury's site	Housing	140 units	-	100%
28	Allt yr Yn Campus	Housing	200 units	100%	100%
29	Penmaen Wharf	Housing	160 units	-	100%
30	Newport Athletic Club	Housing	200 units	-	100%
31	Bettws Comprehensive	Housing	163 units	100%	100%
32	Former Robert Price	Housing	118 units	100%	100%
33	Jubilee Park (Alcan Works)	Housing	347 units	50%	100%

3.4.2 Highway Schemes

In addition to proposed developments, the treatment of uncertainty in model forecasting also needs to include any proposed highway infrastructure schemes.

Firmly proposed network improvements which are likely to be in place by the year that is being modelled are included in both the Do Minimum and Do Something networks. The future year highway networks were developed for the years 2022 and 2037.

The definition of the Do Minimum Network requires the identification of any committed or probable highway schemes within the study area that should be included in the traffic model. Following consultation with the Welsh Government and the local authorities, the schemes described below have been included in the Do Minimum network:

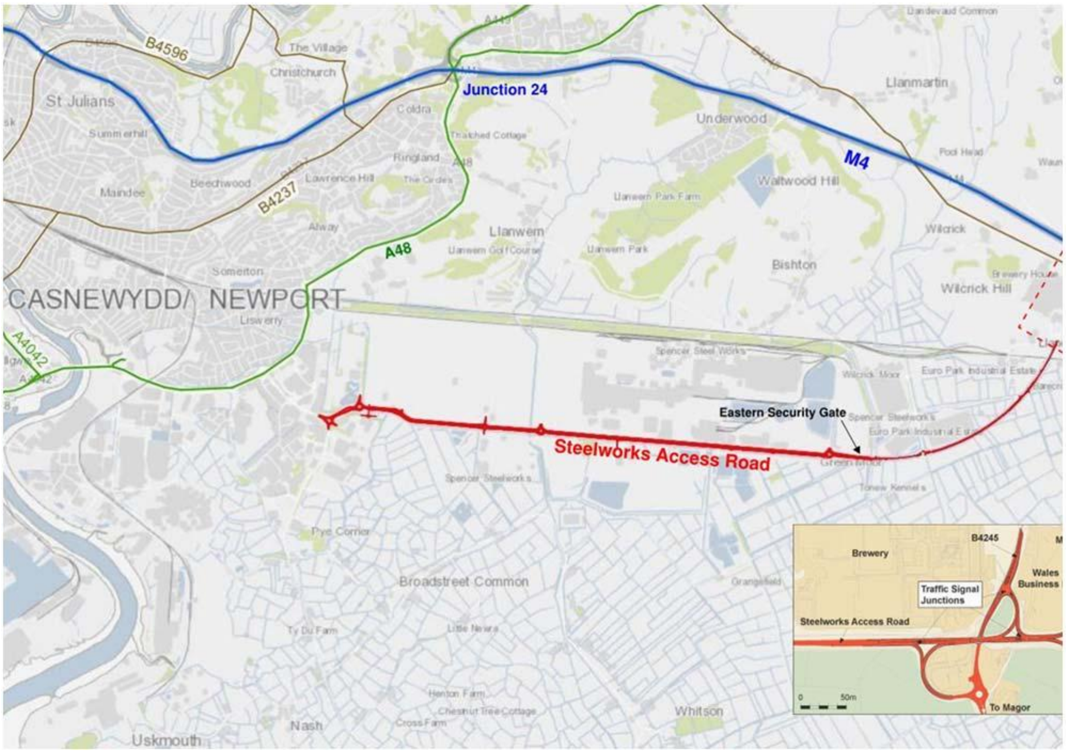
Steelworks Access Road (Phases 1 and 2)

In the 2012 base year, the Steelworks Access Road comprised a single carriageway route from Junction 23a at Magor to the eastern entrance of the Tata Llanwern steelworks site. This scheme involved the upgrade of the existing private road through the steelworks to public highway standards and it was opened to the public as a dual carriageway in September 2013. The existing public road between Junction 23a and Tata's eastern security gate was also improved, with the introduction of new signal-controlled junctions with the B4245 at Magor.

The scheme, shown in Figure 3.2, provides a new connection to south and east Newport from the M4 east of Junction 23a and reinforces the role of the A48 Southern Distributor Road as an east-west route around Newport.

Phase 3 of the improvement proposals, which would comprise the dualling of the existing eastern section of the Steelworks Access Road, is not yet programmed and so has not been included in any of the forecasting networks.

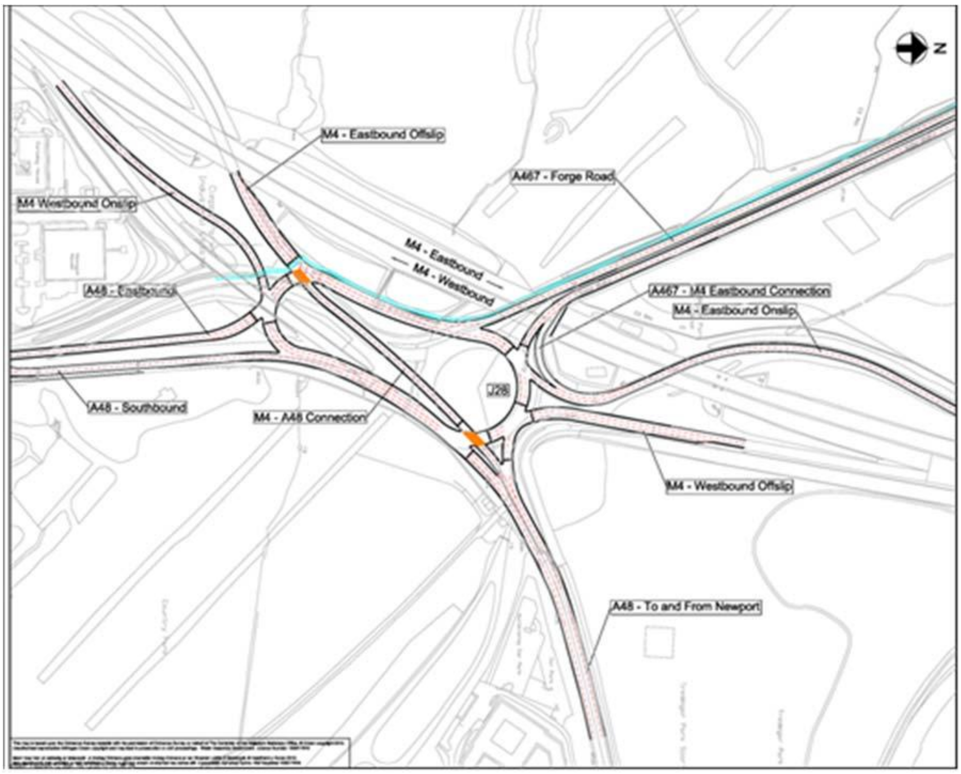
Figure 3.2 Steelworks Access Road Improvement



Tredegar Park Roundabout (Junction 28)

As part of the M4 Corridor Enhancement Measures (CEM) Programme, a scheme to improve the operation of the Junction 28 roundabout at Tredegar Park is being promoted by the Welsh Government. The provisional design for this scheme is shown in Figure 3.3, and comprises an enlarged at-grade signalised gyratory, incorporating a through link from the M4 (west) to the A48 Southern Distributor Road.

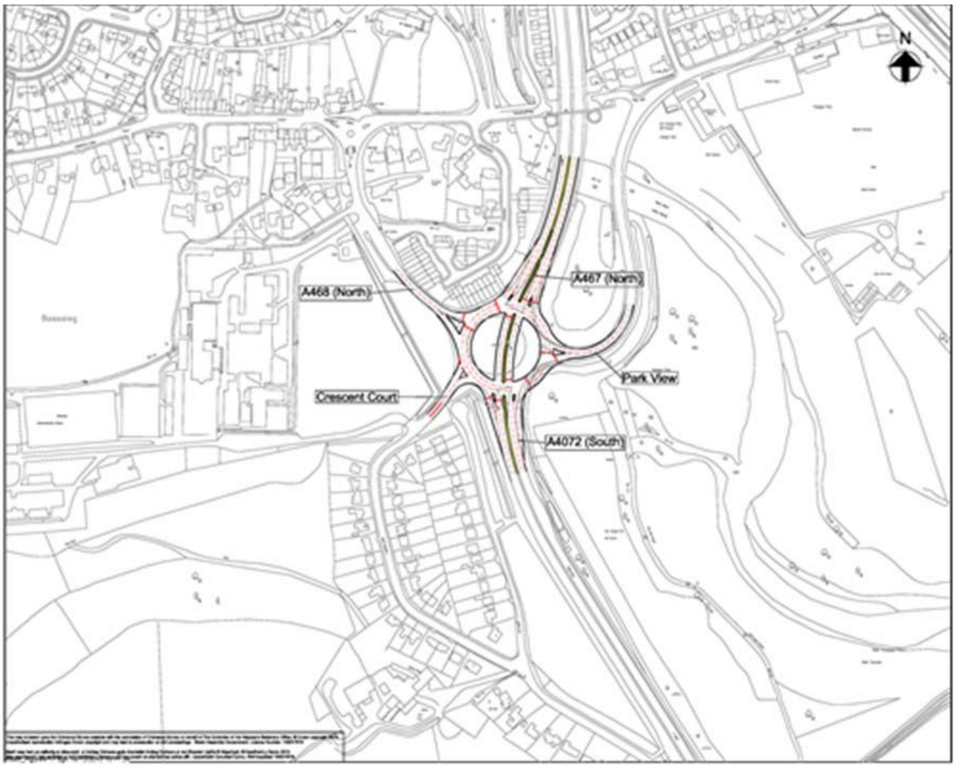
Figure 3.3 Tredegar Park Gyratory



A467 Bassaleg Roundabout

This improvement is also proposed as part of the CEM programme, and would convert the existing A467 Bassaleg roundabout into a signalised ‘throughabout’, with a new two-way link connecting the A467 northern and southern arms. The provisional design of this improvement is shown in Figure 3.4.

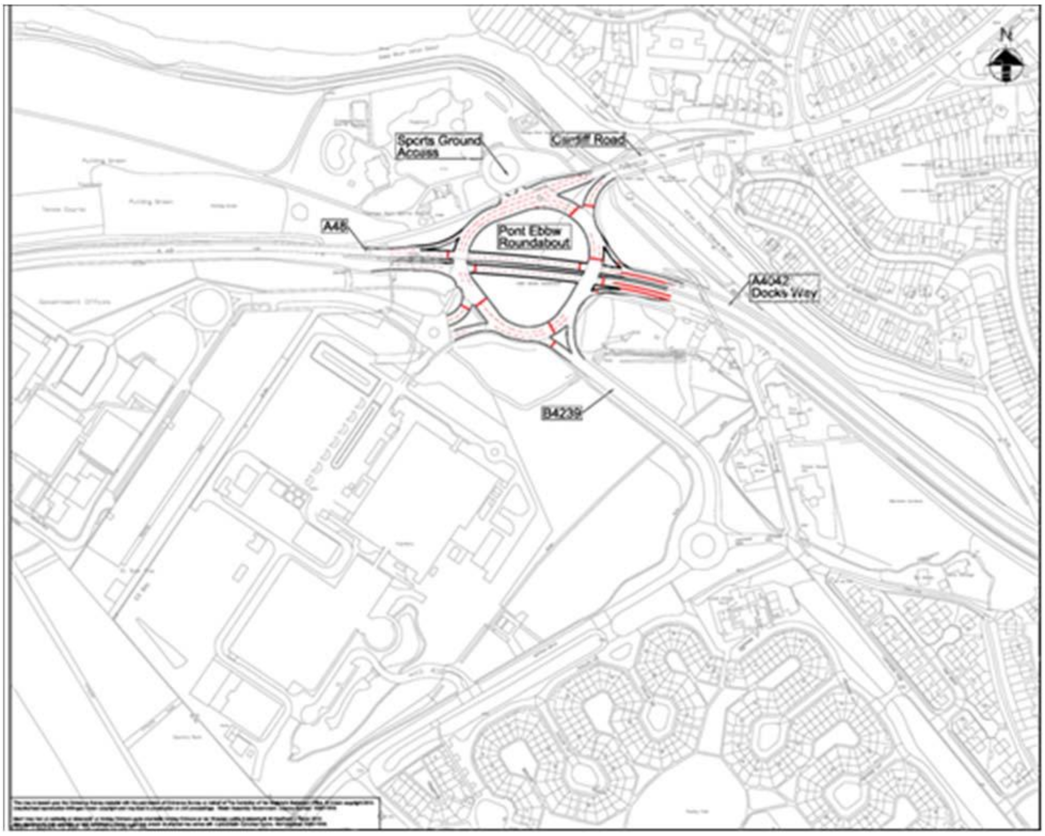
Figure 3.4 A467 Bassaleg Roundabout Improvement



3.4.2.1 A48 Pont Ebbw Roundabout

This is an additional proposal that is being promoted as part of the CEM programme. The scheme would convert the existing signalised roundabout into a signalised 'throughabout', with a new link connecting the eastern and western arms of the A48 Southern Distributor Road. The provisional design of this scheme is shown in Figure 3.5.

Figure 3.5 A48 Pont Ebbw Roundabout Improvement



A465 Heads of the Valleys Dualling (Abergavenny to Hirwaun)

The A465 trunk road forms an alternative east-west strategic route to the M4, particularly for traffic travelling between the Midlands and West Wales. Four sections of this improvement scheme are in the planning stage:

- Section 3 (Brynmawr to Tredegar) was approved following a Public Inquiry in 2012, and is scheduled to be completed by 2015;
- Section 2 (Gilwern to Brynmawr) was the subject of a Public Inquiry in Spring 2014.
- Section 5 (Dowlais Top to the A470) is not yet programmed, but is expected to commenced in time for completion by 2022; and
- Section 6 (A470 to Hirwaun) is not yet programmed, but is expected to commence in time for completion by 2022.

Newport Eastern Expansion Area

Additional infrastructure is proposed to serve the major residential developments planned on the former steelworks site (Glan Llyn) and the area north of the railway around the village of Llanwern. The proposals comprise:

- A new north-south link over the mainline railway, connecting Llanwern village to the improved Steelworks Access Road; and

- Upgrading of the A48 SDR / Cot Hill junction, from the existing left-in/left-out priority arrangement to an all-movement signal-controlled junction.

The phasing of the development proposals has been extended, and it is now assumed that these infrastructure proposals will be in place prior to the 2037 design year.

By the 2022 opening year, it is assumed that the only additional infrastructure will be the construction of a new junction on Cot Hill west of Llanwern village, to facilitate access for the initial development phases on the land north of the mainline railway.

3.4.3 Severn Tolls

The traffic model network includes the two Severn River Crossings, which link Wales and South West England. These bridges are currently both tolled in the westbound direction. The tolls are collected via toll booths, at Aust on the first Severn Bridge and approaching Magor for the Second Severn Crossing. The tolls are represented in the base year model by a monetary penalty (in 2012 prices) to represent the toll charge for each of the different vehicle types and a time penalty to represent the delay at the toll booths.

The Severn Bridges Act 1992 established the conditions under which the current concession agreement will end, and both bridges crossing the River Severn will revert to public ownership. The Act notes that the concession agreement ends either at:

- The end of the period of 30 years beginning with the appointed day; or
- Where it appears to the Secretary of State that the revenue requirement has been met on a day, the right of the concessionaire to exercise the power to levy tolls shall end at such time after that day as the Secretary of State may determine.

On 6 March 1992 the Secretary of State signed the Order setting the start date of the concession as 26 April 1992.

It is therefore the case that, unless new legislation is agreed between the Department for Transport and the Welsh Government, the collection of Severn Crossing Tolls will cease by 2022 at the latest.

Since removal of the Severn Crossing Tolls would be likely to result in increased demand, the retention of tolls is deemed to be a conservative base position. Removal of tolls will be thus treated as a sensitivity during traffic forecasting.

4 Reference Case Demand

4.1 Introduction

A Core Scenario has been developed in line with the principles outlined in WebTAG Unit M4 Forecasting and Uncertainty. The Core Scenario is therefore based on;

- NTEM growth in demand, at a suitable spatial area;
- Sources of local uncertainty that are more likely to occur than not; and
- Appropriate modelling assumptions.

In addition to the Core Scenario, alternative scenarios are required to allow decision makers to see how scheme performance varies depending on the assumptions made within the assessment. As such sensitivity tests are defined around the core scenario. High and Low Growth Scenarios are required to test the impact of uncertainty in projections such as demographic data (population, households and employment), GDP growth and fuel price trends.

Optimistic and Pessimistic sensitivity tests may be used to test the impact of Local uncertainty. This typically depends on whether developments or other planned transport schemes go ahead in the vicinity of the scheme being built. A review of all planned developments and highway schemes was undertaken at the time of preparing the forecasts, as described in Sections 3.4.1 and 3.4.2.

At this stage, all developments to be included in the core scenario were identified based on their size, nature of the development, phasing, planning status and likely impact on traffic patterns within the study area. As Newport is a concentrated area, it was decided that there would be no changes to these to account for ‘pessimistic’ or ‘optimistic’ development scenarios to incorporate into the low and high growth scenarios. TAG Unit M4 stipulates that with developments taken into account, total growth should be constrained to the NTEM/NTM totals calculated for the core scenario and the totals adjusted to reflect national uncertainty for the low and high growth scenarios. This has been the approach adopted for the M4 Corridor around Newport forecasting.

4.2 Core Scenario

The ‘Core Scenario’ is defined by TAG Unit M4 as ‘*a scenario based on the most unbiased and realistic set of assumptions that will form the central case that is presented in the Appraisal Summary Table (AST)’*

The core scenario for the M4 Corridor around Newport comprises:

- NTEM/NTM Growth assumptions as detailed in Sections 3.2 and 3.3;
- Inclusion of the proposed developments listed in Section 3.4.1;
- Inclusion of the highway schemes listed in Section 3.4.2;
- Retention of the Severn Crossing Tolls; and
- Assumptions in accordance with WebTAG.

4.3 Construction of Reference Case Matrices

The 2022 forecast trip matrices were developed from the validated 2012 base year matrices, and these in turn formed the basis for the development of the 2037 forecast trip matrices.

NTEM factors for the forecast years (excluding the adjustment for income and fuel cost growth) are extracted using TEMPRO for the three car trip purposes in the AM peak, interpeak and PM peak periods. For each user class the relevant set of growth factors from NTEM, as detailed in Appendix A, is applied to the corresponding model zones in the base trip matrices.

The trips generated by the development proposals listed in Table 3.2 are then added to the factored matrices. WebTAG Unit M4 states, however, that model forecasts should be controlled to the benchmark provided by the NTEM data. In order to ensure that overall growth is constrained to the level set by the NTEM forecasts, the NTEM factored matrices are reduced by the equivalent number of development trips that are added separately.

This process ensures that the forecast trip matrices form a reference case for traffic growth that is consistent with NTEM growth forecasts at a district level while taking account of specific development proposals. A similar process is undertaken with the NTM growth applied to the LGV and HGV user class matrices.

The resulting forecast trip matrices, with the inclusion of the specific developments listed in Table 3.2, are therefore controlled to the overall growth factors obtained from NTEM and NTM. The growth in trips by user class from 2012 to 2022 is shown in Table 4.1, and that from 2022 to 2037 is shown in Table 4.2.

Table 4.1: Forecast Vehicle Trip Matrix Totals, 2022 (Central Growth)

User Class	2012	2022				
	Base Trips	NTEM Reference Growth	Adjusted Development Trips (a)	Revised Base Growth (b)	Revised Growth with Dvlpts (a+b)	% Growth from 2012
AM						
Car Employer Business	7,805	8,794	399	8,395	8,794	12.6
Car Other	13,493	14,911	864	14,047	14,911	10.5
Car Commuting	22,596	25,544	1,382	24,163	25,545	13.1
LGV	5,407	6,899	341	6,558	6,899	27.6
HGV	7,390	7,893	580	7,313	7,893	6.8
Total	**58,539**	**64,041**	**3,566**	**60,476**	**64,042**	**9.4**
IP						
Car Employer Business	5,545	6,236	399	5,837	6,236	12.5
Car Other	19,785	22,014	1,730	20,284	22,014	11.3
Car Commuting	5,888	6,629	620	6,009	6,629	12.6
LGV	4,349	5,550	258	5,292	5,550	27.6
HGV	7,703	8,226	364	7,862	8,226	6.8
Total	**43,270**	**48,655**	**3,371**	**45,284**	**48,655**	**12.4**
PM						
Car Employer Business	8,857	10,016	530	9,486	10,016	13.1
Car Other	21,202	23,679	1,320	22,358	23,678	11.7
Car Commuting	19,120	21,437	1,175	20,263	21,438	12.1
LGV	4,154	5,301	224	5,077	5,301	27.6
HGV	4,294	4,586	250	4,336	4,586	6.8
Total	**57,627**	**65,019**	**3,499**	**61,520**	**65,019**	**12.8**

Table 4.2: Forecast Vehicle Trip Matrix Totals, 2037 (Central Growth)

User Class	2022	2037				
	Growth with Dvlpts	NTEM Reference Growth	Adjusted Development Trips (a)	Revised Base Growth (b)	Revised Growth with Dvlpts (a+b)	% Growth from 2022
AM						
Car Employer Business	8,794	10,312	742	9,570	10,312	17.3
Car Other	14,911	16,221	2,094	14,127	16,221	8.8
Car Commuting	25,545	30,171	2,691	27,481	30,172	18.1
LGV	6,899	9,791	825	8,966	9,791	41.9
HGV	7,893	9,363	1,467	7,896	9,363	18.6
Total	**64,042**	**75,858**	**7,819**	**68,039**	**75,859**	**18.5**
IP						
Car Employer Business	6,236	7,279	650	6,629	7,279	16.7
Car Other	22,014	24,022	2,326	21,696	24,022	9.1
Car Commuting	6,629	7,697	798	6,900	7,698	16.1
LGV	5,550	7,877	641	7,236	7,877	41.9
HGV	8,226	9,759	1,162	8,597	9,759	18.6
Total	**48,655**	**56,634**	**5,477**	**51,058**	**56,635**	**16.4**
PM						
Car Employer Business	10,016	11,788	1,256	10,532	11,788	17.7
Car Other	23,678	26,420	2,283	24,137	26,420	11.6
Car Commuting	21,438	24,968	2,027	22,943	24,970	16.5
LGV	5,301	7,523	544	6,979	7,523	41.9
HGV	4,586	5,441	399	5,042	5,441	18.6
Total	**65,019**	**76,140**	**6,509**	**69,633**	**76,142**	**17.1**

4.4 Alternative Scenarios

WebTAG Unit M4 advises that, in addition to a ‘core’ scenario, a range of sensitivity tests and/or alternative scenarios should be developed to account for future uncertainty in traffic forecasting, in order to allow the provision of a range of outcomes that consider the potential effects of uncertainty within the model.

4.4.1 Low and High Growth Alternative Scenarios

Alternative Low Growth and High Growth scenarios have been produced in accordance with the guidance.

The high growth scenario comprises a proportion of the base year demand added to the demand from the core scenario. The low growth scenario comprises the same proportion of demand from the base year subtracted from the core scenario demand.

The proportion of the base year demand adjustment depends on the forecast year. For highway demand, the adjustment is ±2.5% of base demand for forecasts one year ahead, rising with the square root of the number of years to ±15% for forecasts 36 years ahead (i.e. 5% four years ahead, 7.5% nine years ahead, 10% 16 years ahead, 12.5% twenty five years ahead).

On this basis, the proportion of base demand added to the core scenario to give the low and high growth alternative scenarios is as shown in Table 4.3.

Table 4.3: Adjustment Factors to Account for Uncertainty

Year	Low Growth	High Growth
2022	- 7.91%	+ 7.91%
2037	- 12.50%	+ 12.50%

4.4.2 Removal of Severn Crossing Tolls

An alternative to the central growth core scenario has been run where it was assumed that the tolls across the River Severn were removed. Removal of the Severn tolls would be expected to encourage travel between South East Wales and England and this additional demand could affect the scheme appraisal for the new section of motorway to the south of Newport.

The demand in the 2012 base year traffic model did not include trips within Severnside that do not cross the Severn Bridges and therefore enter south east Wales. For this reason, the variable demand model developed for the M4 Corridor around Newport could not be used to estimate the number of trips that would redistribute from origins/destinations in Severnside to locations in South East Wales in response to removal of the tolls.

A previous study[10] estimated that if the tolls across the Severn were removed that demand in 2018 would increase by 12%. The projected increases in traffic across the Severn were taken from this study and interpolated/extrapolated to give the expected increases for the forecast years of 2022 and 2037.

The traffic crossing the Severn Bridges in the forecasts has thus been factored to take account of the predicted increase due to the removal of the tolls. This increased demand has been re-run through the Variable Demand Model to take account of the impact of this increased traffic on congestion levels and therefore overall demand.

4.4.3 No Future Traffic Growth

A further alternative forecast scenario has been developed assuming that there would be no future traffic growth within the study area. For the purposes of this, the base year demand has been assigned to the future year networks, with no variable demand applied.

4.5 Reference Case Forecasts

The reference case demand detailed in this Chapter has been assigned onto the Do Minimum network described in Section 5.1. This assignment does not form any part of the traffic forecasts for the M4 Corridor Around Newport, but it does

[10] 'The Impact of the Severn Tolls on the Welsh Economy', Arup and University of the West of England on behalf of Welsh Government, May 2012

provide a useful benchmark for monitoring the effects of the variable demand modelling (VDM).

5 Future Year Highway Networks

This section describes the development of the forecasting networks, which have been built for the future year situation without the new section of motorway to the south of Newport (the Do Minimum network) and with the new section of motorway south of Newport in place (the Do Something network).

5.1 Do Minimum Scenario

5.1.1 Do Minimum Highway Schemes

A review of proposed highway schemes within the study area has been undertaken. From this, a list of highway improvements to be included in the traffic model for the M4 Corridor Around Newport has been identified, as detailed in Section 3.4.2 of this report. All of these schemes are coded into the Do Minimum Scenario networks.

5.1.2 Severn Crossing Tolls

As discussed in Section 3.4.3, the current tolls across the two Severn River Crossings have been included in the base and forecast year scenarios.

The toll charges in the forecast networks have been retained at the same values as in the base year model. The underlying assumption for this is that the tolls would increase in line with inflation in future years but would need to be in terms of 2012 prices for consistency with the other route choice generalised costs, PPM and PPK, as detailed in Section 2.5.

The time penalties are also the same as in the 2012 base year model as it is assumed that Severn River Crossing plc would work to ensure that delays would not deteriorate at the toll booths due to increasing volumes of traffic.

Removal of the Severn Crossing Tolls has been tested as an alternative to the core scenario. As well as the demand adjustments, detailed in Section 4.4.2, this involves editing the future year highway networks to remove the monetary and delay penalties associated with the tolls.

5.1.3 Buffer Network

The buffer network is the wider highway network in the area of influence of the M4 Corridor around Newport, which is less detailed than the core model (simulation) network. The buffer network in the model includes links carrying all traffic that would pass through the model study area; however it would not include the full flows on these links. For example, traffic on the M5 motorway that enters Wales would be included on the M5 links in the M4 Corridor around Newport traffic model, but M5 trips between Bristol and the Midlands would not. As such links in the buffer network do not include the full traffic flows, so speed-flow relationships cannot be used directly to ascertain the speed on these links.

In the base year model, the buffer link speeds have been estimated based on recorded speed data or by applying speed-flow relationships to traffic count data. For the forecast model, the buffer link speeds have been estimated by applying national growth factors to the buffer link counts (or flows corresponding to the observed speeds) to determine the likely future year traffic flow and then applying appropriate speed-flow relationships for the type of road. These have been then coded directly into the buffer network as fixed speeds.

5.2 Do Something Scenario

5.2.1 New Section of Motorway to the South of Newport

In order to define the Do Something network, the new section of motorway to the south of Newport between Junction 23 (Magor) and Junction 29 (Castleton) has been added to the Do Minimum network described in Section 5.1. The new section of motorway to the south of Newport is some 22.5km in length and includes the following elements:

- construction of new sections of dual 3-lane motorway routed to the south of Newport with major tie-in arrangements east of Magor and at Junction 29 (Castleton Interchange) on the existing M4 motorway;
- an all movements junction on the west bank of the River Usk to improve access to central Newport and Newport Docks (Docks Junction);
- an all movements junction at Glan Llyn (Glan Llyn Junction) to provide access to the East Newport Development Area, which is allocated for employment and residential uses within the Newport Unitary Development Plan and the emerging Local Development Plan; and
- a junction east of Magor to improve connectivity between the M4, M48 and B4245;

The motorway south of Newport scheme proposal is shown in Figure 1.1.

5.2.2 Alternative Scheme Options

As part of option development, the new section of motorway to the south of Newport scheme has been tested further to ascertain the impact on scheme performance of removing the proposed Docks Junction.

5.3 Forecast Network Checks

Checks of the future year networks have been undertaken to ensure that all future year schemes are accurately represented.

The future year schemes have been coded within GIS. Link distances have been derived directly from the software, and visual checks have been made.

Traffic signal information was not available for all of the schemes. In this case, initial assignments have been checked, and signal timings manually adjusted to ensure the most efficient operation practicable at the junction. It should be noted that SATURN has not been used to optimise signal timings, as it is recognised that doing so can lead to questionable results within the SATURN assignment process.

In addition to the above, the variable demand model has been run where the generalised costs in the forecast networks have been kept the same as in the 2012 base year model. This has enabled the effects of network changes to be isolated, along with background growth. Time and distance skim matrices have been examined and differences between the 2012 base, Do Minimum and Do Something costs have been checked to ensure that these are realistic given the network changes taking place in each scenario.

6 Variable Demand Model

6.1 Introduction

Transport schemes that have an effect on journey times and cost will, in principle, influence the level of demand for travel. The opening of a new scheme can elicit a number of responses by travellers including trip reassignment, re-timing, re-distribution and modal shift. These responses can result in additional trips and additional vehicle kilometreage on the road network, known as “induced traffic”.

Conversely, congested conditions can lead to “trip suppression” which could manifest itself as peak spreading, modal switching to public transport, and/or reduction in the number, length or frequency of journeys. These responses, as well as re-distribution, can lead to reduced vehicle kilometreage on the road network.

Variable Demand Modelling (VDM) is required to reflect these changes in travel demand in response to changes in travel cost. TAG Unit M2[11] provides guidance on VDM.

6.2 VDM Methodology

6.2.1 The VDM Process

DfT recommendation in WebTAG has been followed in setting up an incremental rather than an absolute model. Incremental models predict changes in demand when fed by changes in costs.

For the M4 Corridor around Newport, the VDM is undertaken using DIADEM (Dynamic Integrated Assignment and Demand Modelling) software, which makes use of the SATURN highway assignment model. Figure 6.1 illustrates the variable demand modelling process.

The variable demand model for the M4 traffic model uses trip demand matrices in Origin-Destination (O-D) format rather than Production-Attraction (P-A) format. This is because at the time that the base matrices were originally developed from the 2005 roadside interview surveys, which form the basis of the demand in the 2012 base year model, the DIADEM software was only able to process matrices in O-D format.

Chapter 4 provides a description of the derivation of the Reference Case matrices, which are input to the demand model in the future years. These matrices reflect the changes in demand from the base year attributable to demographic changes such as the number of jobs in an area, the number of residents in an area and the number of cars they own. They represent the travel demand that would arise if there were no changes in travel costs from the base year model.

This chapter documents the adjustments made by the variable demand model to the input Reference Case matrices for the Core scenario. The adjustments are described for the Do Minimum and Do Something scenarios.

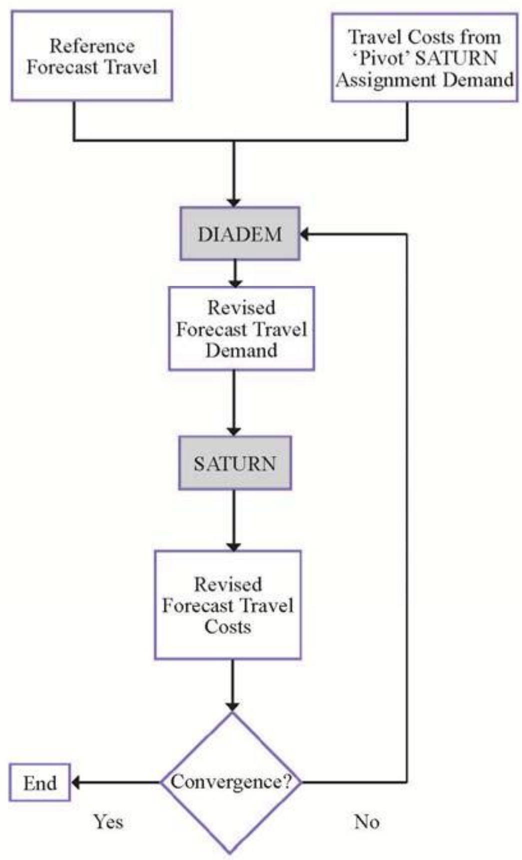
[11] Transport Analysis Guidance, TAG Unit M2, Variable Demand Modelling, Department for Transport, January 2014

The demand model is an incremental multinominal logit model. The demand model applies variable demand by using the base year costs and the Reference Case trip patterns, derived from the base year trip matrix assuming no changes in travel costs. The demand model then pivots travel costs off the base year assignment to create the Do Minimum matrix accounting for:

- Transport interventions between the base year and the forecast year;
- Increases in the value of time resulting from real increases in income;
- Increases in levels of congestion arising from increased car usage; and
- Increases in fuel efficiency that make car travel cheaper.

The Do Something scenario is then generated by using travel costs from the converged Do Minimum Scenario as the pivot point.

Figure 6.1 The Variable Demand Modelling Process



If the generalised cost for a trip is greater than the cost in the reference assignment, then there would be some degree of trip suppression. Similarly, a decrease in travel cost would lead to trip induction. The extent of trip suppression/induction is governed by the spread parameter λ and the scaling parameter θ, for which, in the absence of local data, illustrative values are provided in TAG Unit M2.

Prior to the traffic forecasting using VDM, realism testing on the base year traffic model was undertaken to ensure that the M4 Corridor around Newport traffic model responds to changes in travel costs in a realistic way. Further details of the calibration of the VDM and base year realism tests carried out to demonstrate realistic model responses are given in the LMVR, referred to in Section 2.1 of this report.

In developing the variable demand model parameters to be used in forecasting, the initial values have been based on median illustrative values of λ by journey purpose quoted in WebTAG. A systematic approach has then been followed to calibrate the parameters. This process also involves the incorporation of cost damping parameters to weaken the response of long distance journeys.

In creating the VDM forecasts, a systematic procedure has been followed in order to identify changes in travel demand and trip lengths that occurred as a result of the various possible causes discussed in this chapter. The Core Scenario Reference Case matrices were developed first and assigned onto the forecast year Do Minimum network as a fixed demand assignment in order to capture the growth in trips and kilometres travelled resulting from growth factors included in creating Reference Case matrices, but excluding any variable demand effects. The Reference Case assignments act as a benchmark to compare against in each forecast year, but are not an essential component of the VDM process.

The Core Scenario Do Minimum forecasts were then produced and changes in trip totals and travel patterns compared with the respective Reference Case for each of the two modelled years 2022 and 2037. By comparing these model runs variable demand responses resulting from any changes in travel costs between the base year and the forecast Do Minimum could be isolated.

Finally the Core Scenario Do Something forecasts have been produced and changes in travel patterns compared with the Do Minimum. Any demand responses from the VDM process within this run are attributable to the new section of motorway south of Newport.

6.2.2 Elastic/Fixed User Classes

Variable Demand Modelling is only carried out for car trips and not for freight trips, as it is sufficient to assume that the total freight traffic is fixed, but susceptible to re-routeing. For car trips, the variable demand parameters (the spread parameter λ and scaling parameter θ) can vary significantly between different trip purposes. This reflects the likelihood that more essential travel, such as employer's business trips, may be less affected by congestion than discretionary travel, such as leisure trips.

6.2.3 Dynamic Responses

In practice, there are a number of possible responses to changes in travel costs including:

1. Changing route (reassignment);
2. Trip re-timing;
3. Travelling to alternative destinations;

4. Changing mode of travel;
5. Switching from travelling as a car passenger to driving and vice versa;
6. Changing frequency of some journeys;
7. Making entirely new journeys or deciding not to travel; and
8. In the longer term changing land use patterns, which will also change trip patterns.

The M4 Corridor around Newport traffic model handles the first response listed above, changing route, as part of the SATURN assignment process. The remaining responses are modelled through DIADEM in the form of a SATURN interface and multi-stage demand models. These are summarised in Table 6.1.

Table 6.1: Travel Choices within DIADEM

Type of Model	Responses Covered
Trip Generation/Frequency	6, 7 and some of 8
Trip Redistribution	3
Mode choice	4
Peak Spreading/Travel Time Choice	2

In the case of the M4 corridor around Newport traffic model, trip redistribution and frequency responses have been included. In the absence of a mode choice model, the frequency has also been used as a proxy for mode transfer.

The trip redistribution response has not taken account of intra-zonal trips in the variable demand modelling as the zones within the modelled area are small, especially in the immediate area of influence of the new section of motorway to the south of Newport. The derivation of the M4 Corridor around Newport SATURN zoning system is in accordance with the guidance in WebTAG. There are 443 zones in the forecast model with a detailed coverage within and around Newport and a coarser level of detail outside the larger area of influence as shown on Figure 2.1. The level of detail for the intermediate sized zones between Newport and this larger area of influence is considered appropriate to include those trips that are relevant for the purposes of this study. The zoning adopted is such that the scope for demand and opportunities for trip redistribution to impact on the motorway network is considered to be negligible. The extent of the traffic model zones is shown in Figures 2.2 to 2.4.

The re-timing of trips can be split into two distinct elements:

- macro time period choice, where travellers alter the timing of their activities and hence the time of day in which they travel; and
- micro time period choice, representing much smaller adjustments to departure times resulting in peak spreading.

Macro time period choice is typically only required where time period specific toll charges are introduced on highway schemes. If forecast models predict unrealistically severe congestion within peak hours then micro time period choice modelling can be introduced to reallocate trips between the peak hour and the shoulders of the peak to achieve a more realistic estimate.

In the case of the M4 Corridor around Newport, it is unlikely that future year scenarios will introduce a differential in travel cost at different times of day which would be strong enough to lead to a significant shift in trips from peak to interpeak. Whilst congestion levels within the peak are forecast to increase, the majority of peak spreading would occur within the peak hours represented in the M4 Saturn model and would therefore not lead to a notable change in the demand within the peak hour. For these reasons, the re-timing of trips has not been included as a response in the M4 variable demand modelling.

6.3 VDM Convergence

DIADEM software undertakes the variable demand modelling process in response to changing travel times or costs. The process is iterative and modifies the model demand matrices between SATURN assignments until a balance is achieved between demand and the capacity of the road network. The success in achieving this balance or equilibrium is defined using convergence criteria such as the demand/supply gap, commonly termed '%Gap'.

The objective of this process is to achieve well converged models with realistic demand responses, thereby improving the accuracy of the scheme benefit calculations. TAG Unit M2 recommends, where possible, to aim to achieve a demand/supply gap of less than 0.1%. If that cannot be reached then a demand/supply gap of no greater than 0.2% is recommended.

The results achieved from the convergence of the variable demand model for the core scenario are shown in Table 6.2.

Table 6.2: Variable Demand Model Convergence – Core Scenario

Year	Time Period	Demand / Supply Gap	
		Do Minimum	Do Something
2022	AM Peak	0.19%	0.09%
	Interpeak	0.08%	0.10%
	PM Peak	0.07%	0.06%
2037	AM Peak	0.21%	0.12%
	Interpeak	0.07%	0.06%
	PM Peak	0.06%	0.09%

The results show that the 2022 variable demand model achieves the recommended demand/supply gap in all time periods and scenarios, apart from the AM peak in the Do Minimum Scenario. However, the convergence for the AM peak in the Do Minimum Scenario is below the recommended 0.2% upper limit.

The gap parameter for the 2037 model exceeds 0.1% in the AM peak period in the Do Minimum and Do Something scenario, however the value in the Do Something does not exceed the 0.2% recommended upper limit and is therefore considered acceptable. The convergence for the AM peak Do Minimum Scenario is 0.21% and as such lies marginally above the recommended upper limit. However, a sensitivity test was carried out to determine the difference in traffic volumes, network wide travel kilometres and travel time between assignment iterations at various convergence levels. This analysis showed that the effect of a difference in convergence of 0.21% compared to the recommended upper limit of 0.2% would be negligible.

6.4 VDM Results

The output matrix resulting from VDM varies between the Do Minimum and Do Something scenarios. This is because the travel cost for vehicle trips affected by the new section of motorway to the south of Newport is likely to reduce in the Do Something scenario and consequently could lead to induced traffic. The difference in vehicle trips and kilometres travelled between the Do Minimum and Do Something traffic represents the impact of the new section of motorway to the south of Newport on network wide traffic levels.

Appendix C contains a series of tables which show the effects of the variable demand modelling in terms of number of trips and overall vehicle kilometres travelled on the network for the Core Scenario. The relative change in vehicles and kilometres travelled between the key scenarios is summarised in Table 6.3.

Table 6.3: Effects of Variable Demand Modelling on the Core Scenario

Year	Scenario	AM Peak Hour		Interpeak Hour		PM Peak Hour	
		Trips (Vehicles)	Vehicle-Kms	Trips (Vehicles)	Vehicle -Kms	Trips (Vehicles)	Vehicle-Kms
2022	Base to Reference Case	+13.5%	+11.2%	+13.1%	+11.7%	+13.1%	+11.2%
	Reference Case to Do Minimum	+0.8%	+4.1%	+0.5%	+6.9%	+0.7%	+5.4%
	Do Minimum to Do Something	+0.1%	+0.5%	+0.1%	+0.1%	+0.1%	+0.4%
2037	Base to Reference Case	+34.4%	+29.9%	+31.3%	+31.5%	+32.4%	+28.9%
	Reference Case to Do Minimum	+0.9%	+5.5%	+1.0%	+13.1%	+0.8%	+8.5%
	Do Minimum to Do Something	+0.3%	+1.4%	+0.1%	+0.2%	+0.2%	+1.2%

As described in Section 6.2.2, the matrices for LGVs and HGVs were fixed, and as such, the statistics for these userclasses are the same for the reference, Do Minimum and Do Something matrices.

Table 6.3 shows that the number of trips in the variable demand Do Minimum trip matrices is larger than in the reference matrices, with a further increase in the number of trips in the variable demand Do Something trip matrices. The increase in trips in the variable demand Do Minimum Scenario compared with the reference case results from:

- the changes in the generalised cost parameters from the base year;
- changes in the road network after the base year which are included in the Do Minimum network; and
- the effect of the additional trips due to traffic growth on the trip costs.

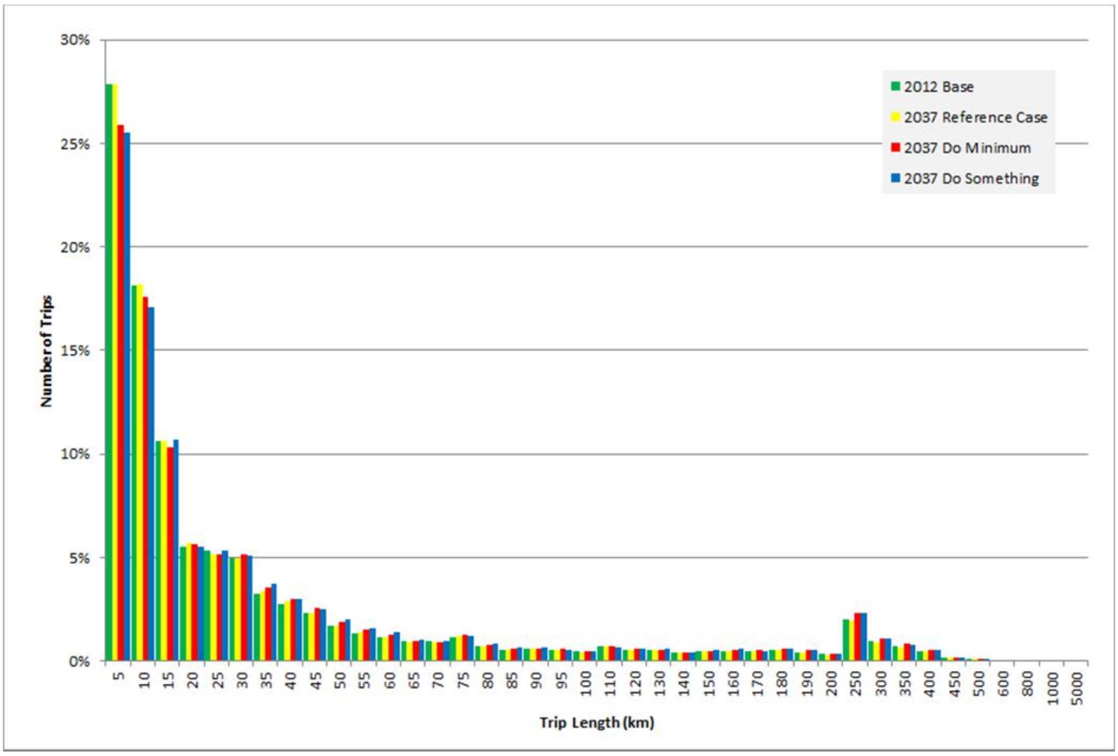
The increase in trips indicates that the effects of capacity increases due to road network improvements introduced in the Do Minimum Scenario and the effects of changes in the generalised cost parameters outweigh the effects of the increase in traffic congestion due to the traffic growth in the matrix as a whole, though these effects will vary at different locations in the network and hence for different origin-destination pairs.

The increase in trips in the Do Something scenario compared to the Do Minimum Scenario is due to induced trips as a result of the reduction in travel costs due to the increased capacity provided by the new section of motorway to the south of Newport. The change in vehicle kilometres, however, is more significant, indicating that the redistribution of trips, which can be measured as trip length reduction or increases, is the most significant variable demand response.

The distribution of trip lengths on a typical weekday in 2037 in the Reference Case, Do Minimum and Do Something scenario is shown in Figure 6.2 and compared against the average trip length from the base assignment. The data shows that there is a small amount of shift in trip lengths between scenarios, which however does not cause a significant distortion in trip lengths between the modelled scenarios. Further analysis of the core scenario in 2022 and individual time periods within both years is included in Appendix C.

The most notable change in trip lengths occurs between the Reference Case forecasts and the Do Minimum Scenarios. This confirms the point made above that the effects of capacity increases due to road network improvements introduced in the Do Minimum Scenario and the effects of changes in the generalised cost parameters outweigh the effects of the increase in traffic congestion over time.

Figure 6.2 Average Weekday Trip Length Distribution in 2037 Scenarios against Base



Further analysis of the effects of VDM for the core scenario is given in Appendix C, including a detailed analysis of the effects of VDM on trip length distribution and the spatial redistribution of travel demand in individual time periods.

6.5 VDM Sensitivity Tests

The approach adopted for the VDM for the M4 corridor around Newport traffic forecasts is described in this chapter, with further details of the rigorous checking of the outputs documented in Appendix C.

VDM runs were undertaken assuming that the generalised costs in forecast years were the same as in the 2012 base year. This was used to isolate the effects of congestion in future years on travel demand by excluding the impacts of travel costs changing over time. The results are discussed in Appendix C.

Also, sensitivity tests were undertaken where the spread parameter λ was increased by 50% for each user class. The purpose of this was to ensure that the traffic forecasts for the M4 Corridor around Newport are not so sensitive to VDM that the assumptions significantly affect the results of the economic assessment for the scheme. Further details of the results of this test are given in the Economic Assessment Report[12].

The Uncertainty Log, shown in Appendix B, includes the sensitivity tests on the VDM parameters.

[12] M4 Corridor Around Newport – Motorway to the South of Newport, Economic Assessment Report, Ove Arup and Partners, June 2014

7 M4 Corridor Around Newport Traffic Forecasts

7.1 Introduction

This chapter describes the traffic forecast assignments undertaken for the Core Scenario. Where appropriate, a description is also given for the alternative demand assumptions and scheme options.

Traffic forecasts have been prepared for two future years, 2022 and 2037. In addition to the central growth Core Scenario forecasts, traffic forecasts have also been prepared for the following alternative scenarios relating to demand:

- Low growth;
- High growth;
- Removal of Severn Tolls
- No future traffic growth after 2012.

In addition to this, traffic forecasts have also been prepared for an alternative scheme, which is the core scheme with the Docks Junction excluded.

The above traffic forecasts cover the three modelled periods of the AM Peak hour, the Interpeak hour and the PM Peak hour.

This chapter presents the traffic forecasts and an assessment of the likely future traffic patterns and journey times in forecast years on the M4 Corridor around Newport.

7.2 Model Convergence

The assignment of the trip matrix onto the model network is an iterative process, with each successive iteration converging upon the optimum equilibrium situation. The completed assignment is then based upon the final iteration. The better the convergence, the more stable the model, with less variation between successive iterations.

Guidance on the degree of model convergence is given in the DMRB Volume 12, Section 2, Part 1, Appendix H. The convergence of a traffic assignment is measured by the following two statistics:

- %FLOW, or the proportion of links in the overall network with flows changing less than 5% from the previous iteration; and

- Delta, or the duality gap, a measure of the difference between the assignment and the equilibrium situation.

A %FLOW value of above 95% and a Delta value of less than 0.1% are the criteria given in DMRB and WebTAG for stable and robust assignment results. For the M4 Corridor around Newport traffic forecasts, the duality gap was under 0.1% and the %FLOW value was above 95% for all forecast scenarios, indicating acceptable convergence.

A comparison of the convergence statistics from each of the forecast scenarios with those achieved in the 2012 base model is given in Appendix D. This shows that the level of convergence achieved in the forecast models is consistent with that achieved in the validated base model and that the convergence for all of the forecast scenarios is acceptable.

7.3 Traffic Flows

The traffic flows from the 2012 base model are shown in Figures 7.1 and 7.2 to enable a comparison of forecast traffic flows with current volumes. These Figures show that the most heavily trafficked sections of the M4 around Newport are those between Junctions 27 and 29, with between 4,500 and 5,500 vehicles travelling in each direction during the peak hours and around 100,000 vehicles per day on these sections. The least trafficked part of the motorway is the two-lane section through the Brynglas Tunnels (Junctions 25a to 26). At this location there are around 3,000 vehicles travelling in each direction during the peak hours and around 70,000 daily two-way trips. The figures show little tidality in traffic patterns, with the peak hour volumes being roughly equal in each direction along the M4 around Newport.

The forecast Do Minimum and Do Something traffic flows for the core central growth scenario are presented in Figures 7.3 to 7.8 for the AM peak hour, PM peak hour and annual average daily traffic AADT in 2022 and 2037.

The AADT flows shown in Figures 7.5 and 7.8 indicate that, with the new section of motorway in place, traffic flows would reduce on the existing route by about 35-45%. The reduction would be more significant through Brynglas Tunnels, where the flows would be expected to drop by more than half. There would also be a reduction in traffic on the local roads within Newport. Through traffic travelling between east of junction 23 and west of junction 29 would use the new section of motorway to the south of Newport, which is shorter and better aligned than the existing route and which would be operating within capacity. In addition, some traffic accessing Newport would also use the new section of motorway, utilising the intermediate junctions.

Traffic from the Valleys communities to the north of Newport would continue to use the existing route as this traffic would not have direct access onto the new section of motorway. There would also be reassignment within Newport as traffic on local roads could divert onto other roads that would be relieved by the new section of motorway, such as the existing motorway or Southern Distributor Road.

Traffic forecasts for the scenario with the new section of motorway south of Newport indicate that, in 2037, around 45,000 vehicles per day (AADT) will use the Brynglas Tunnels compared to around 95,000 vehicles per day (AADT) for the Do Minimum Scenario; whilst around 77,000 vehicles per day (AADT) would be likely to use the Usk River Crossing on the new section of motorway south of Newport.

Figures 7.9 to 7.14 and 7.15 to 7.20 show the corresponding figures for the low and high growth scenarios respectively. These indicate that under the Do Minimum Scenario, the traffic flows through Brynglas Tunnels would be expected to be within the range of 89,000 to 98,000 vehicles per day. With the new section of motorway south of Newport in place, the traffic volumes through the Brynglas Tunnels would be expected to drop to between 40,000 and 49,000 vehicles per day with the new River Usk crossing carrying between 70,000 and 83,000 vehicles per day.

Appendix E contains figures showing the turning movements at the junctions along the new section of motorway for the central growth Core Scenario.

Figures 7.21 to 7.26 show the forecast traffic flows for central traffic growth assuming removal of the Severn tolls. It can be seen that traffic volumes increase compared with the central growth core scenario owing to the removal of the tolls.

The River Severn and River Usk create a physical barrier to traffic. Summing all of the traffic on the river crossings gives ‘screenline’ flows which provide a useful measure of traffic volumes on the network whilst capturing reassignment effects. For the purposes of assessing the increase in traffic volumes due to removal of the Severn Crossing tolls, traffic volumes crossing the River Severn and the River Usk have been examined and are summarised in Tables 7.1 and 7.2.

Table 7.1: Traffic Volumes Crossing River Severn Screenline, 2037

	AADT Crossing Screenline	
Scenario	**Do Minimum**	**Do Something**
Core Scenario	100,500	103,500
High Growth	108,300	111,600
Removal of Severn Tolls	116,000	119,600

Table 7.2: Traffic Volumes Crossing River Usk Screenline, 2037

	AADT Crossing Screenline	
Scenario	**Do Minimum**	**Do Something**
Core Scenario	238,800	254,400
High Growth	253,300	275,700
Removal of Severn Tolls	243,900	263,500

The tables show that, as would be expected, the removal of the Severn Crossing tolls would attract more traffic across the Severn, with the forecasts across the Severn Bridges exceeding the high growth forecasts with the tolls in place. The projected increase in traffic across the Severn due to removal of the tolls is higher in Table 7.2 than that given in Section 4.4.2 as it also includes existing traffic travelling from the Midlands to South East Wales that would be attracted to use the Severn Crossings from alternative routes, such as the M50/A449.

The growth in traffic due to the toll removal would be concentrated in the areas closest to the bridges and the additional traffic would dissipate as distance increases. This is demonstrated by the Usk Screenline flows where the additional traffic attracted by removal of the tolls would still exceed the core central growth forecasts but would not exceed the high growth forecasts at this location.

Figures 7.27 to 7.32 show the traffic forecasts for the new section of motorway to the south of Newport scheme with the Docks Junction excluded. Comparison of these forecasts against the core scenario shows that the presence of the Docks junction would attract more traffic onto the new section of motorway south of Newport and therefore increase the level of relief to the existing M4 and other routes within Newport.

7.4 Motorway Level of Service

The traffic forecast flow diagrams referred to above also provide an indication of the level of service on the motorway network around Newport, based on the ratio of flow to capacity (RFC) and the congestion reference flow (CRF).

There is no absolute measure of ‘congestion’, in the same way as there is no trigger point of capacity at which the network fails. It is simply a matter of increased traffic flows leading to decreasing speeds, deterioration of operating conditions or a declining level of service as perceived by road users. The Design Manual for Roads and Bridges uses the concept of the CRF as a measure against which to judge acceptable performance for rural roads. The M4 around Newport also displays characteristics of an urban motorway, as defined in DMRB, passing through a built up area with closely spaced junctions. The performance of urban roads is assessed by comparing the peak hour flows with theoretical capacity (RFC). The assessment of the existing corridor has therefore been based on both CRF and theoretical capacity.

When the ratio of the AADT flow to CRF reaches 100% it is estimated that congestion will occur in approximately half of the weekday peak periods, in the peak direction. However, some problems may occur before the ratio reaches 100%. In the assessment of journey time reliability for rural roads, Transport Analysis Guidance adopts a stress-based approach, which considers the change in the ratio of flow to CRF between 75% and 125%.

The operational assessment has also included analysis of the one-way capacity, or maximum hourly throughput, of the M4 compared with the peak hour forecasts. It is generally accepted that once hourly flows reach about 80% of the theoretical capacity, operational problems can also be expected.

For the purposes of this assessment on level of service, 80% of CRF/hourly capacity has been taken as the point at which journey time reliability becomes adversely affected and congestion begins to be experienced.

Congestion, with frequent incidents, is currently an everyday occurrence on the existing M4 between junctions 23 and 29. Figure 7.1 shows that some sections of the motorway, particularly between the Brynglas Tunnels and Junction 29, are approaching peak hour capacity on a regular basis, while Figure 7.2 shows a similar picture with the CRF assessment. The restricted capacity of the Tunnels form a regular bottleneck on the motorway at peak times, while traffic queuing to leave the motorway at Junctions 26 and 28 frequently extend onto the mainline, exacerbating the problems presented by the poor alignment of the motorway between these junctions.

Under the Do Minimum Scenario, congestion would be expected to worsen as traffic volumes increase over time and 'peak spreading' is likely to occur where the duration of peak periods gets longer. Higher traffic flows will also lead to unstable conditions where a higher number of incidents and accidents are likely to occur, which in turn could bring the motorway to a standstill on a more regular basis.

Figures 7.3 and 7.4, showing the peak hour traffic flows for 2022, indicate that the existing M4 around Newport could be expected to experience frequent peak period congestion. The situation is expected to worsen between 2022 and 2037 due to traffic volumes growing over time, as demonstrated in Figures 7.6 and 7.7. These trends are reinforced by Figures 7.5 and 7.8 which show the AADTs increasing over time to exceed the threshold CRF values along the whole route between Junctions 24 and 28.

For the future year scenarios with the new section of motorway in place, the traffic volumes on the existing motorway would reduce so that it would operate within capacity. The new section of motorway would also be expected to operate within capacity.

7.5 Motorway Traffic Patterns

Analysis of the forecast traffic patterns in 2037 for the Do Minimum Scenario has shown that around 45% of the 93,500 daily traffic (AADT) passing through the Brynglas Tunnels (Junctions 25a to 26) would be likely to be 'through' trips (travelling between Junctions 23 and 29). A further 41% would be likely to either join or leave the motorway between junctions 23 and 29. The remaining 13% of daily traffic would be likely to both join and leave the motorway between Junctions 23 and 29. Figure 7.33 illustrates this breakdown of traffic movements through the Brynglas tunnels for the 2037 scenario without the new section of motorway to the south of Newport.

Analysis of the forecast traffic patterns in 2037 for the scenario with the new section of motorway to the south of Newport has shown that around 71% of daily traffic (AADT) on the River Usk Crossing on the new section of motorway would be likely to be 'through' trips (travelling between Junctions 23 and 29) with no 'through' trips using the existing motorway. A further 22% of daily traffic using the new section of motorway would be likely to either join or leave the motorway at Newport, either via the Docks Junction or Glan Llyn Junction. Some 7% of daily traffic using the new section of motorway would be likely to both join and leave the motorway around Newport, travelling between the Docks Junction and Glan Llyn Junction. This breakdown of traffic movements using Brynglas tunnels and the new section of motorway Usk River crossing is illustrated in Figures 7.34 and 7.35 respectively.

7.6 Journey Times

Information on travel times through the network was extracted from the core scenario traffic forecasts. The journey times between Junction 30 of the M4 and the toll plaza at the Second Severn Crossing were analysed in order to ascertain the journey time savings on the motorway that would result from the construction of the new section of motorway to the south of Newport. The results of the journey time analysis are presented in Table 7.1.

Table 7.1: Journey Time between Junction 30 and M4 Toll Plaza (min:sec)

Direction	Time Period	Route	2022 Central Growth		2037 Central Growth	
			Do Minimum	Do Something	Do Minimum	Do Something
Eastbound	AM	Via M4	00:19:02	00:18:02	00:24:00	00:18:47
	IP	Via M4	00:16:52	00:17:10	00:18:08	00:17:25
	PM	Via M4	00:17:30	00:17:23	00:19:11	00:17:36
	AM	Via new motorway		00:14:36		00:15:00
	IP	Via new motorway		00:14:19		00:14:32
	PM	Via new motorway		00:14:22		00:14:33
Westbound	AM	Via M4	00:19:00	00:18:12	00:22:38	00:18:33
	IP	Via M4	00:17:09	00:17:41	00:17:57	00:17:55
	PM	Via M4	00:19:14	00:19:42	00:23:51	00:19:59
	AM	Via new motorway		00:14:30		00:14:47
	IP	Via new motorway		00:14:19		00:14:28
	PM	Via new motorway		00:14:35		00:14:59

The motorway journey times in 2022 show that, in most cases, travel on the existing M4 would become quicker in both directions as a result of the new section of motorway to the south of Newport. The journey time along this section of motorway would be expected to increase slightly in both directions during the interpeak and westbound in the PM peak hour. This is because of the proposed realignment of the existing corridor between Junctions 23 and 23a at the tie in with the new section of motorway, which results in an increase in distance of around 600m. Despite the distance increase, travel times during the AM peak hour would be expected to reduce slightly.

By 2037, the increased traffic volumes would mean that the reduced congestion levels due to the new section of motorway would outweigh the additional distance to travel, giving a time saving overall in each time period. During the peak hours, this average time saving would be expected to be between around 1.5 and 5 minutes.

Through traffic would be expected to use the new section of motorway to travel east-west between Magor and Castleton and the journey time savings for this traffic would be more significant due to the shorter distance and reduced congestion levels. During the interpeak, the time savings would be expected, on average, to be around 2.5 minutes in 2022, increasing to around 3.5 minutes by 2037. During the peak hours, the journey time savings could be expected to be, on average, between 3 to 4.5 minutes in 2022, increasing to between 4.5 and 9 minutes in 2037.

It should be noted that the traffic model assumes 'typical' conditions without any incidents to disrupt traffic. In reality, as traffic volumes increase on the existing corridor without the new section of motorway in place, conditions are likely to become more unstable leading to a higher frequency of incidents. Incidents on the existing corridor have been seen to result in stop-start conditions, sometimes even bringing traffic to a standstill. These impacts on journey time reliability are not taken into account by the traffic model.

Further details of the expected journey times along the motorway for the alternative scenarios tested are given in Appendix F.

7.7 Summary

The traffic forecasts indicate that future traffic growth will result in severe congestion on the existing M4 which will result in increased journey times. The results indicate that, for the Do Minimum Scenario, one-way flows on the M4 motorway links would be constrained by the capacity of the motorway (theoretically, some 5,600 vehicles per hour for the 3-lane sections and 4,000 vehicles per hour on 2-lane sections).

As flows approach the theoretical capacity, the following characteristics will become increasingly evident:

- The speeds of individual vehicles will not be constant.
- Lane changing will still occur, although opportunities are likely to be very limited.
- Off-side speeds will be similar to the near-side speeds and may be slightly lower over short periods.
- Any minor incident is likely to result in unrecoverable flow breakdown and queuing traffic and will lead to a reduction in throughput.

This indicates that as flows approach, and in some cases exceed, capacity on the existing corridor, traffic conditions will become unstable, where there is likely to be an increased number of accidents and incidents which could bring the motorway to a standstill as an increasingly frequent occurrence.

With the motorway to the south of Newport, the traffic volumes on the existing route between junctions 23 to 29 would be reduced. Unlike the Do Minimum Scenario, this section of the route around Newport is not expected to be congested by the year 2037. The new section of motorway is also expected to reduce traffic flows on local roads within Newport as capacity is released on the existing motorway route and the Newport Southern Distributor Road. Journey times along the new section of motorway would be expected to reduce compared to those on the existing motorway in the Do Minimum Scenario. Realignment of the existing corridor between Junctions 23 and 23a to accommodate the tie-in with the new section of motorway would result in a slight increase in distance along this route. However, the reduced congestion levels would mean that journey times would only slightly increase during the interpeak and pm peak in 2022. Overall journey times along the existing corridor would be expected to reduce during the am peak in 2022 and for all time periods by 2037 compared to the Do Minimum Scenario.

Journey time reliability is also likely to improve as a result of the new section of motorway to the south of Newport. The existing motorway currently experiences congestion, which can lead to stop-start conditions on a regular basis. As traffic volumes increase over time the frequency, severity and duration of incidents that bring the motorway to a standstill can be expected to increase. With the new section of motorway in place, the existing motorway would be expected to experience less frequent incidents leading to stop-start traffic conditions due to the lower volumes of traffic. In addition to this, the new section of motorway would offer increased network resilience as it could provide a diversionary route in the event of maintenance work, an incident or congestion on the existing corridor.

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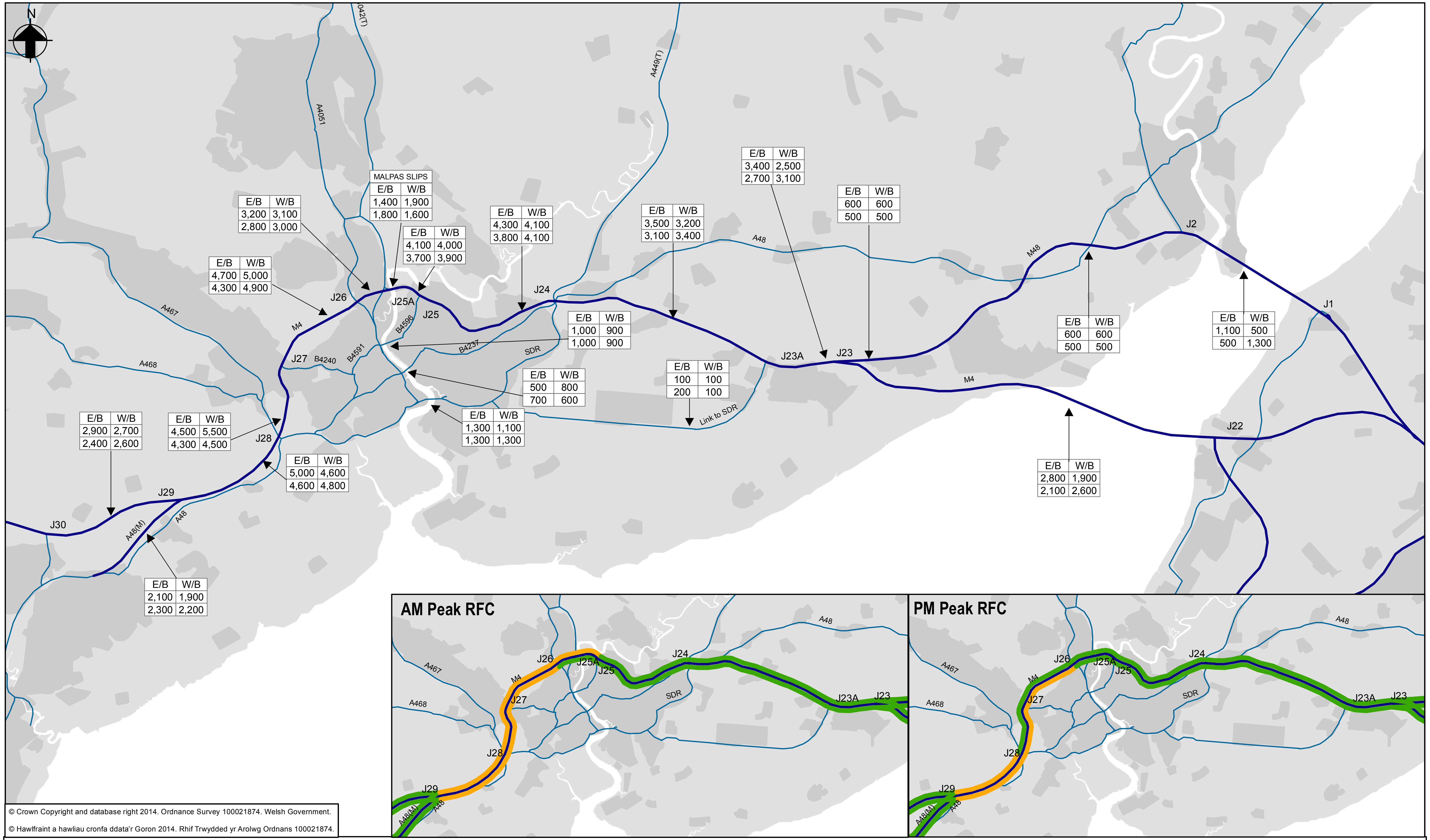

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Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	AM Peak Flows (veh/hr)
x	x	PM Peak Flows (veh/hr)

P0	2014-06-19	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
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Llywodraeth Cymru
Welsh Government

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title

Figure 7.1
Base Year
Peak Hour Flows

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0120**

Issue **P0**

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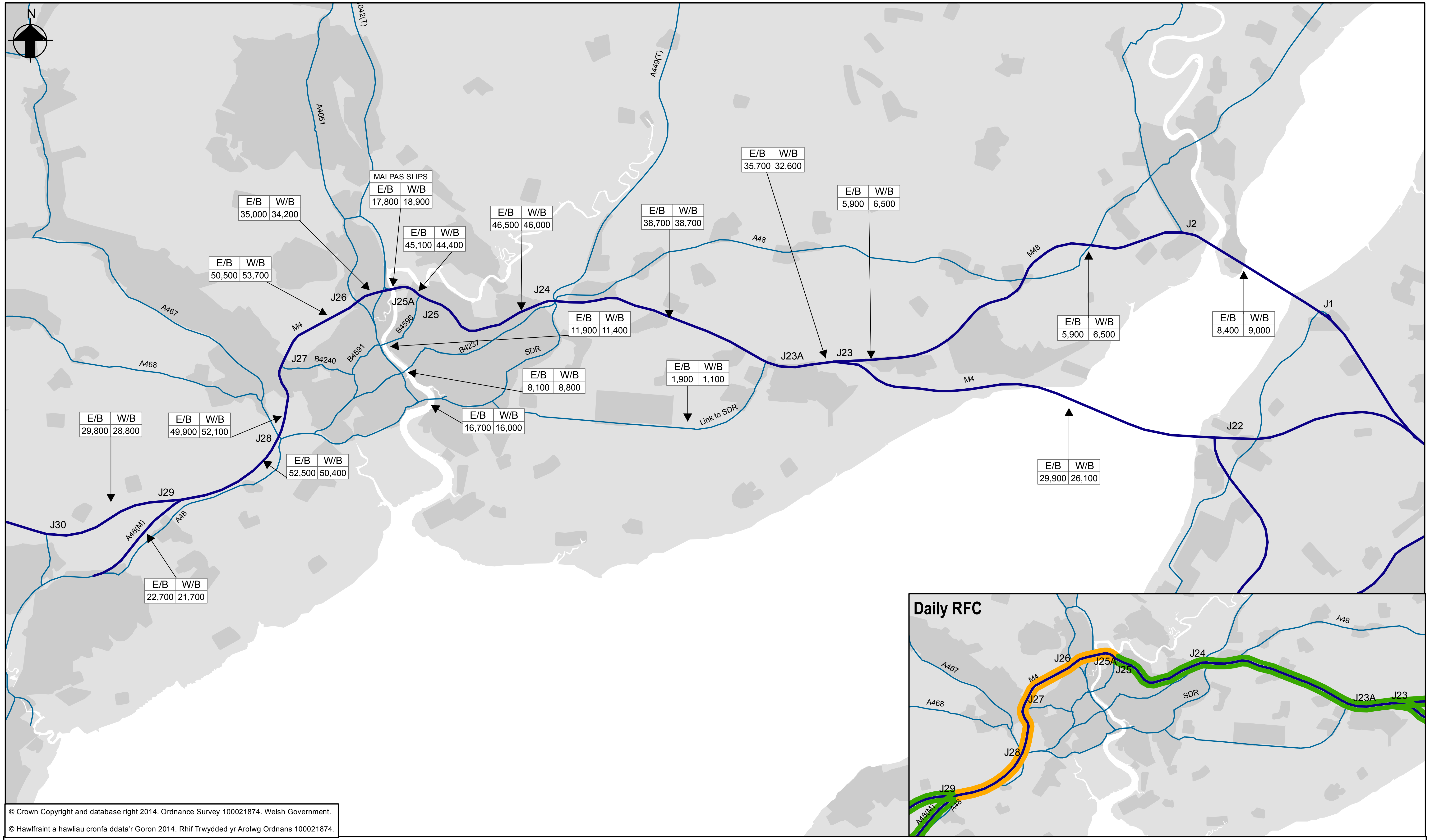

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Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B
x	x

Daily Flows (veh/day)

P0	2014-06-19	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
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Trafnidiaeth
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Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title

Figure 7.2
Base Year
AADT Flows

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0121**

Issue **P0**

25/06/2014 15:32:51

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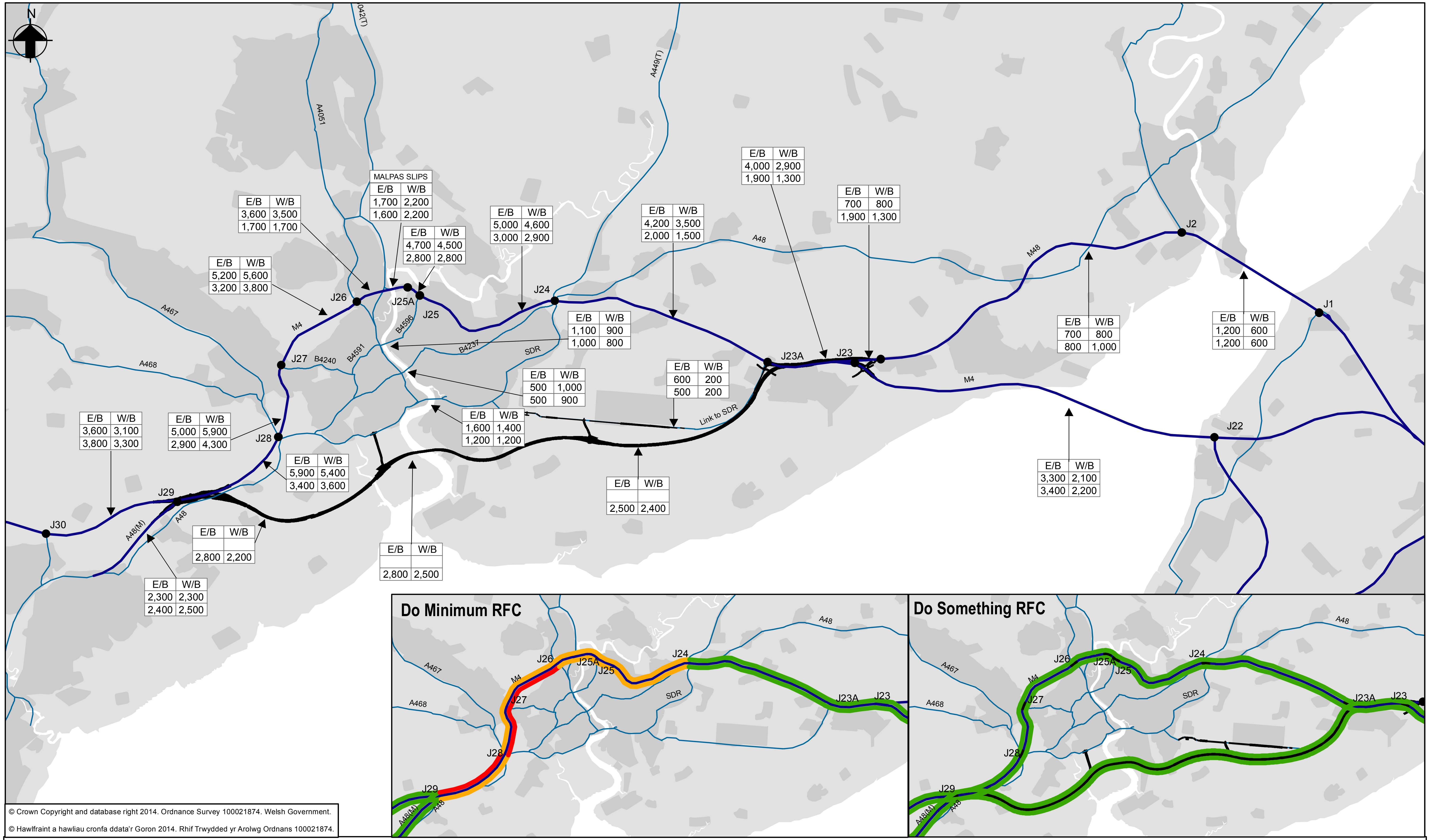

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-12	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
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CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title
Figure 7.3
Core Scenario
2022 AM Peak Hour
Central Growth

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0105**

Issue **P0**

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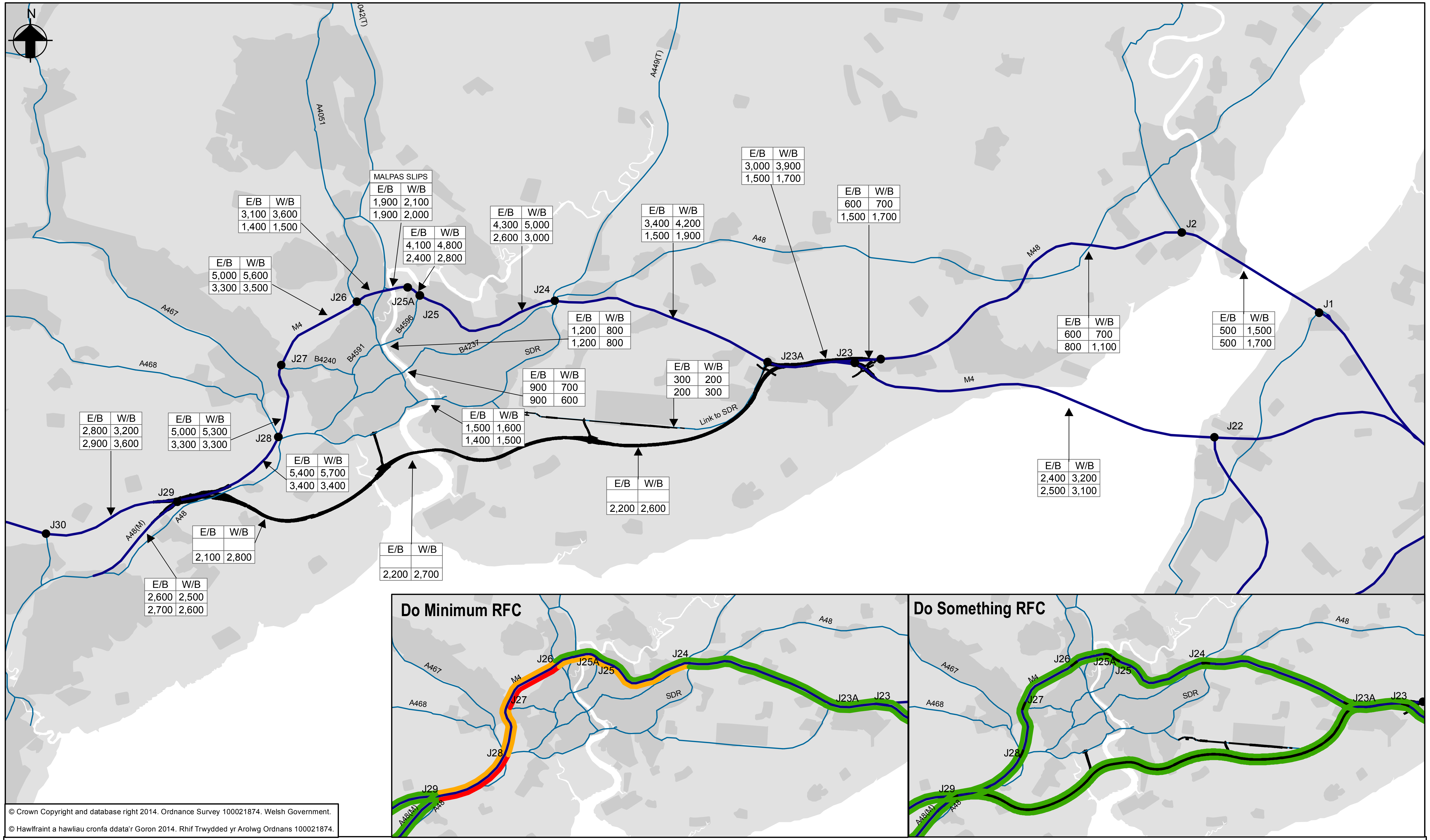

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

Issue	Date	By	Chkd	Appd
P0	2014-06-18	JO	SP	SP
	Preliminary			

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

ARUP

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Drawing Title
Figure 7.4
Core Scenario
2022 PM Peak Hour
Central Growth

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0106**

Issue **P0**

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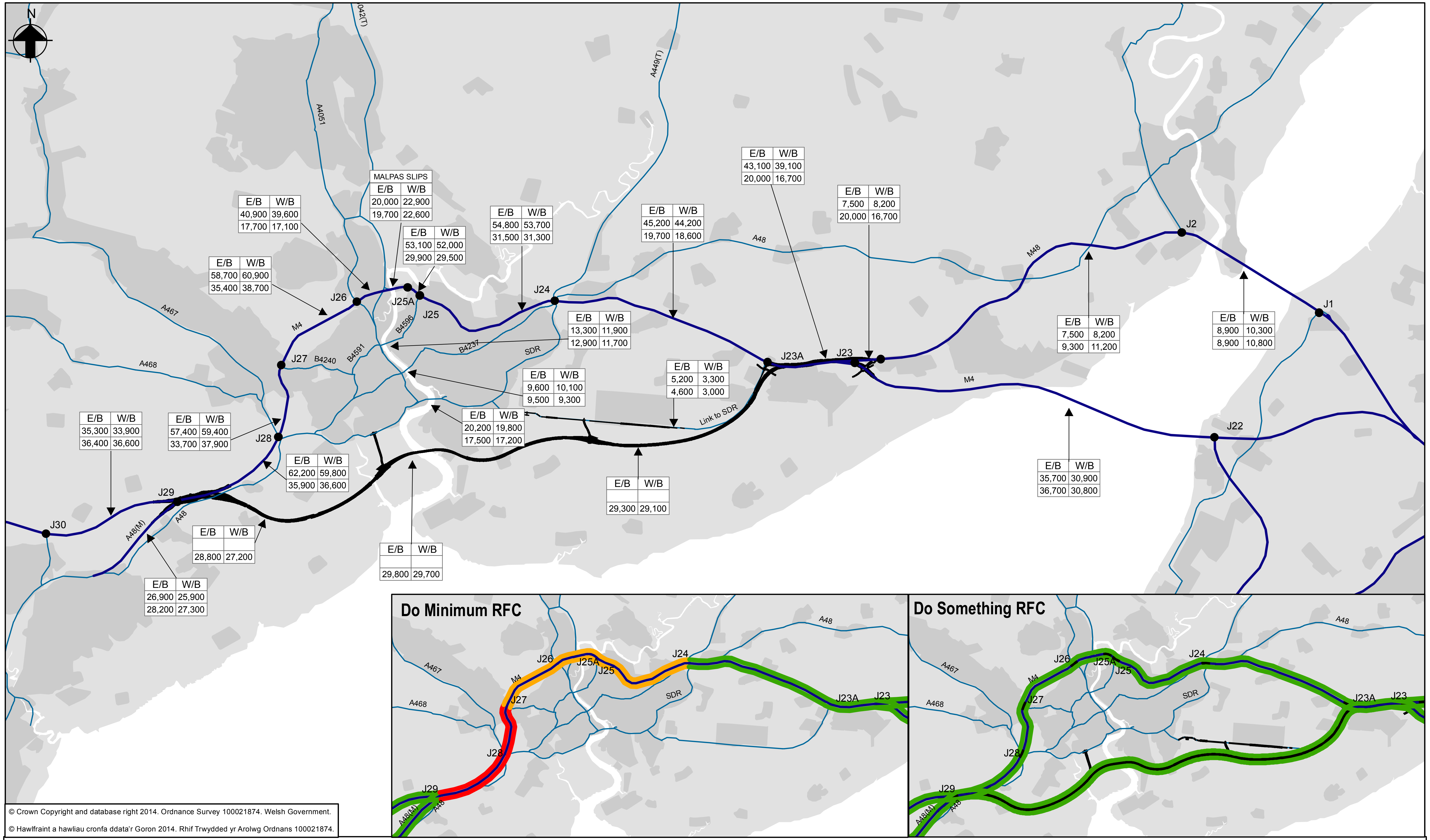
A3



Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

ARUP

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Drawing Title
Figure 7.5
Core Scenario
2022 AADT
Central Growth

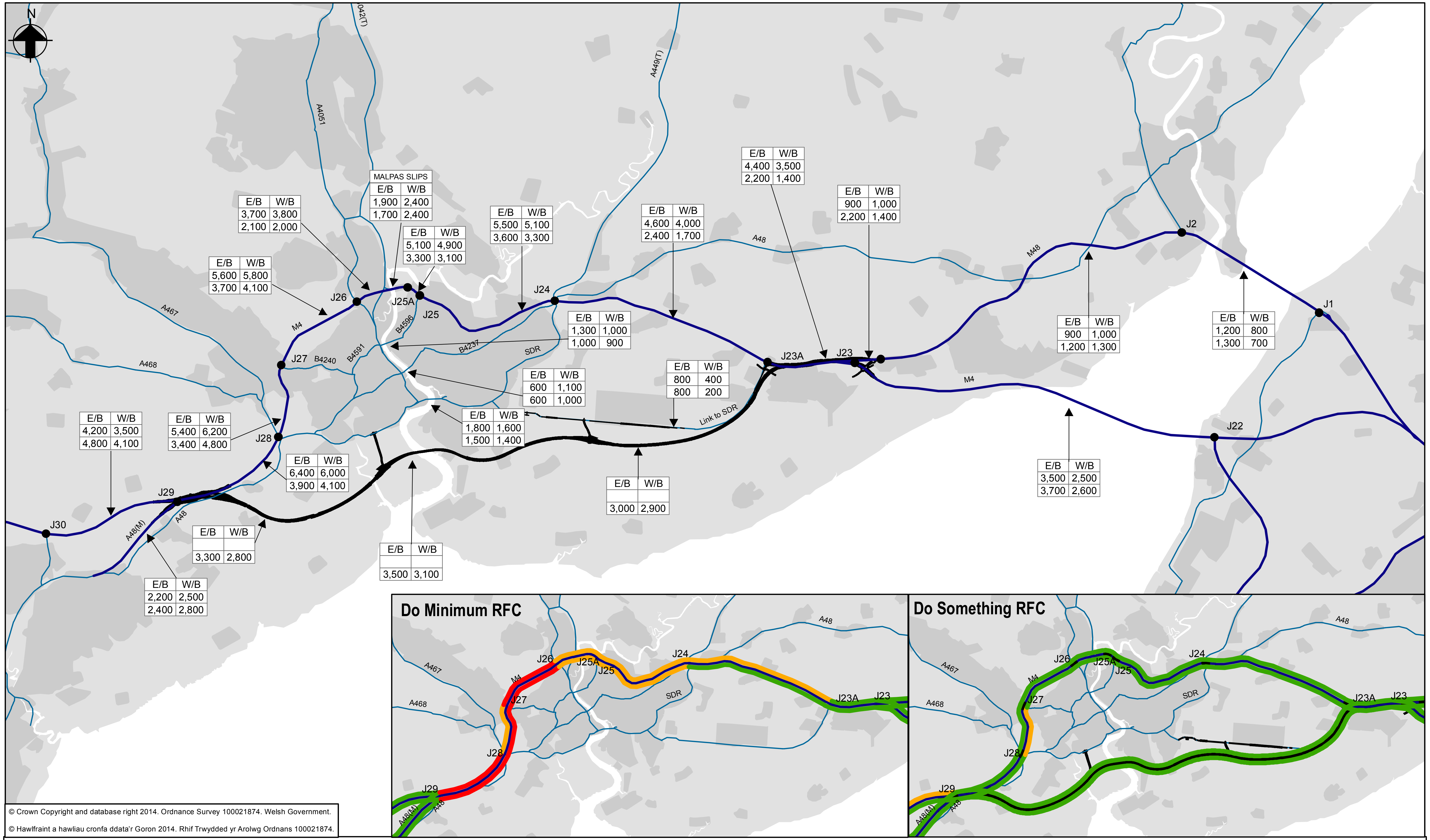
Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0109**

Issue **P0**

A3



Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.6
Core Scenario
2037 AM Peak Hour
Central Growth

Job No
117300-01

Drawing Status
Preliminary

Drawing No
M4-OA-50-00-DR-Z-XX-0107

Issue
P0

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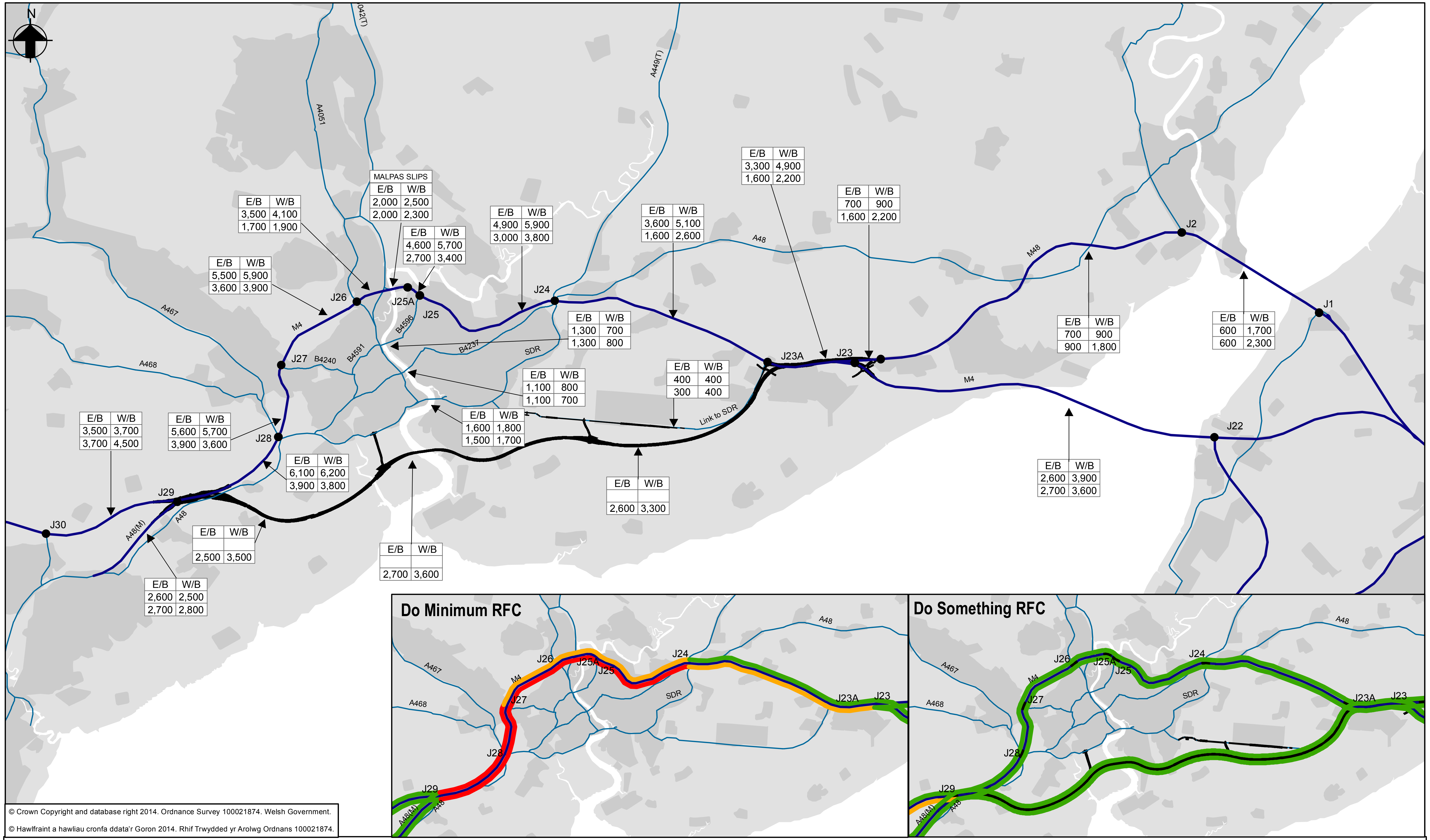

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Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.7
Core Scenario
2037 PM Peak Hour
Central Growth

Job No
117300-01

Drawing Status
Preliminary

Drawing No
M4-OA-50-00-DR-Z-XX-0108

Issue
P0

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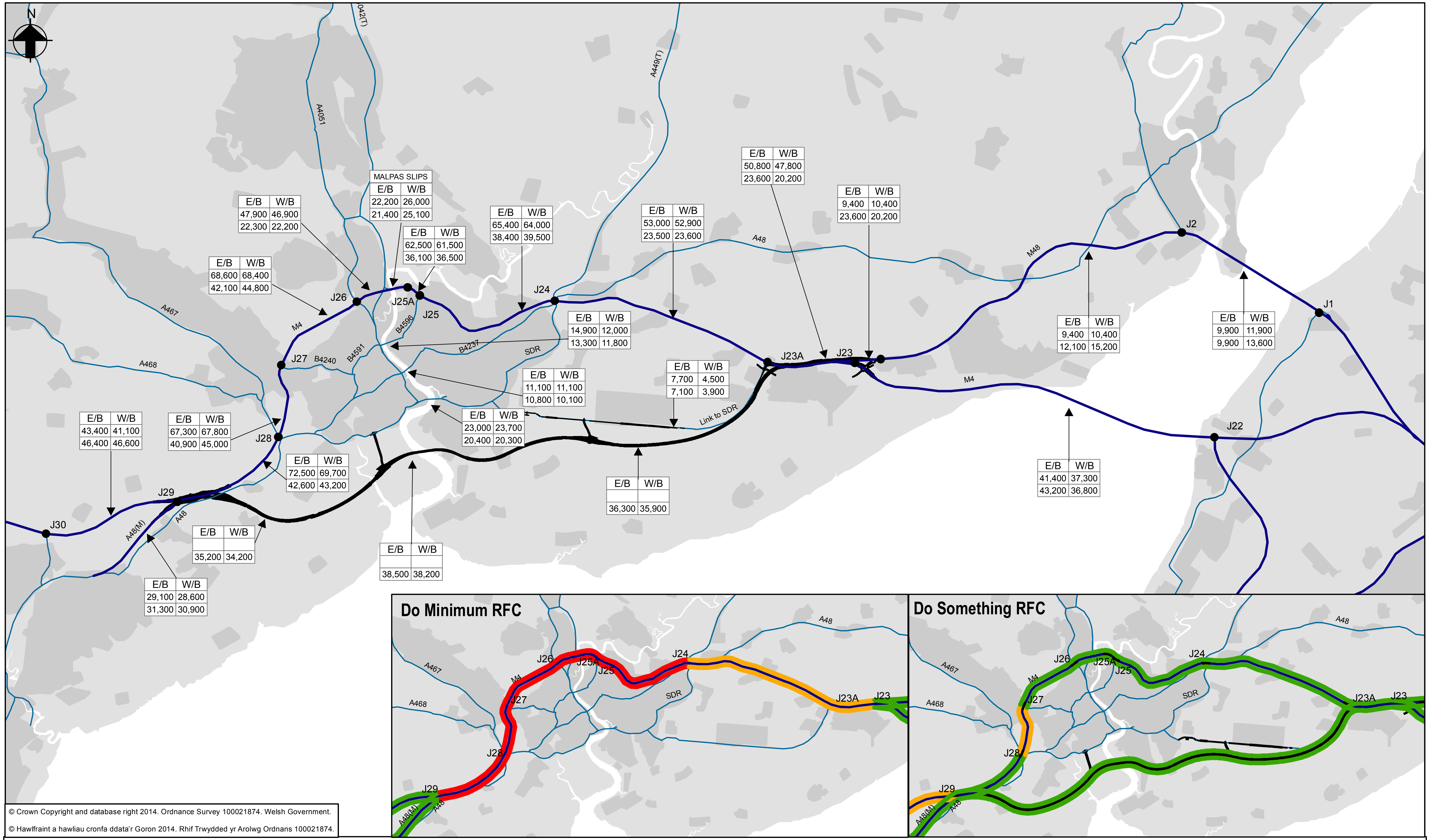
A3



Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

ARUP

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Drawing Title
Figure 7.8
Core Scenario
2037 AADT
Central Growth

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0110**

Issue **P0**

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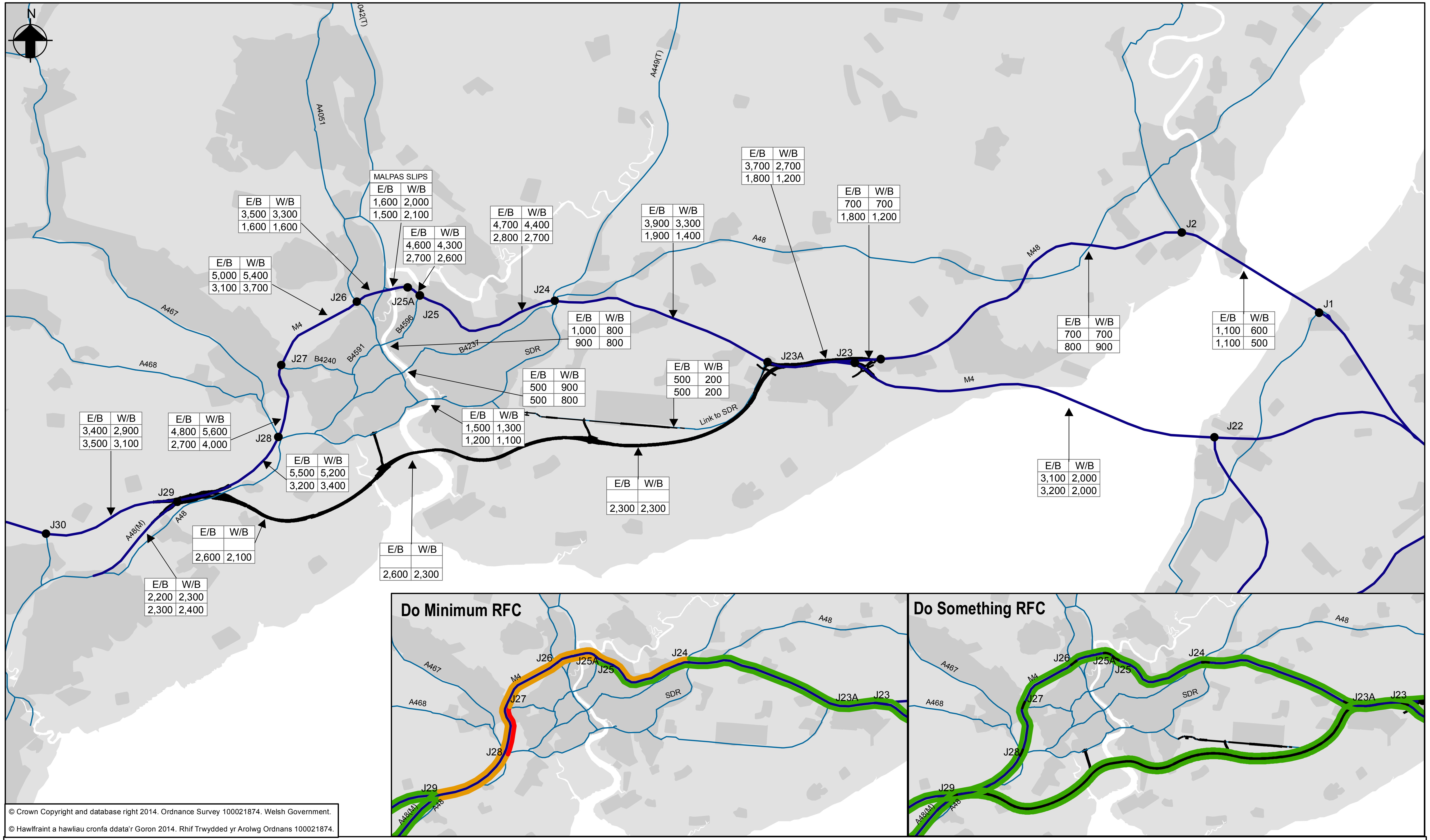

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-12	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title

Figure 7.9
2022 AM Peak Hour
Low Growth

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0093	P0

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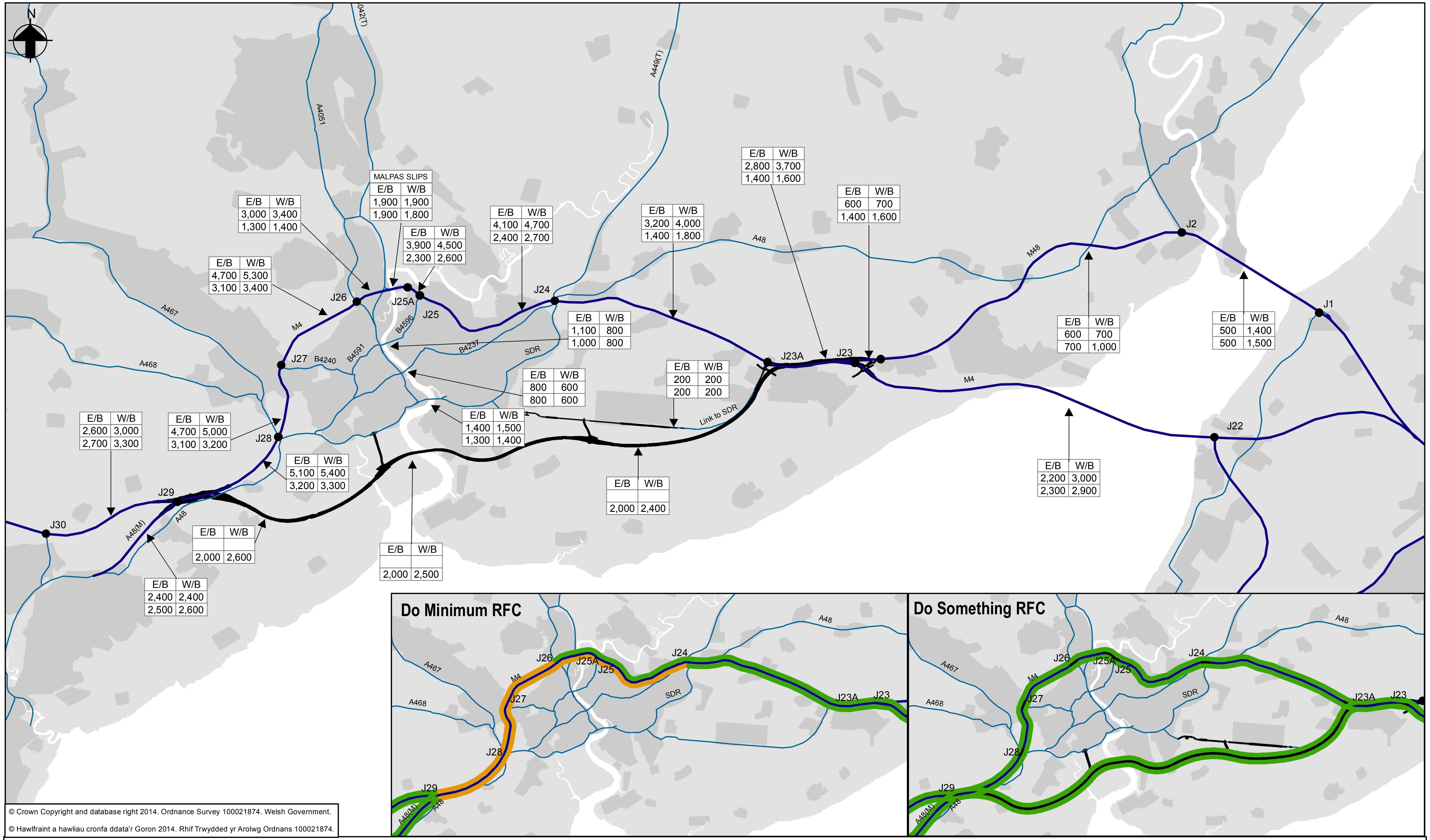

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.10
2022 PM Peak Hour
Low Growth

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0094**

Issue **P0**

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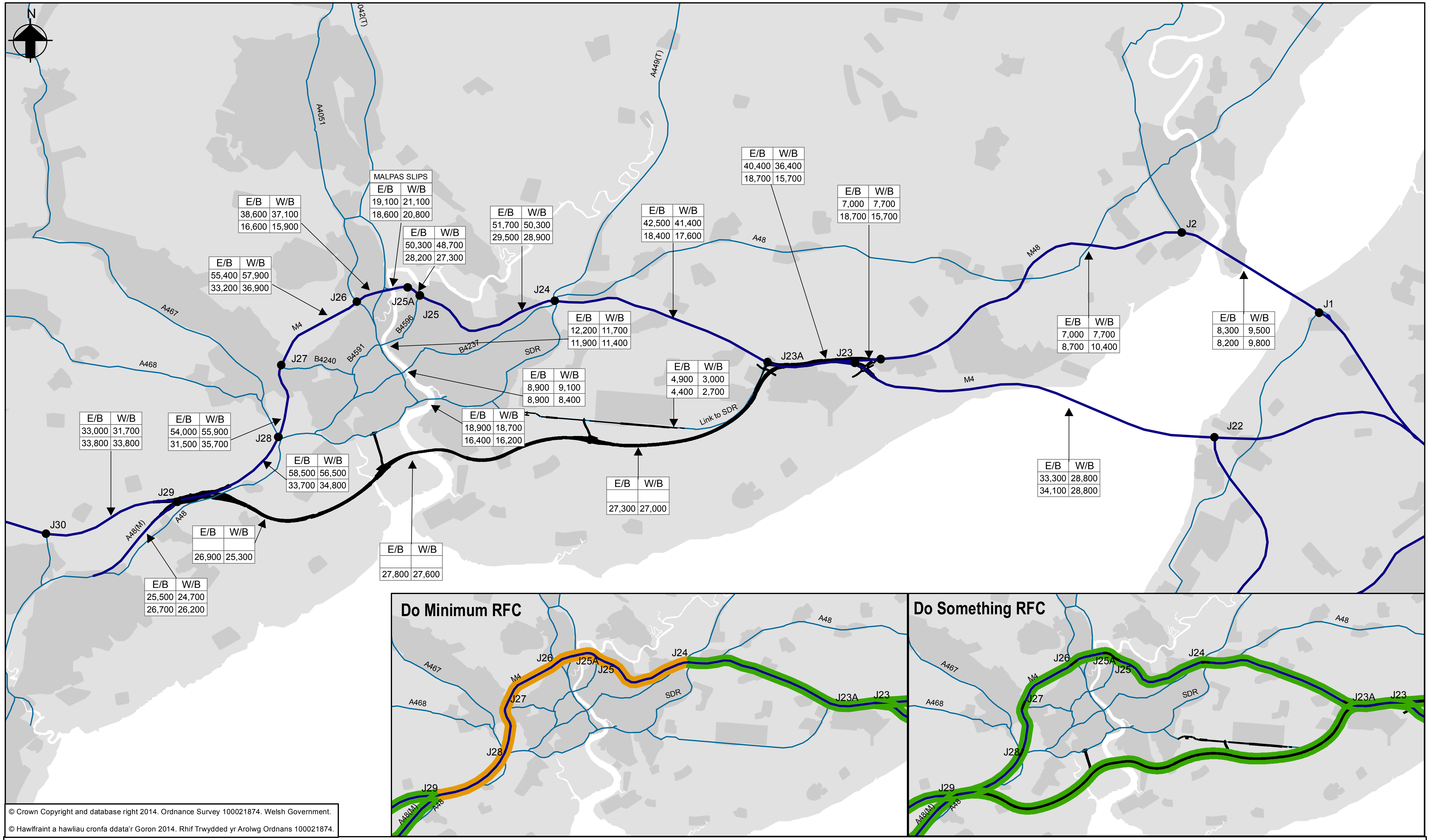

Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title

Figure 7.11
2022 AADT
Low Growth

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0097**

Issue **P0**

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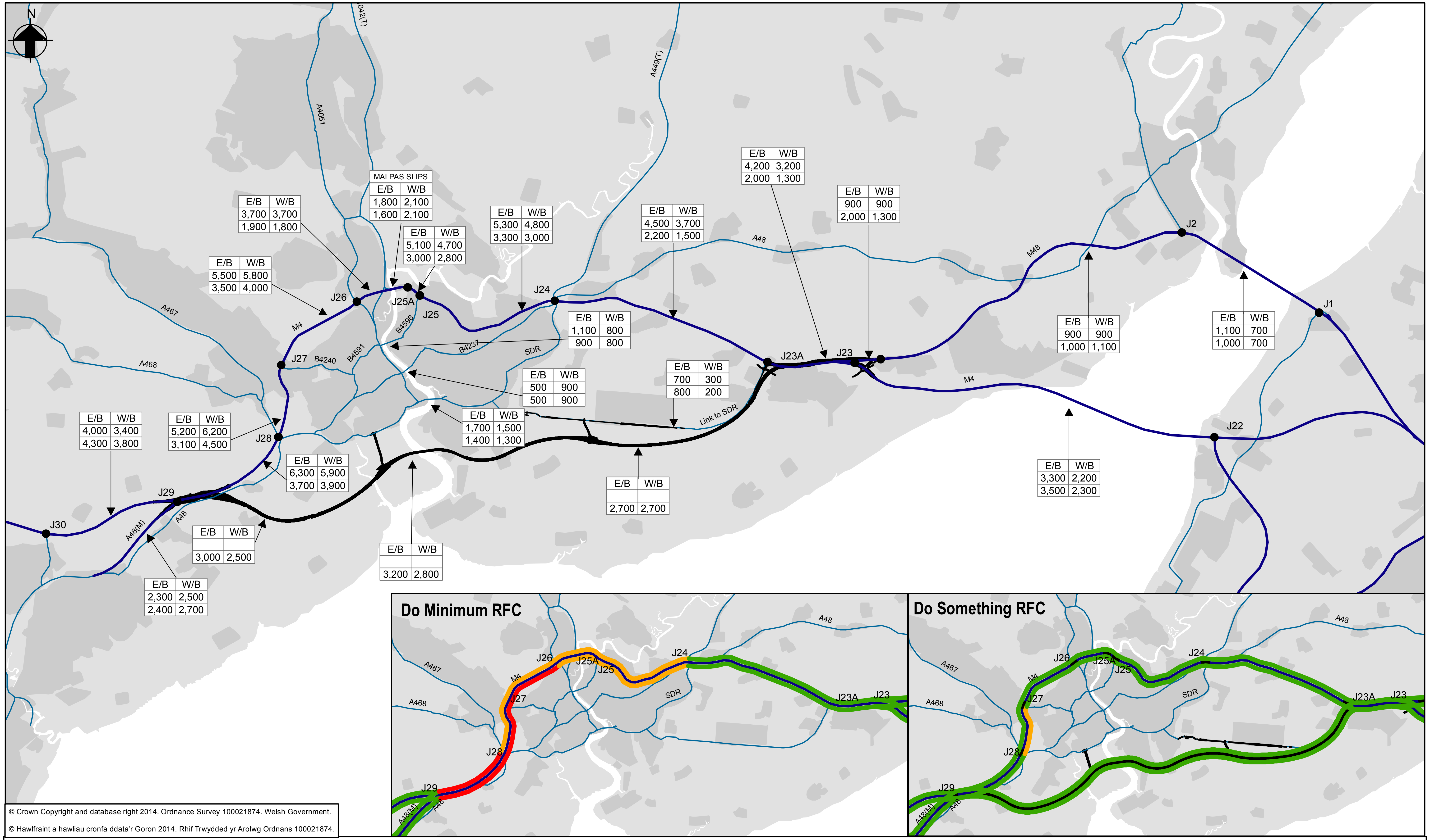

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

Issue	Date	By	Chkd	Appd
P0	2014-06-18	JO	SP	SP
	Preliminary			

Client

Llywodraeth Cymru
Welsh Government

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Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3 **1:100,000**

ARUP

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Drawing Title

Figure 7.12
2037 AM Peak Hour
Low Growth

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0095	**P0**

25/06/2014 16:11:36

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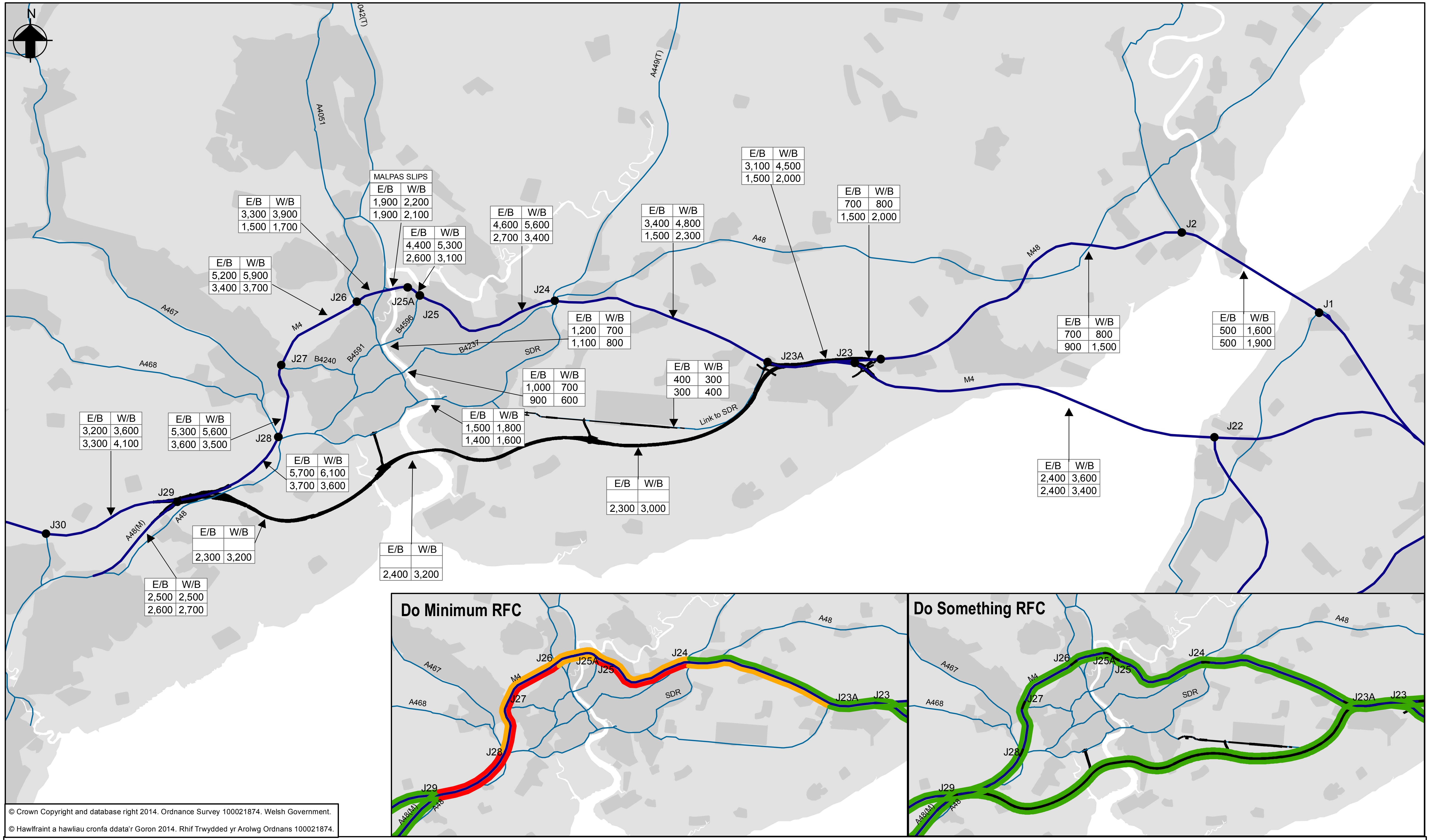

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Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
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Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.13
2037 PM Peak Hour
Low Growth

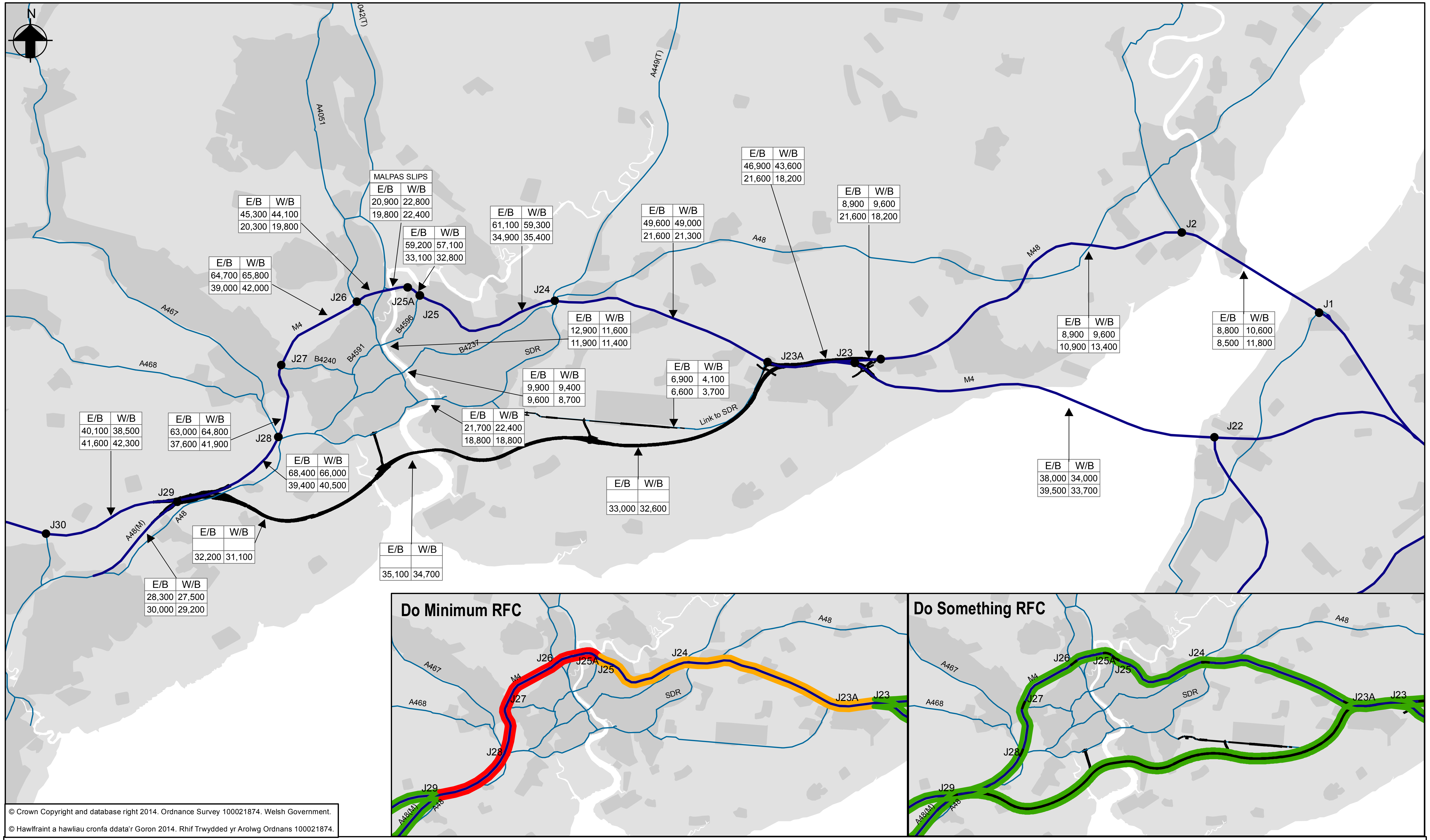
Job No
117300-01

Drawing Status
Preliminary

Drawing No
M4-OA-50-00-DR-Z-XX-0096

Issue
P0

A3



Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
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Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.14
2037 AADT
Low Growth

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0098	P0

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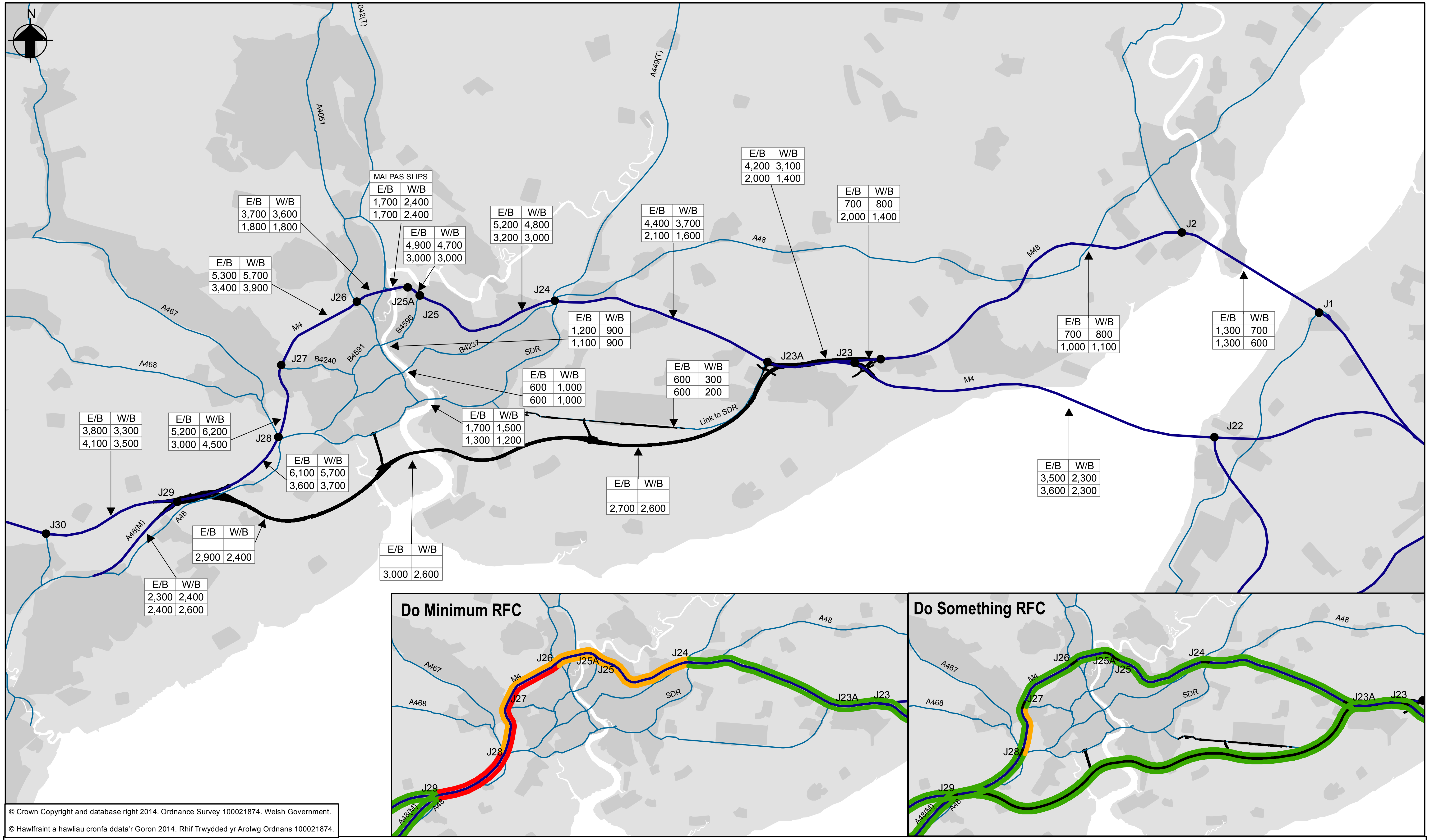

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-12	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
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Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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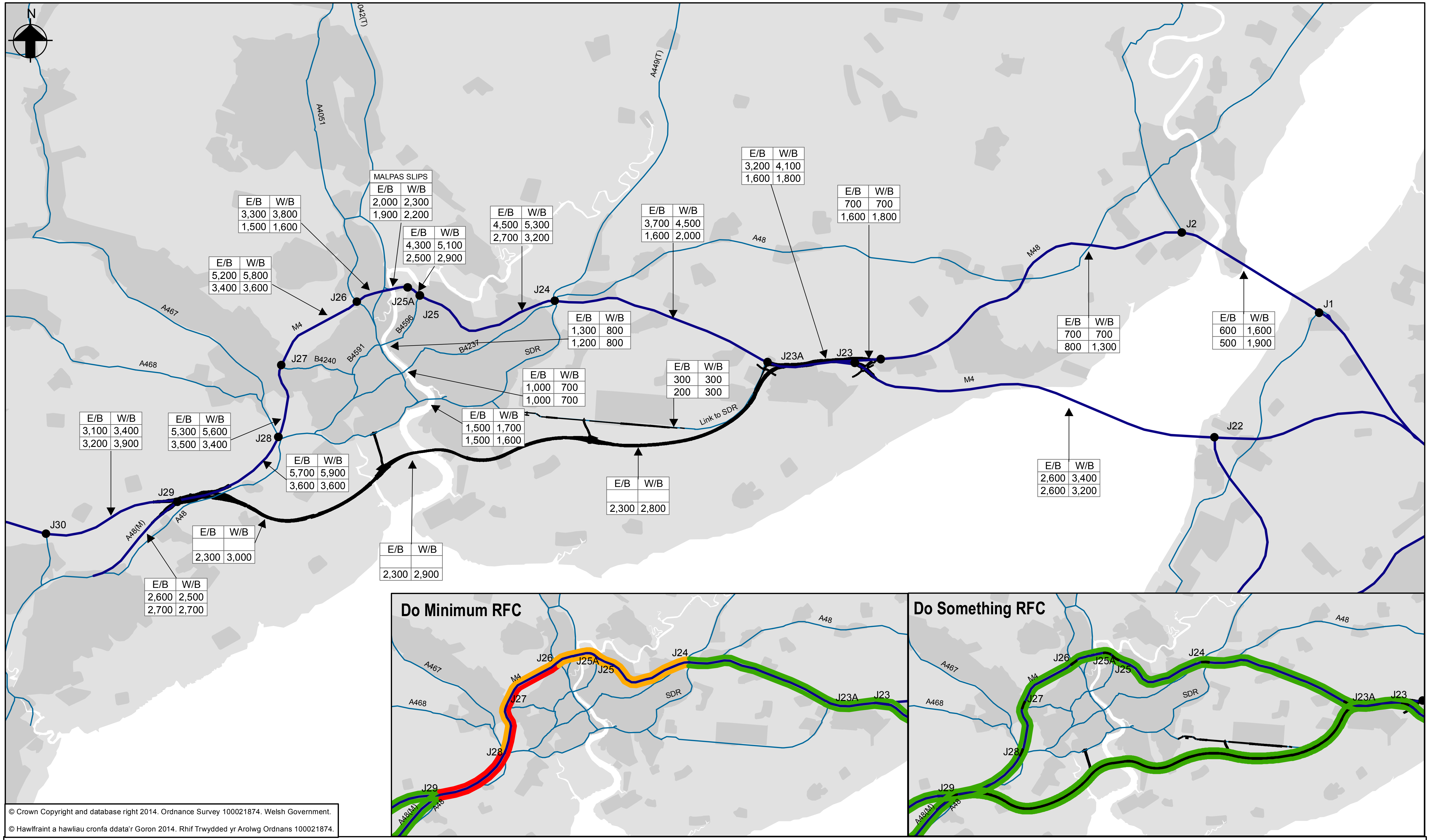
Drawing Title

Figure 7.15
2022 AM Peak Hour
High Growth

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0099	**P0**

A3



Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
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Trafnidiaeth
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Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title

Figure 7.16
2022 PM Peak Hour
High Growth

Job No
117300-01

Drawing Status
Preliminary

Drawing No
M4-OA-50-00-DR-Z-XX-0100

Issue
P0

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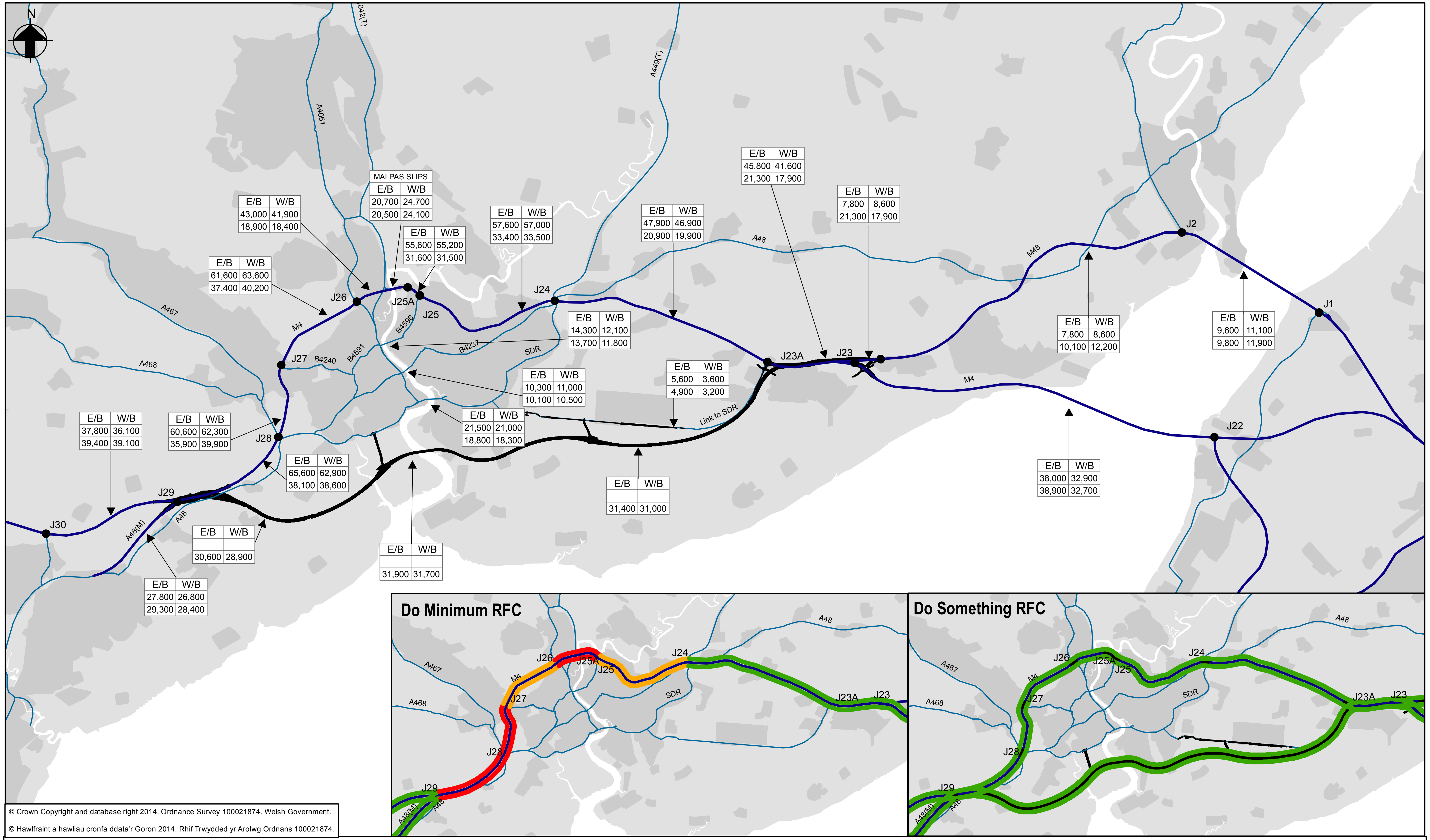

Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title

Figure 7.17
2022 AADT
High Growth

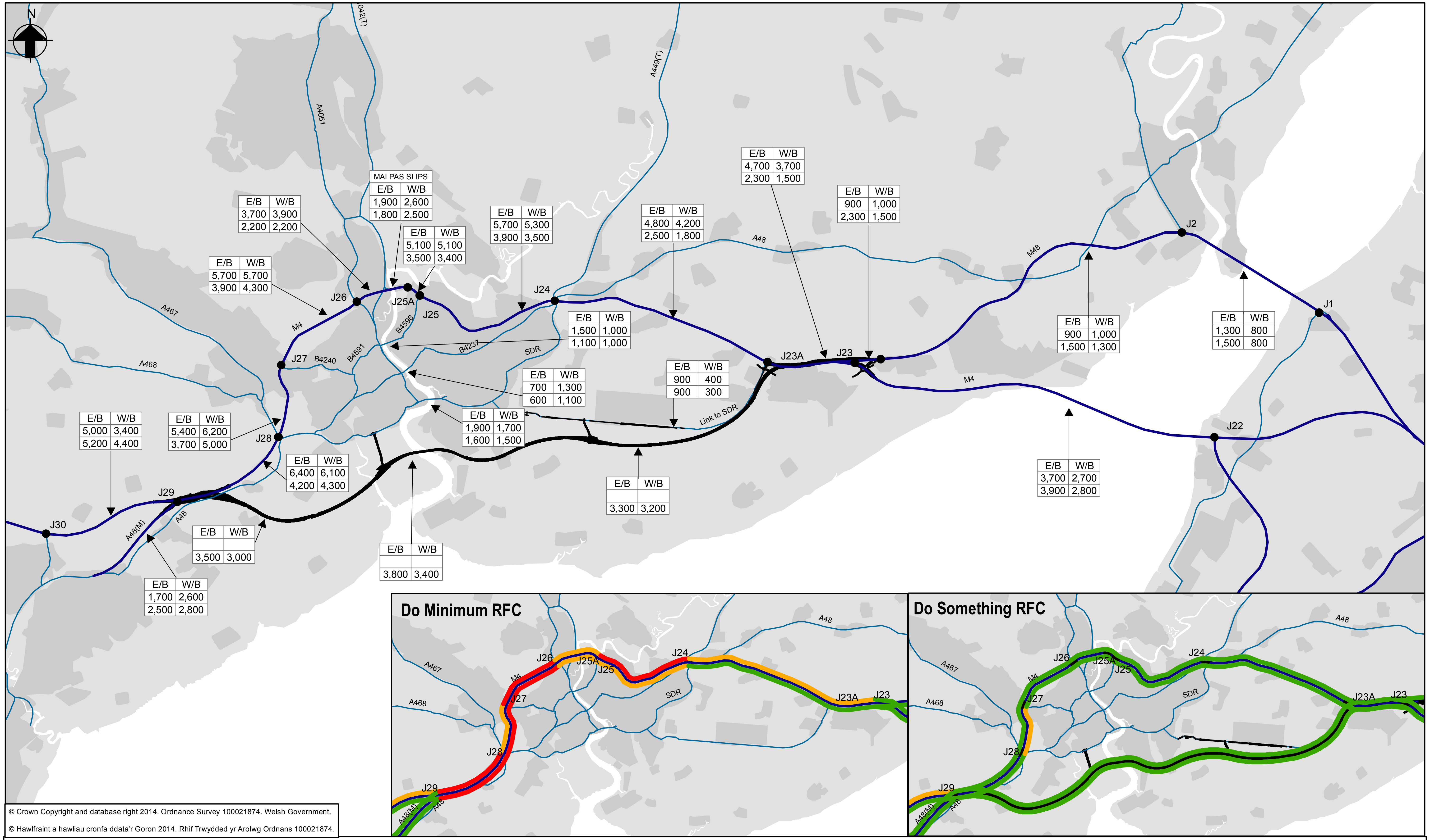
Job No
117300-01

Drawing Status
Preliminary

Drawing No
M4-OA-50-00-DR-Z-XX-0103

Issue
P0

A3



Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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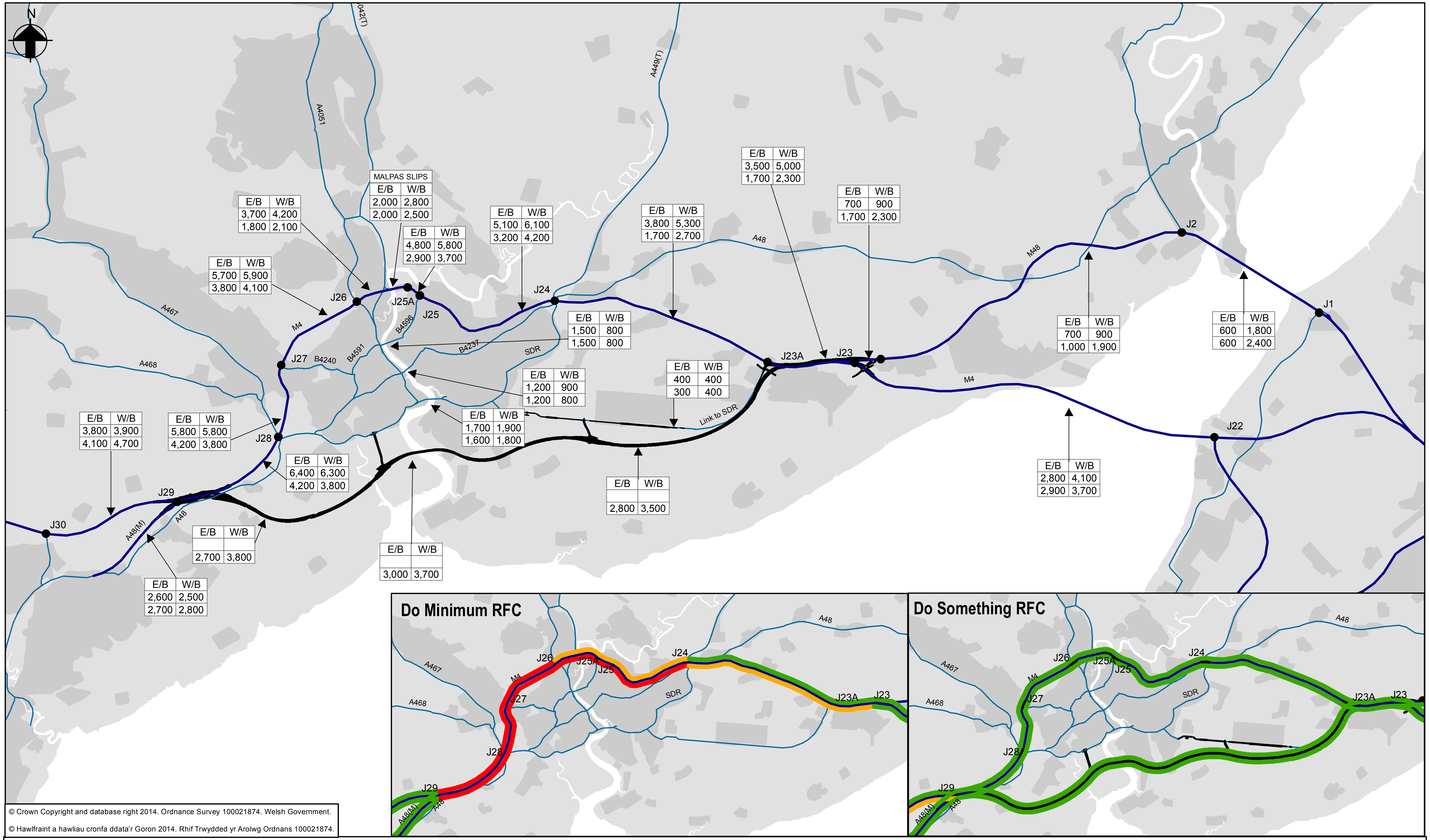
Drawing Title

Figure 7.18
2037 AM Peak Hour
High Growth

Job No: **117300-01**
Drawing Status: **Preliminary**
Drawing No: **M4-OA-50-00-DR-Z-XX-0101**
Issue: **P0**

A3



25/06/2014 16:03:25

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title

Figure 7.19
2037 PM Peak Hour
High Growth

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0102	**P0**

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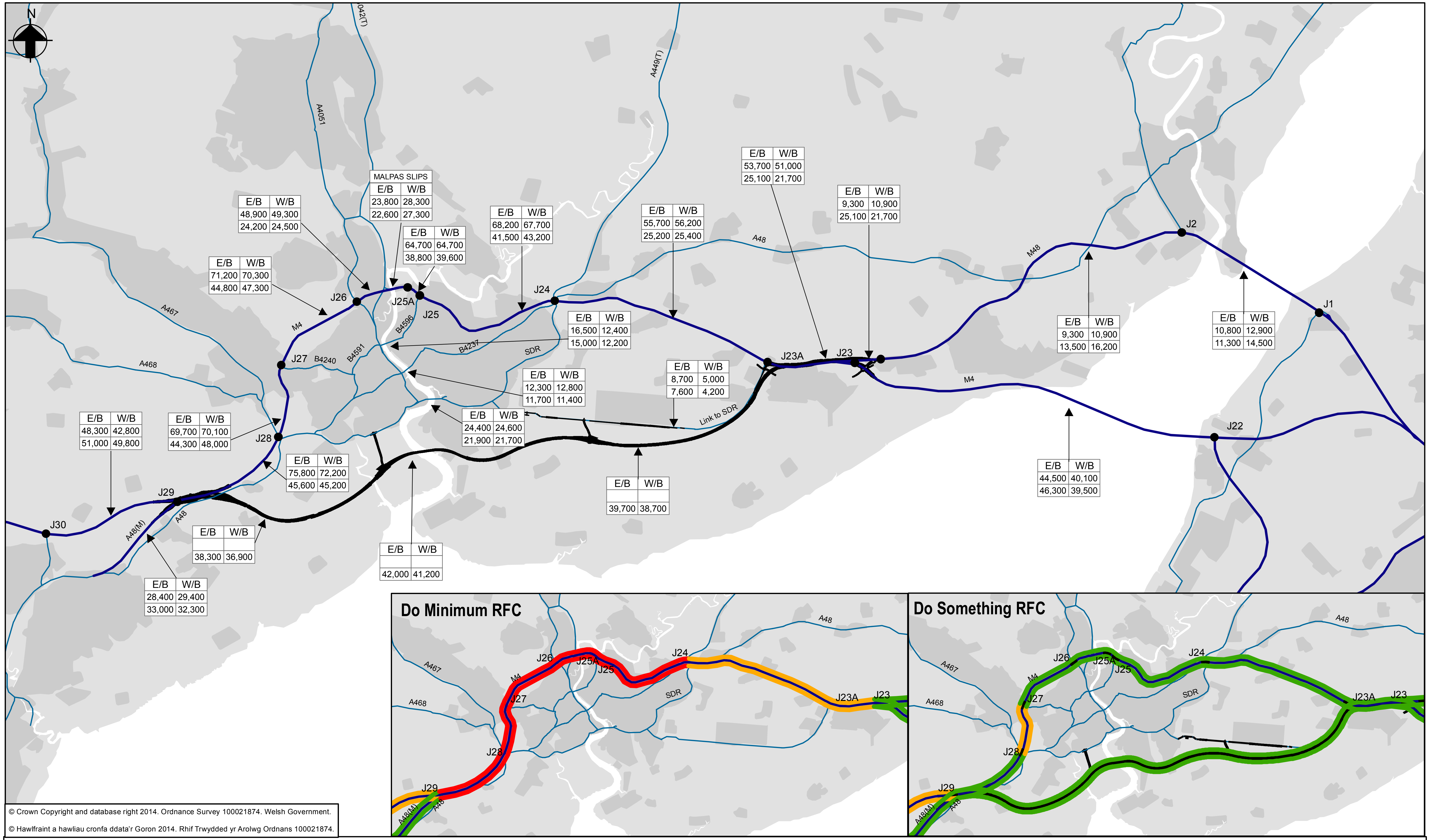
A3



Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title

Figure 7.20
2037 AADT
High Growth

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0104**

Issue **P0**

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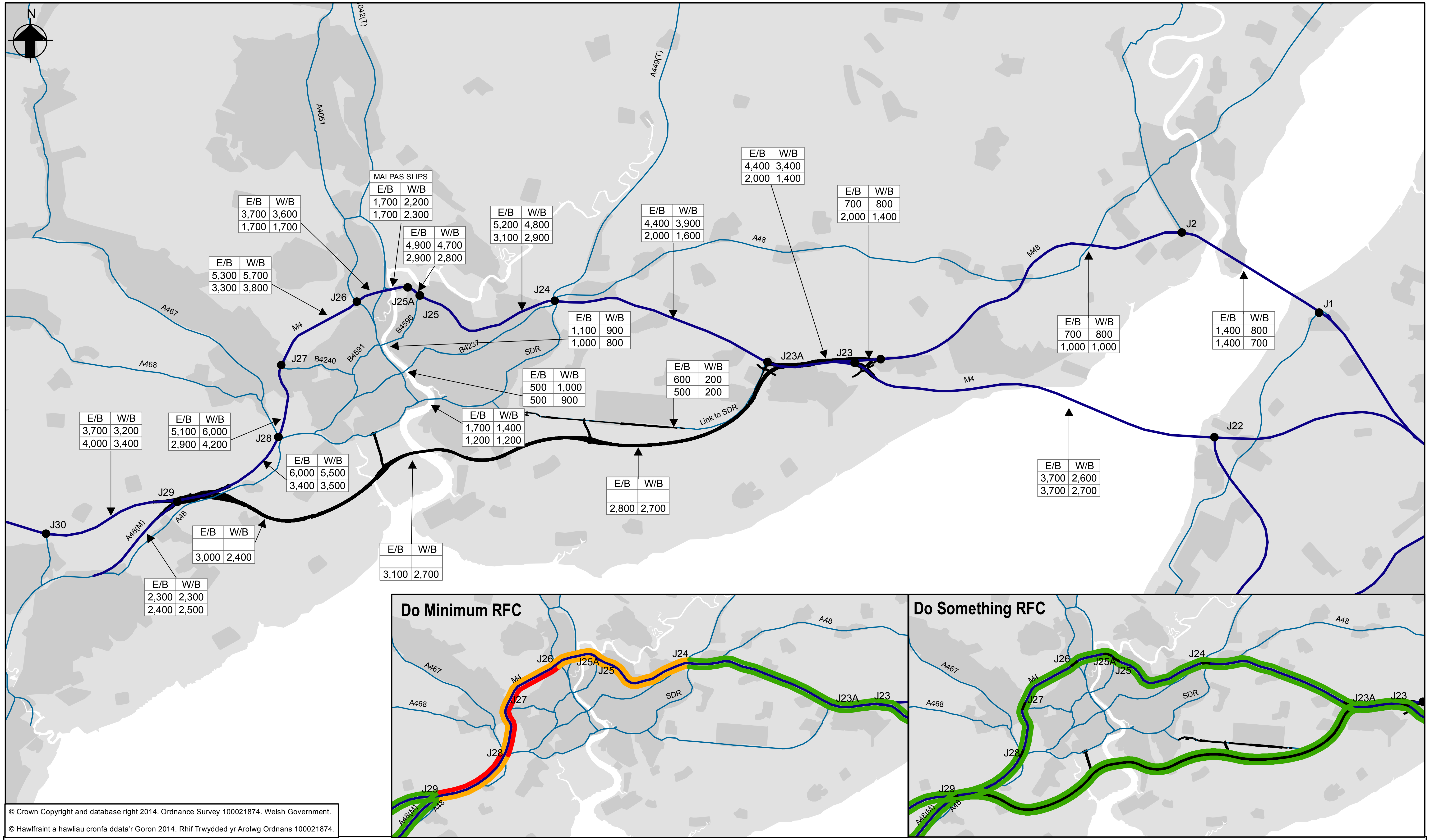

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-12	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government
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Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Llywodraeth Cymru
Welsh Government

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.21
No Severn Tolls
2022 AM Peak Hour
Central Growth

Job No
117300-01

Drawing Status
Preliminary

Drawing No
M4-OA-50-00-DR-Z-XX-0122

Issue
P0

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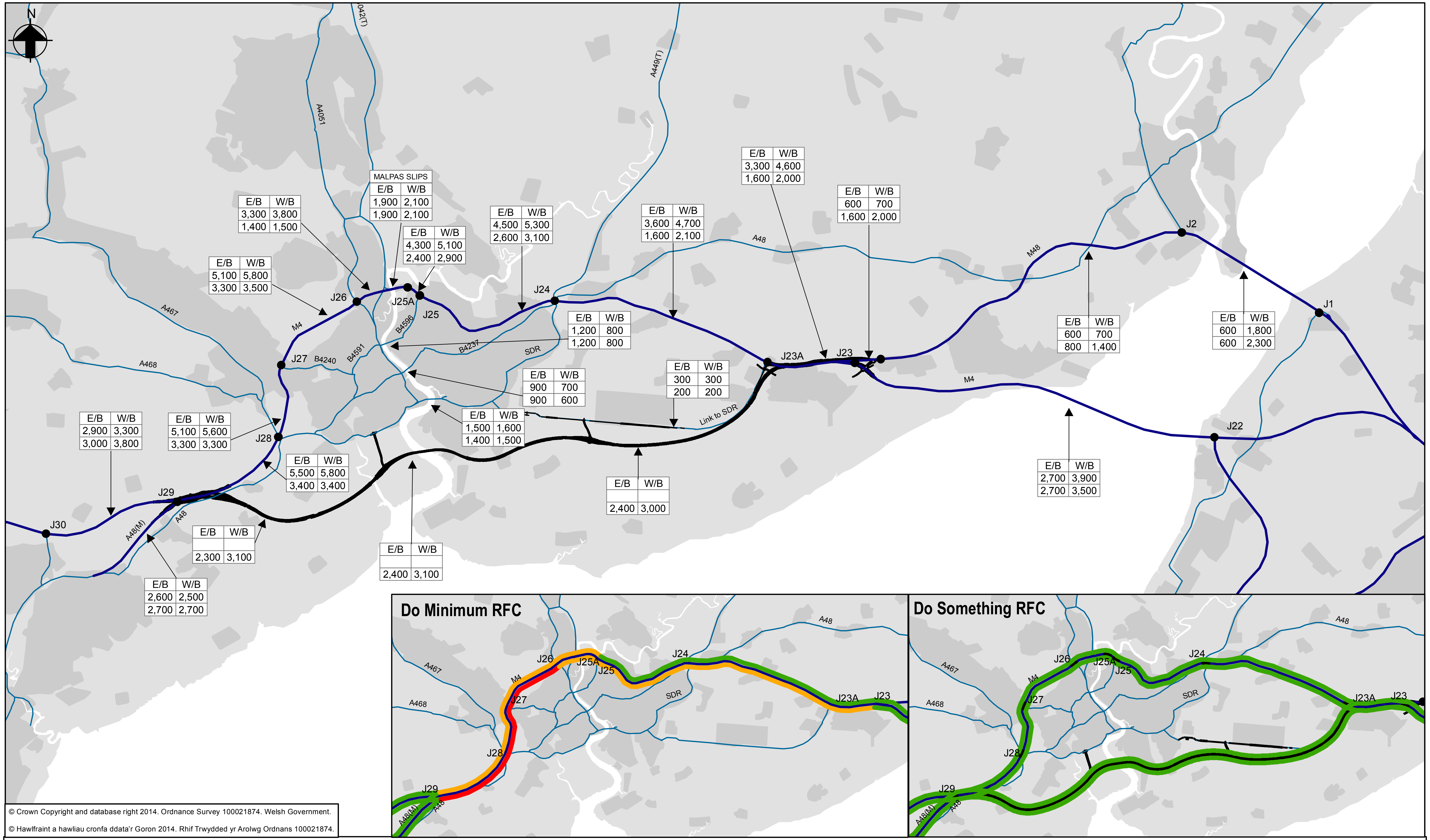

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

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Drawing Title
Figure 7.22
No Severn Tolls
2022 PM Peak Hour
Central Growth

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0123	P0

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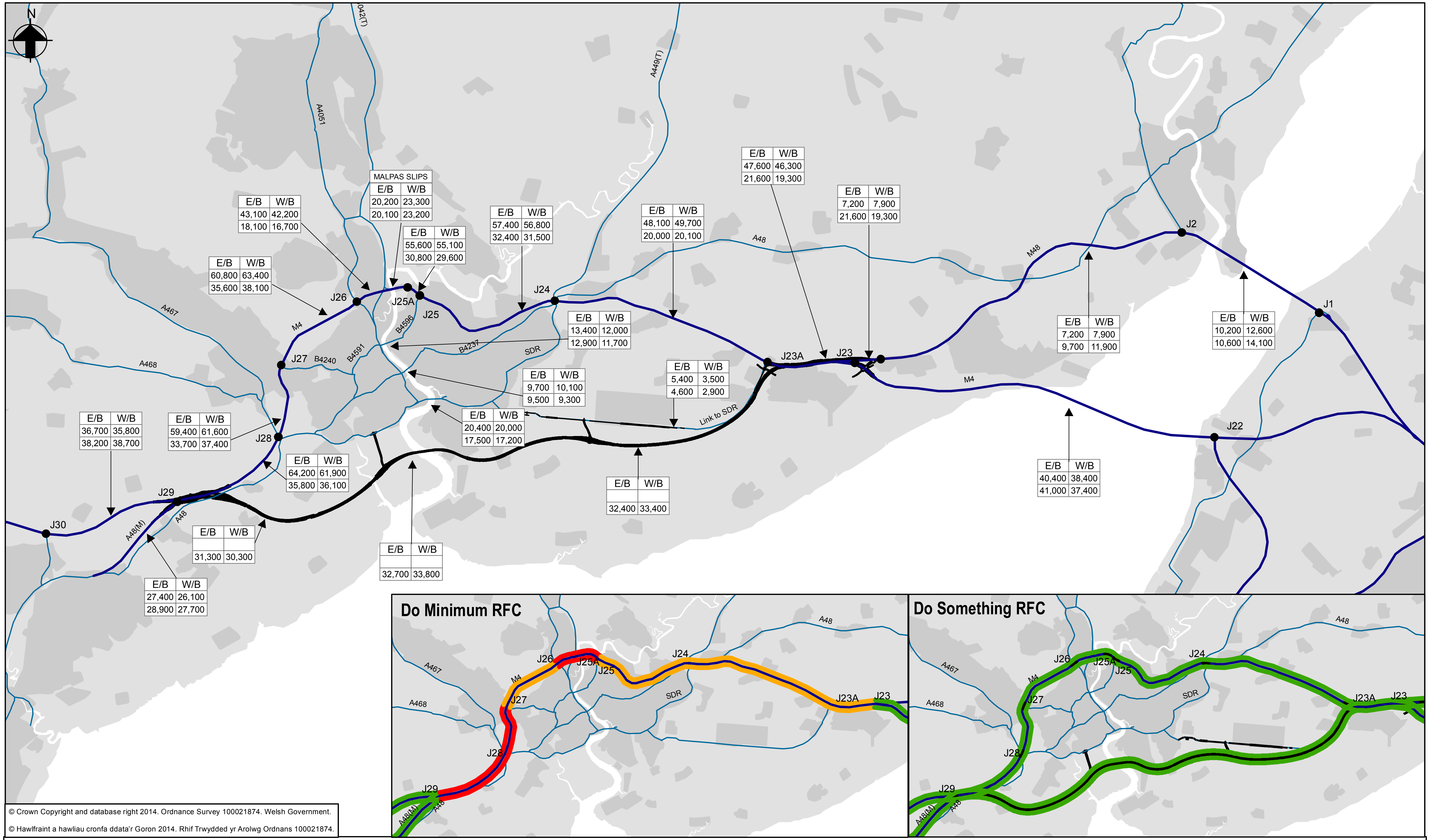

Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government
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Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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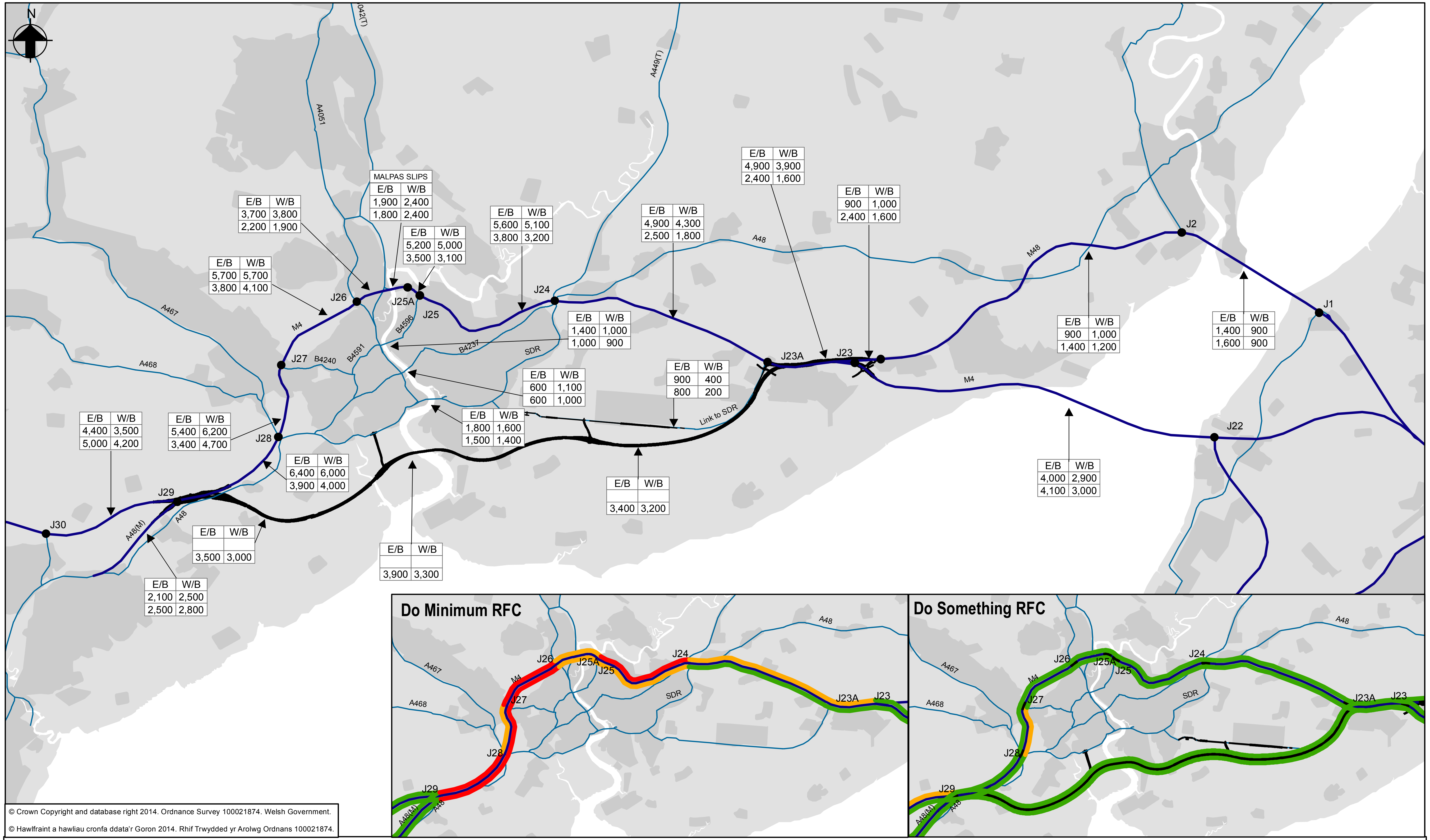
Drawing Title
Figure 7.23
No Severn Tolls
2022 AADT
Central Growth

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0126	P0

A3



Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title
Figure 7.24
No Severn Tolls
2037 AM Peak Hour
Central Growth

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0124	**P0**

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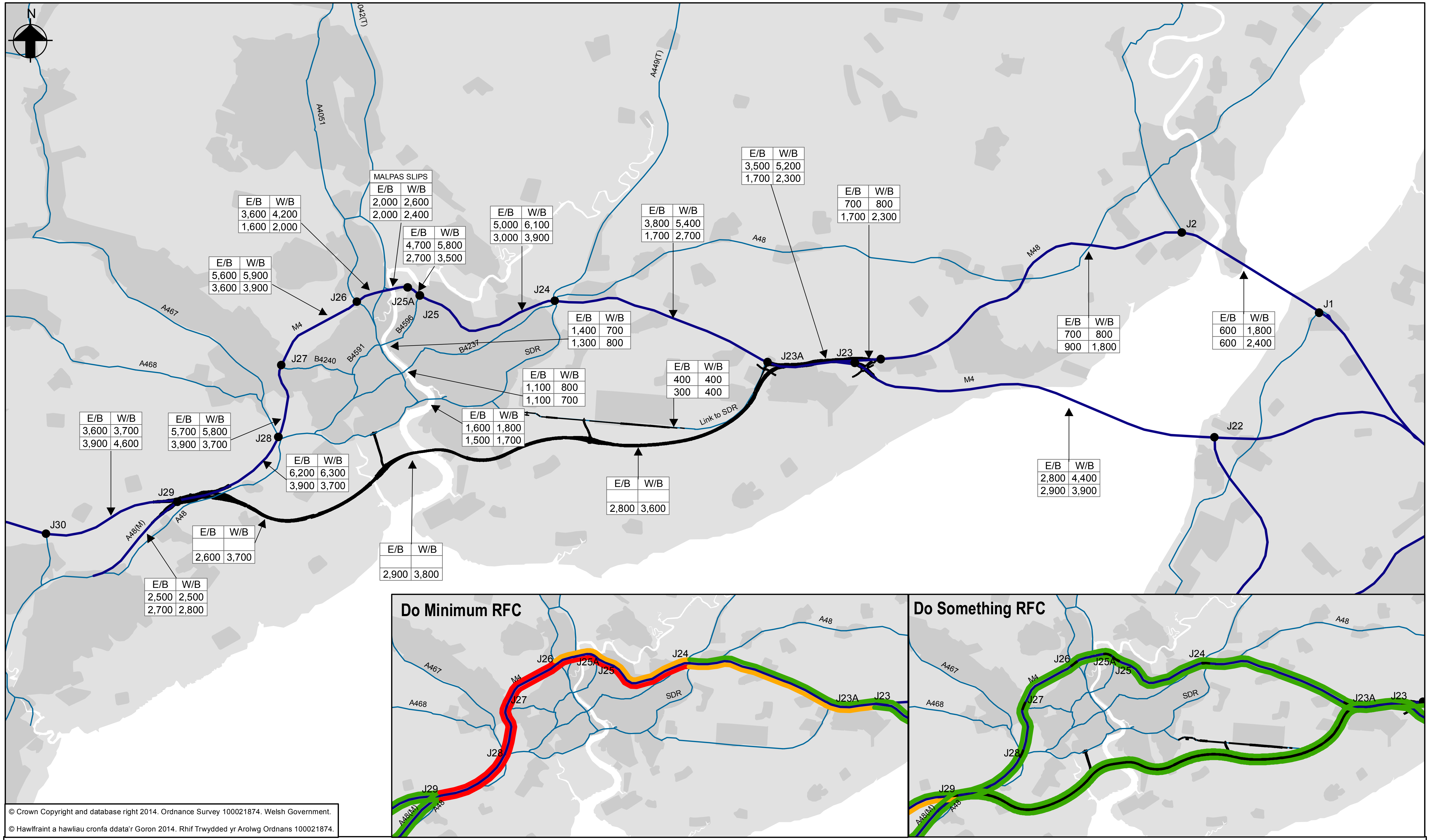

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Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

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Drawing Title
Figure 7.25
No Severn Tolls
2037 PM Peak Hour
Central Growth

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0125	**P0**

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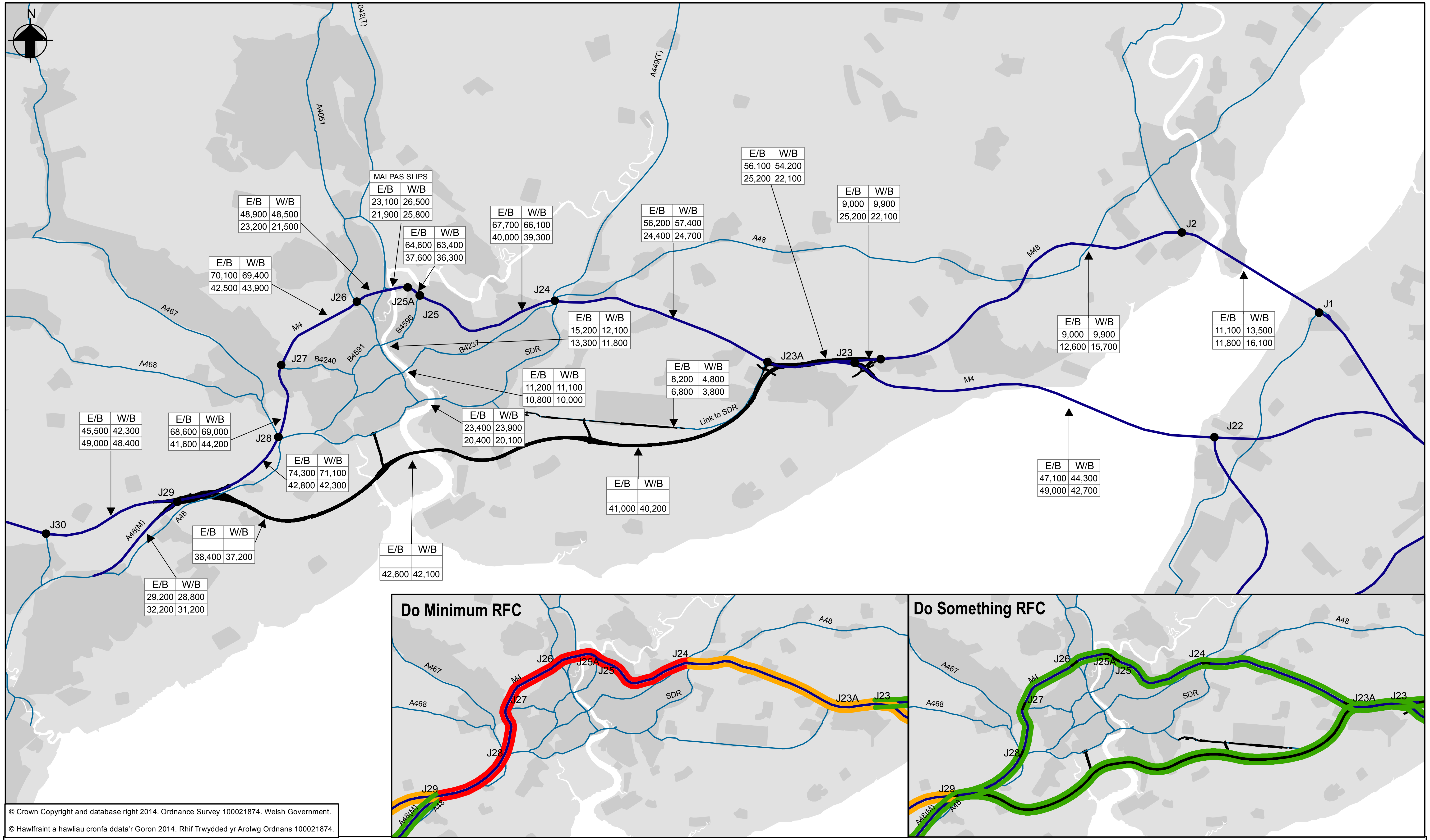

Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres: 0, 750, 1,500, 3,000

Scale at A3: **1:100,000**

ARUP

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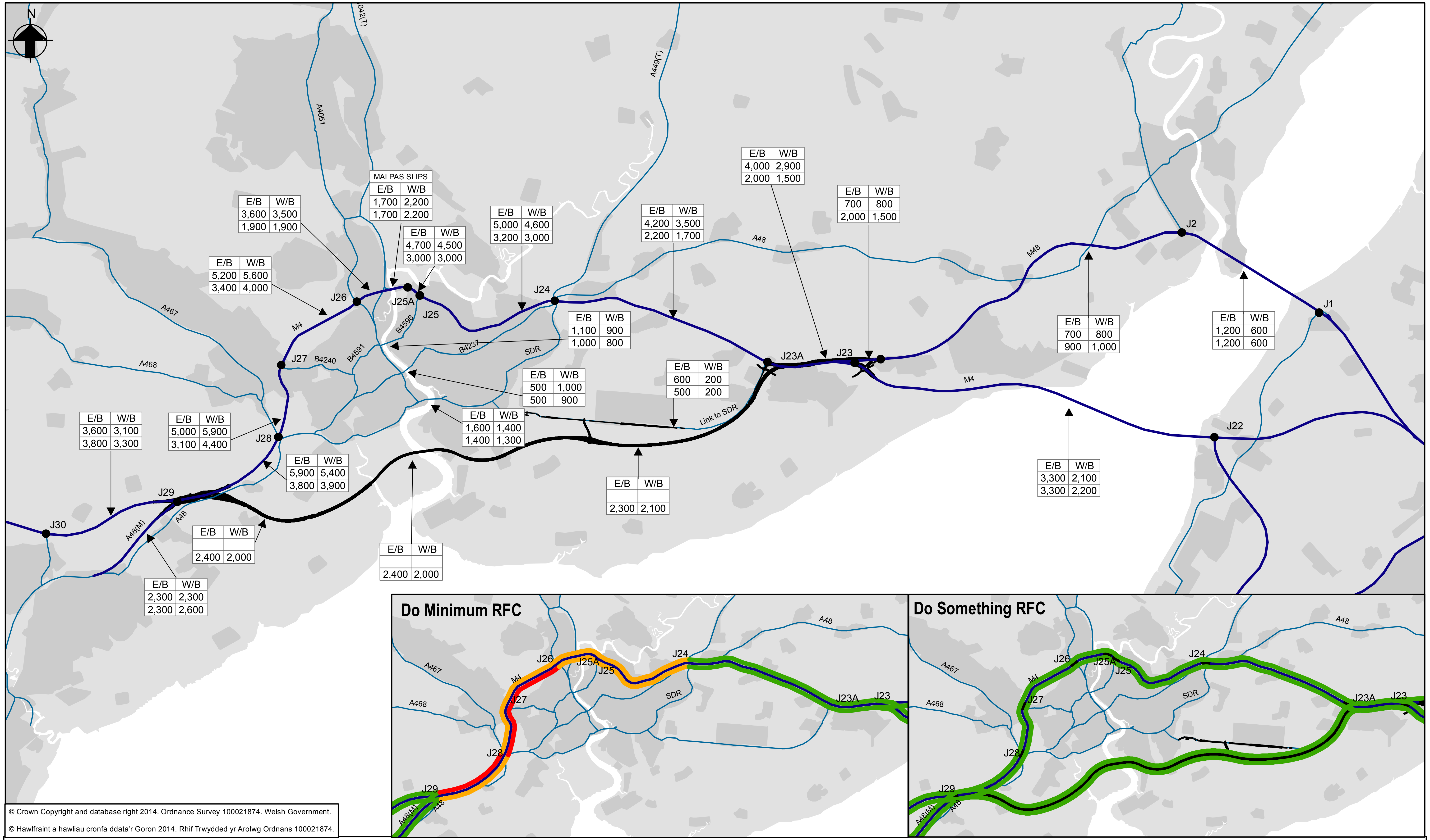
Drawing Title

Figure 7.26
No Severn Tolls
2037 AADT
Central Growth

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0127	P0

A3



Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-12	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

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Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title

Figure 7.27
Core Scheme Excluding Docks Junction
2022 AM Peak Hour

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0111	**P0**

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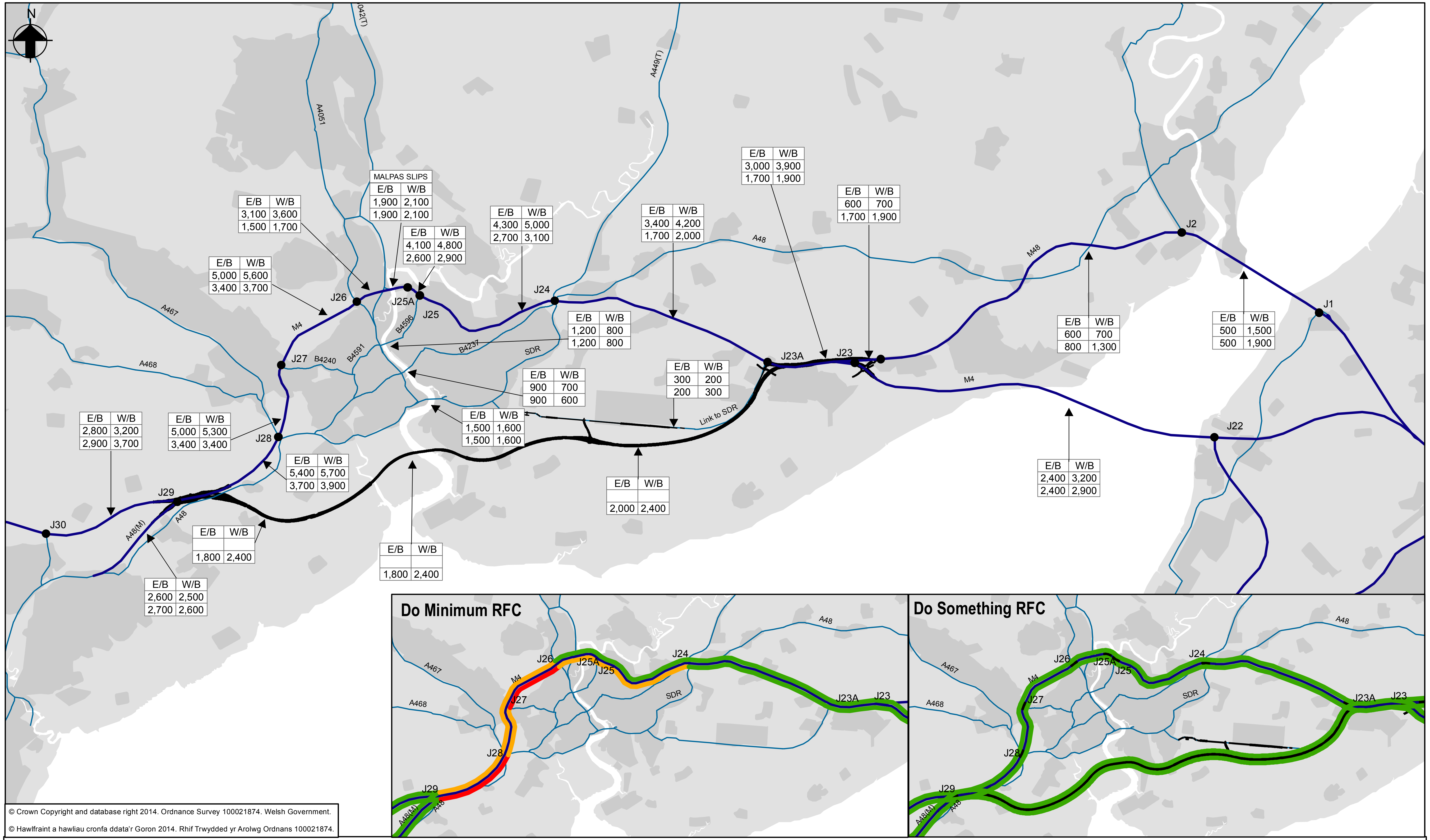

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

ARUP

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Drawing Title

Figure 7.28
Core Scheme Excluding Docks Junction
2022 PM Peak Hour

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0112	P0

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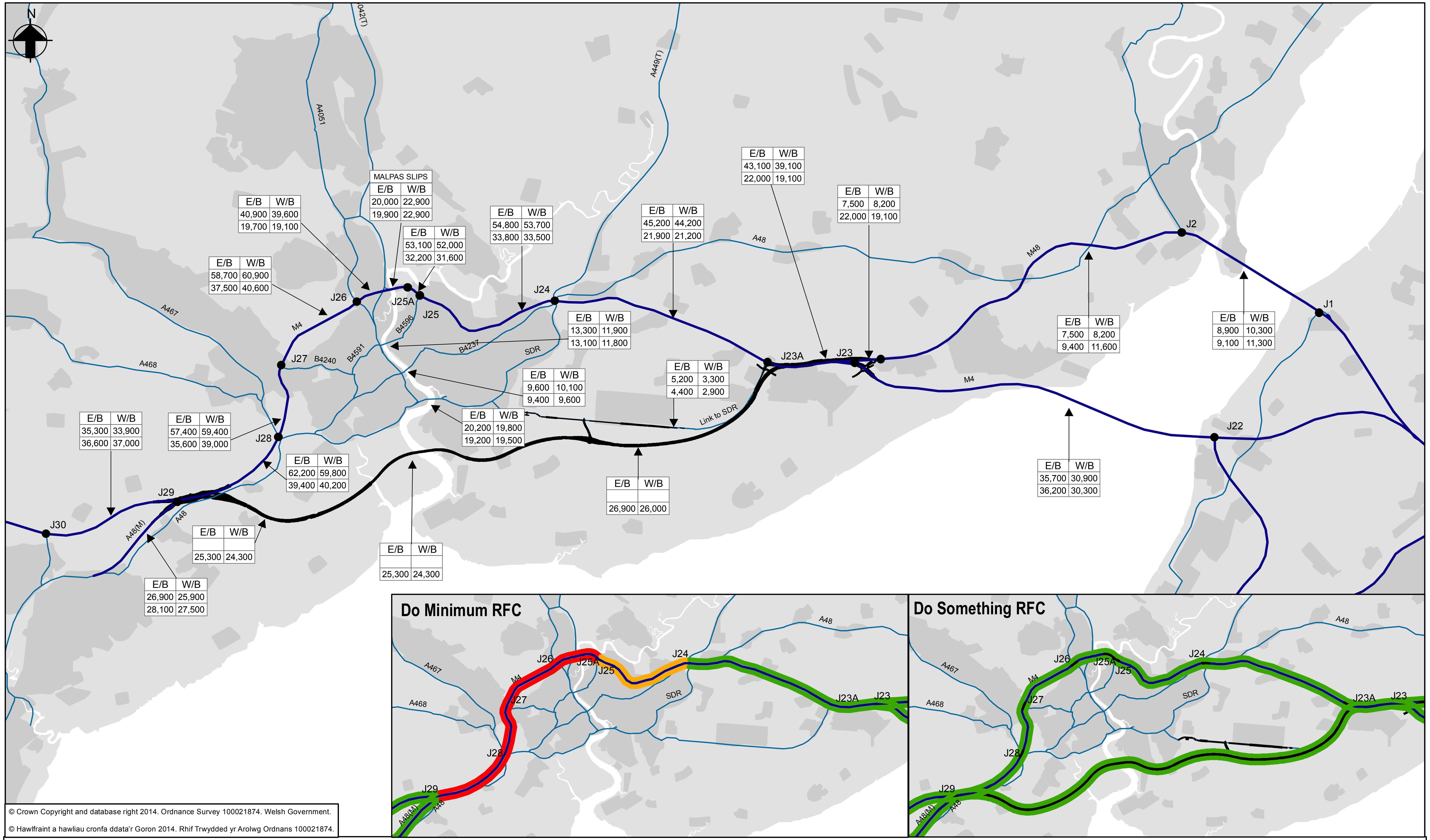
A3



Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

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Drawing Title

Figure 7.29
Core Scheme Excluding Docks Junction
2022 AADT

Job No **117300-01**

Drawing Status **Preliminary**

Drawing No **M4-OA-50-00-DR-Z-XX-0115**

Issue **P0**

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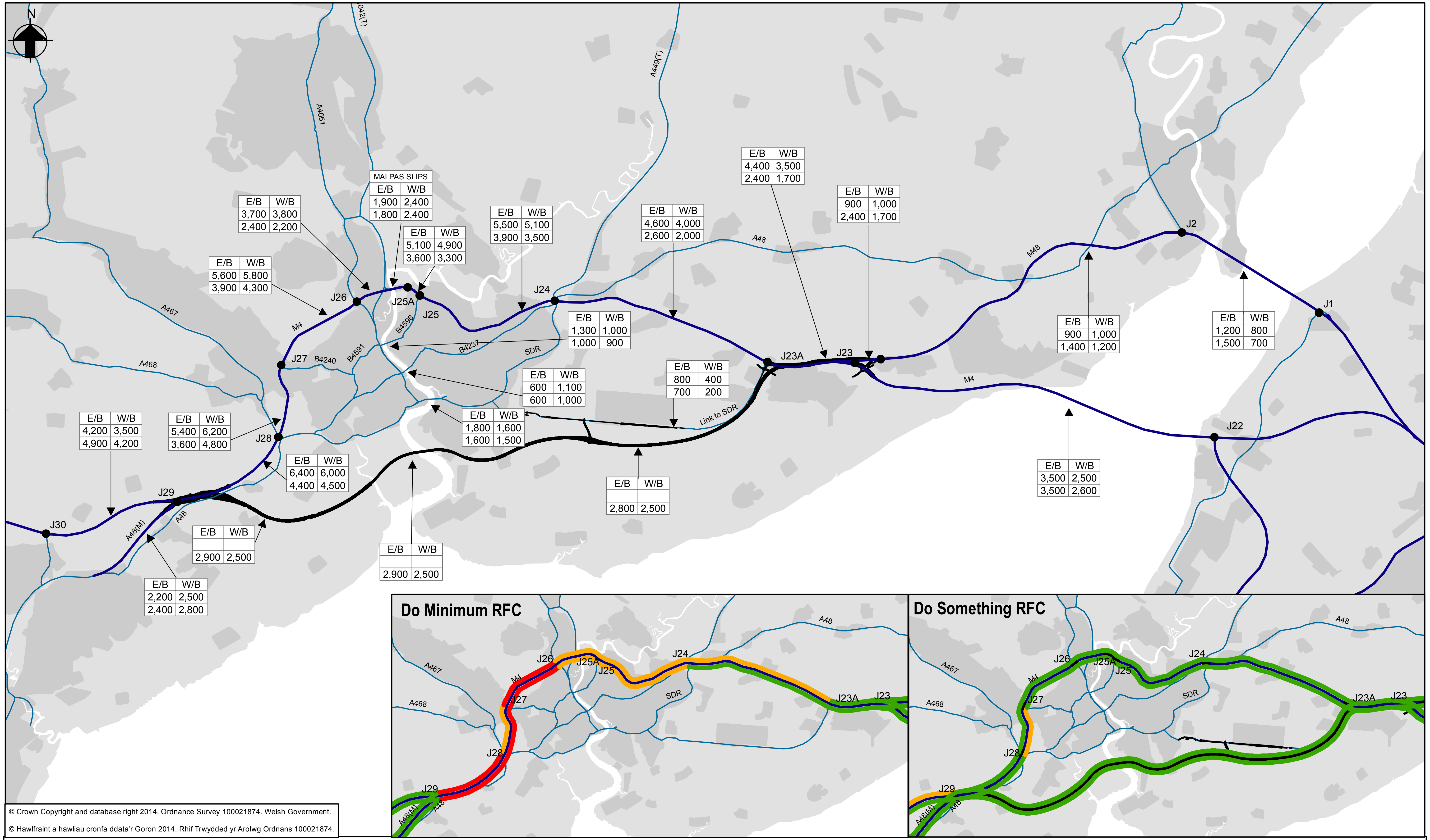

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

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Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
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Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title

Figure 7.30
Core Scheme Excluding Docks Junction
2037 AM Peak Hour

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0113	**P0**

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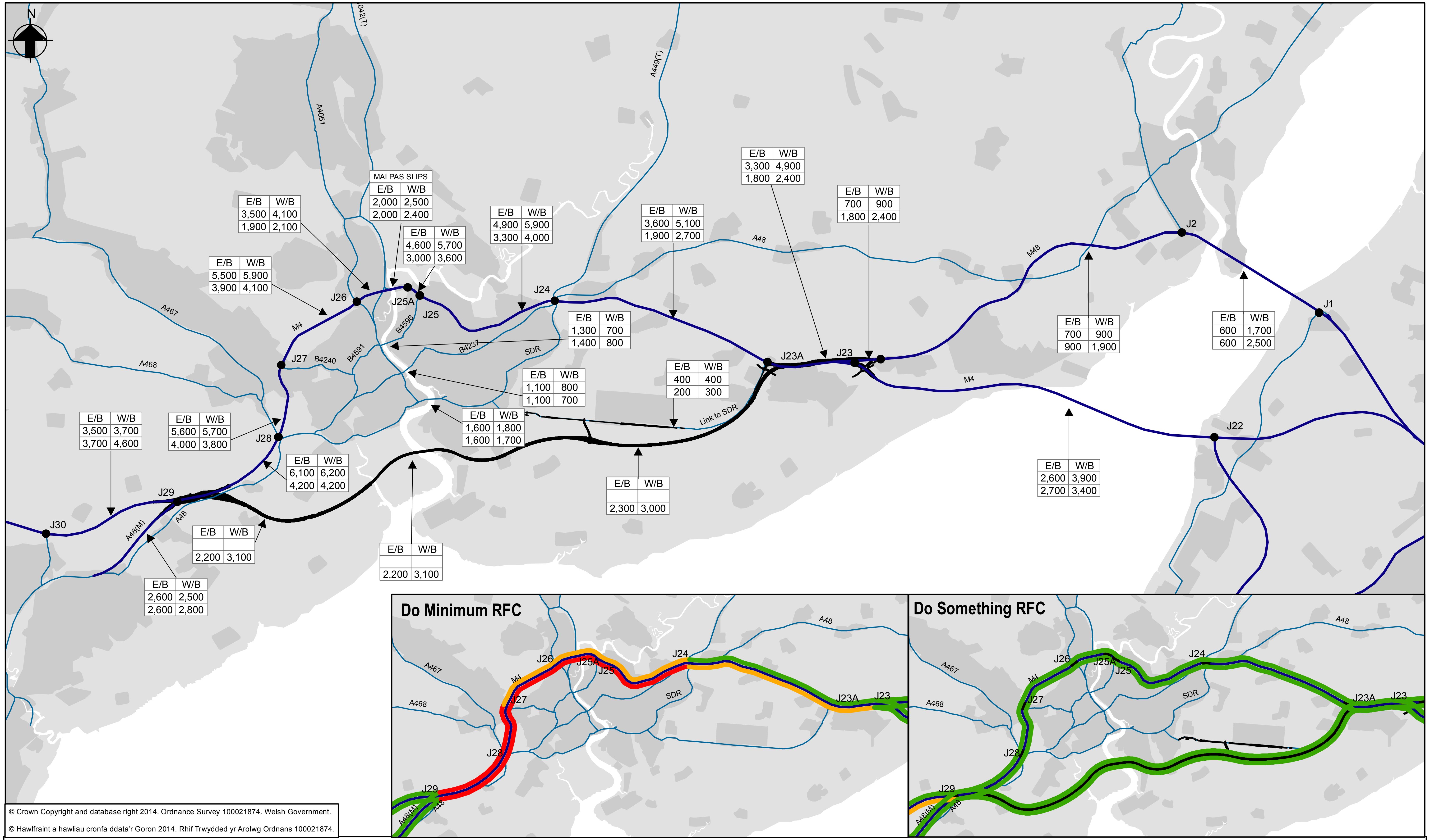

Legend

Ratio Flow to Capacity (RFC)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
Preliminary				
Issue	Date	By	Chkd	Appd

Client

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Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres 0 750 1,500 3,000

Scale at A3 **1:100,000**

ARUP

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Drawing Title

Figure 7.31
Core Scheme Excluding Docks Junction
2037 PM Peak Hour

Job No	Drawing Status
117300-01	**Preliminary**
Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0114	**P0**

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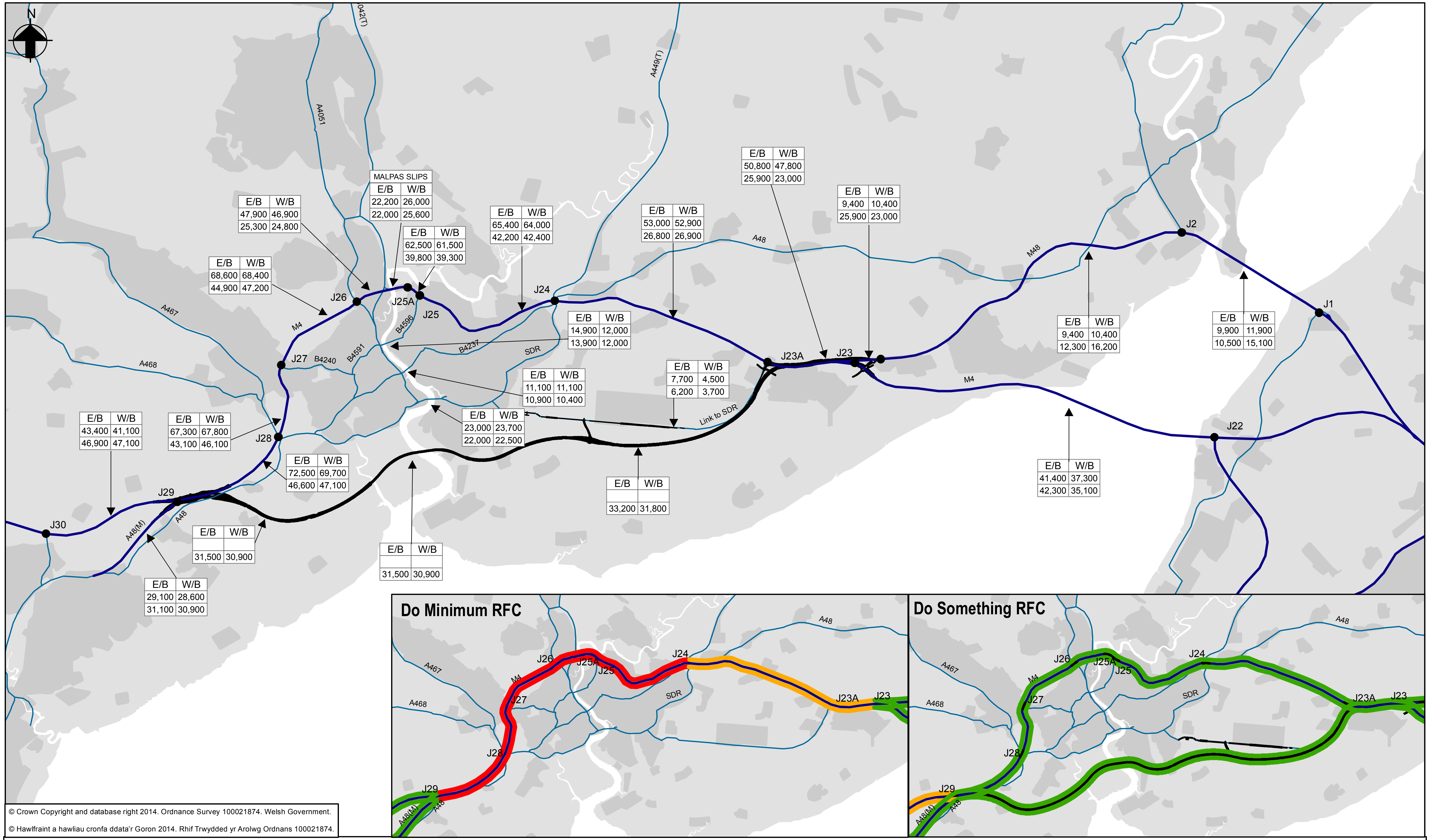

Legend

Ratio Flow to Capacity (AADT/CRF)

- Below 0.8
- 0.8 - 1.0
- Above 1.0

E/B	W/B	
x	x	Do Minimum Flows (veh/hr)
x	x	Do Something Flows (veh/hr)

P0	2014-06-18	JO	SP	SP
	Preliminary			
Issue	Date	By	Chkd	Appd

Client

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Welsh Government
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Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Metres
0 750 1,500 3,000

Scale at A3
1:100,000

ARUP

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Drawing Title

Figure 7.32
Core Scheme Excluding Docks Junction
2037 AADT

Job No	Drawing Status
117300-01	**Preliminary**
Drawing No	Issue
M4-OA-50-00-DR-Z-XX-0116	**P0**

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Figure 7.33: Analysis of Traffic Through Brynglas Tunnels 2037

Do Minimum (vehicles/day)

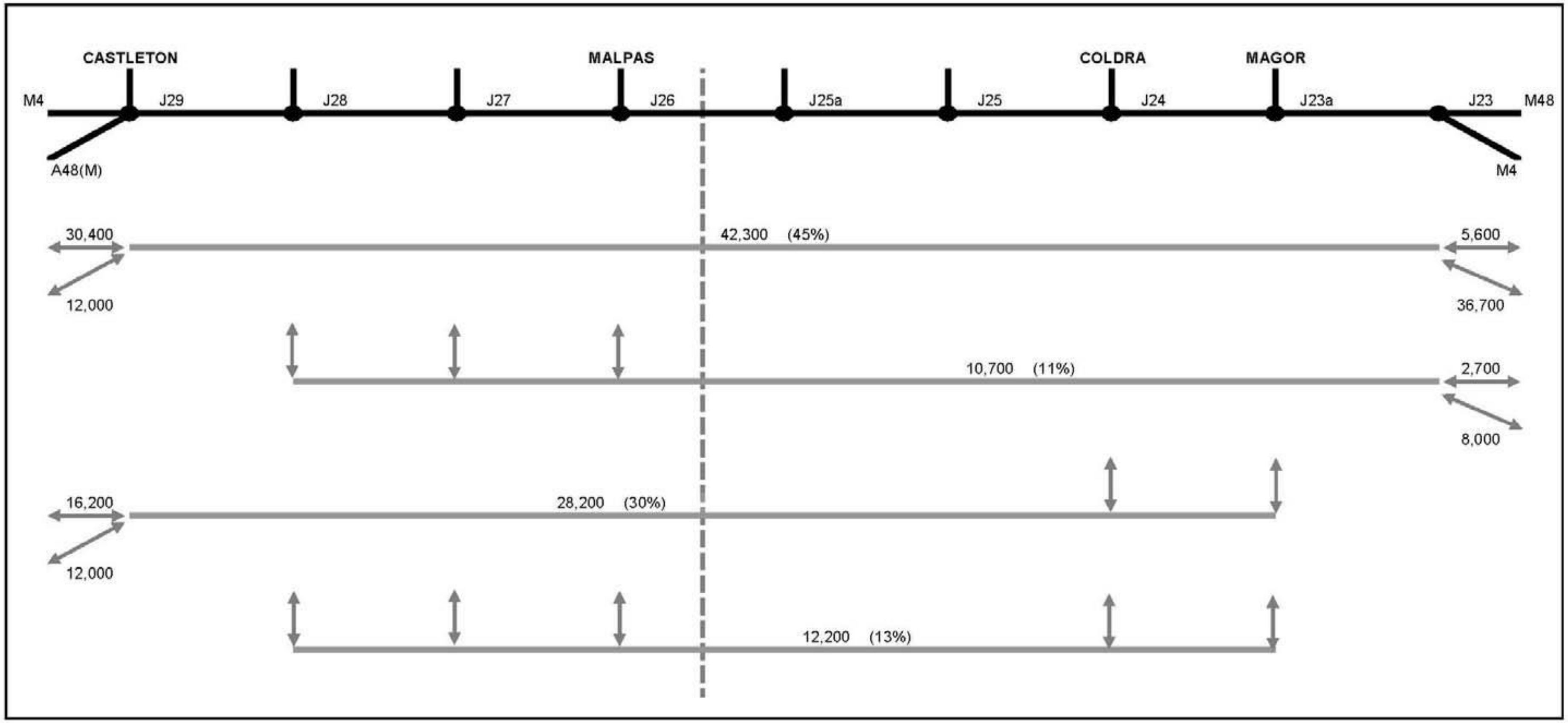

Figure 7.33 Analysis of Traffic Through Brynglas Tunnels 2037 Do Minimum (vehicles/day)

42,300	45%	Through traffic travelling between east of J23 and west of J29
10,700	11%	Two way traffic Joining or Leaving at J28,27,26 travelling through tunnels to east of 23a
28,200	30%	Two way traffic travelling from west of J28 through tunnels and joining or leaving at 24 or 23a
12,200	13%	Two way traffic both joining and leaving between junctions 23 and 29
93,400	**100%**	**Total Brynglas tunnels flow**

Figure 7.34: Analysis of Traffic Through Brynglas Tunnels 2037 Do Minimum (vehicles/day)

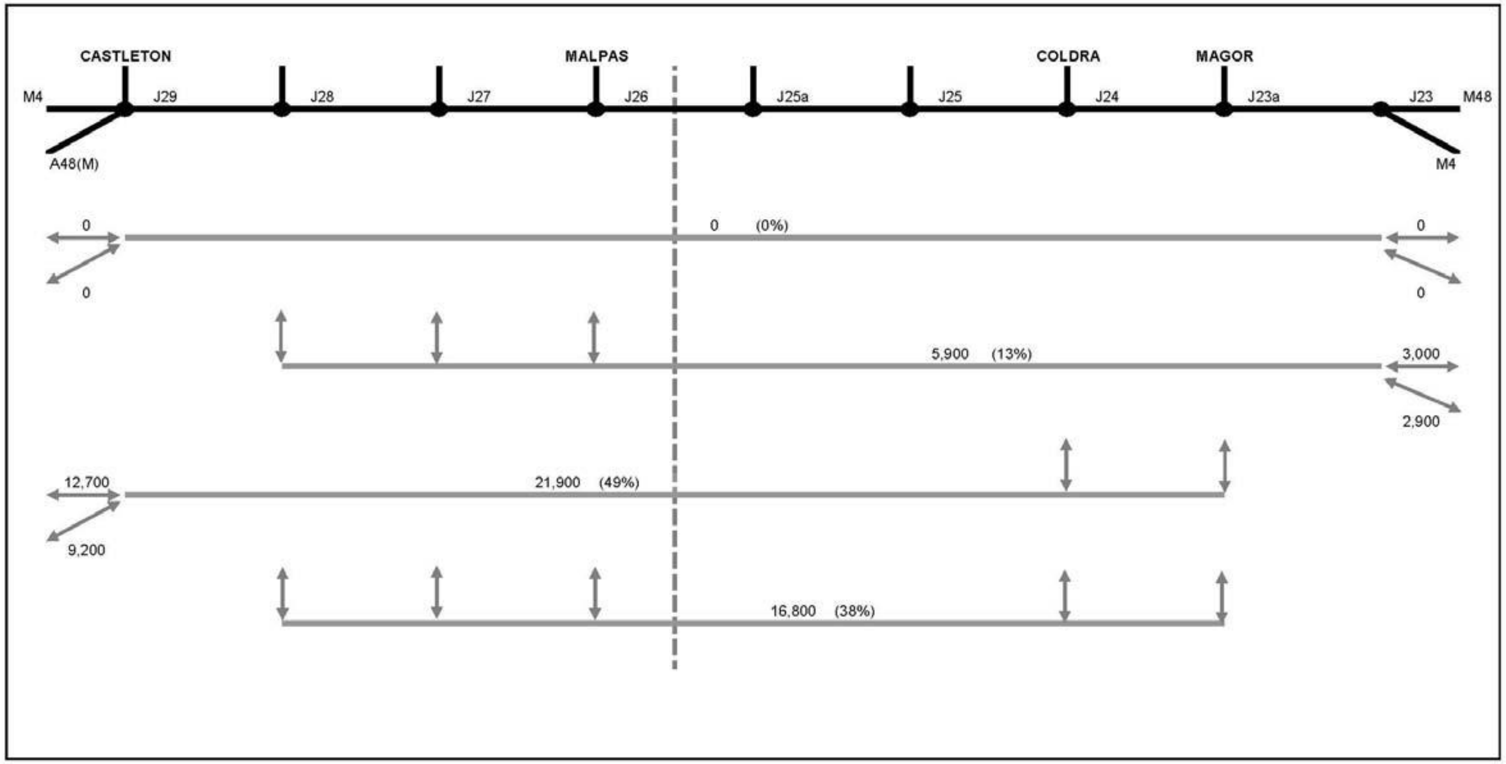

Figure 7.34	
Analysis of Traffic Through Brynglas Tunnels 2037	
Do Something	
(vehicles/day)	

0	0%	Through traffic travelling between east of J23 and west of J29
5,900	13%	Two way traffic Joining or Leaving at J28,27,26 travelling through tunnels to east of 23a
21,900	49%	Two way traffic travelling from west of J28 through tunnels and joining or leaving at 24 or 23a
16,800	38%	Two way traffic both joining and leaving between junctions 23 and 29
44,600	**100%**	**Total Brynglas tunnels flow**

Figure 7.35: Analysis of Traffic on New Usk River Crossing 2037 Do Something (vehicles/day)

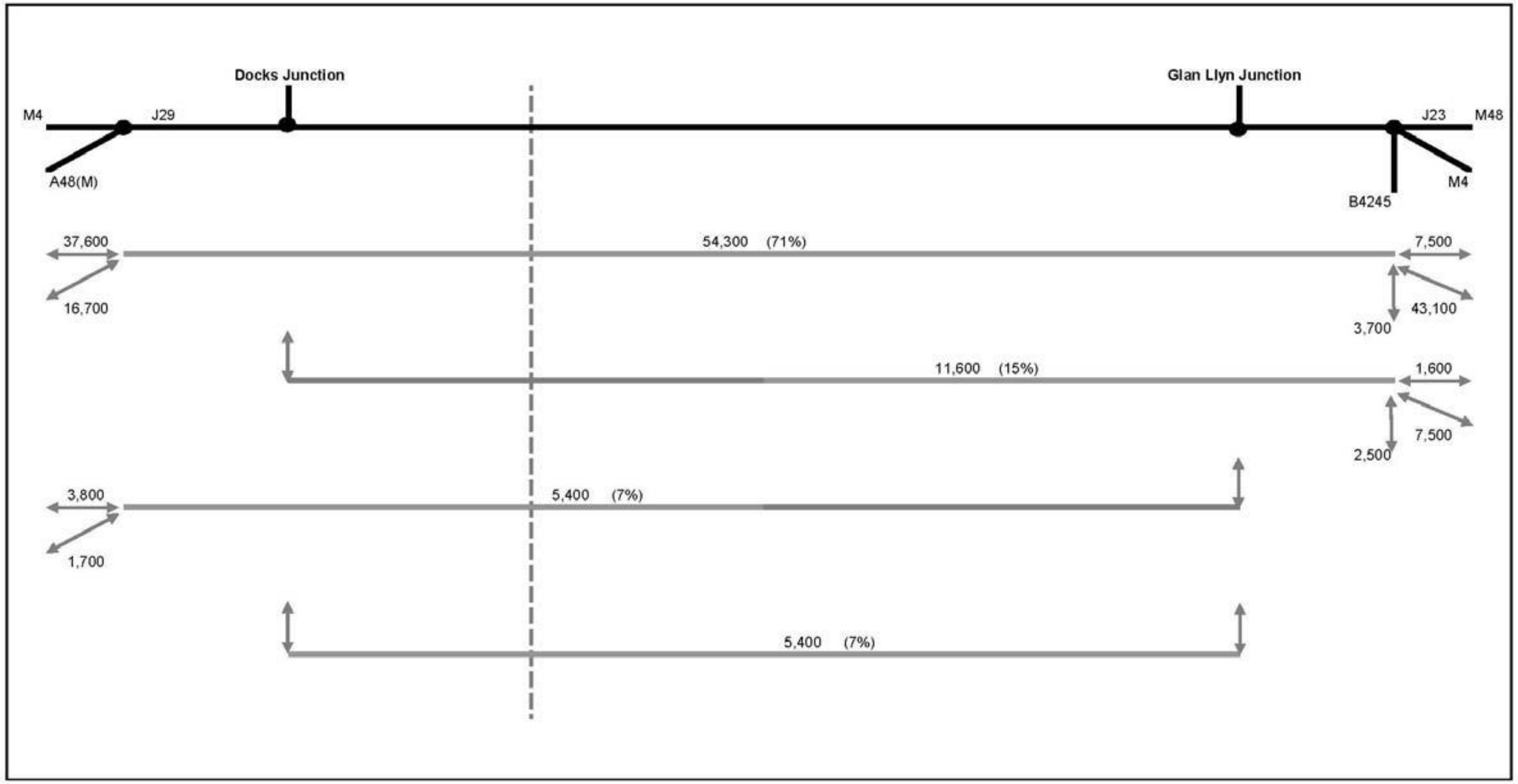

Figure 7.35
Analysis of Traffic on New Usk River Crossing 2037
Do Something
(vehicles/day)

54,300	71%	Through traffic travelling whole length of new motorway
11,600	15%	Two way traffic Joining or Leaving at Docks Junction and travelling on new motorway to East of J23
5,400	7%	Two way traffic Joining or Leaving at Glan Llyn Junction and travelling on new motorway to West of J29
5,400	7%	Two way traffic travelling between Docks Junction and Glan Llyn Junction on New Motorway
76,700	**100%**	**Total New M4 USK River crossing flow**

8 Conclusions

This Traffic Forecasting Report has documented the development of the 2012 base year traffic model to provide forecast scenarios for the M4 Corridor around Newport. Variable demand modelling has been used in accordance with Department for Transport Guidance (WebTAG).

Traffic forecasts have been produced for the AM peak, interpeak and PM peak hours for forecast years of 2022 (the proposed opening year for the new section of motorway south of Newport) and 2037 (the design year).

The traffic forecasts indicate that the Do Minimum Scenario, without the new section of motorway to the south of Newport, would result in congestion on the existing M4, which would be operating over capacity. Constructing the new section of motorway would result in traffic reassignment leading to reduced volumes of traffic on the existing motorway corridor and on local roads within Newport, such that the existing corridor would be likely to operate within capacity. The new section of motorway would also be expected to operate within capacity.

As a result of the new section of motorway to the south of Newport, east-west journey times would be reduced along the existing and new section of motorway corridors compared to the existing M4 corridor in the Do Minimum Scenario. Journey time reliability would also improve as both motorways would be likely to operate within capacity.

In addition to the benefits that the new section of motorway to the south of Newport would offer during normal operating conditions, the new section of motorway would also offer improved network resilience as it would provide an alternative route in the event of maintenance works or an incident on the existing corridor.

Appendix A

NTEM Traffic Growth Factors

A1 NTEM Traffic Growth Factors

		Car Other											
		2012 to 2022						2012 to 2037					
		AM Peak		Inter Peak		PM Peak		AM Peak		Inter Peak		PM Peak	
		origin	destination	origin	destination	origin	destination	origin	destination	origin	destination	origin	destination
Newport 00PR0	Rural	1.157	1.165	1.154	1.156	1.167	1.166	1.278	1.281	1.265	1.269	1.318	1.323
Newport 00PR1	Newport	1.105	1.106	1.110	1.108	1.118	1.116	1.185	1.169	1.184	1.179	1.226	1.225
Newport 00PR4	Caerleon	1.118	1.129	1.126	1.125	1.140	1.134	1.203	1.217	1.215	1.213	1.271	1.259
Monmouthshire 00PP0	Rural	1.087	1.109	1.117	1.116	1.125	1.118	1.168	1.258	1.253	1.250	1.293	1.266
Monmouthshire 00PP1	Chepstow	1.080	1.091	1.107	1.108	1.113	1.110	1.165	1.223	1.244	1.242	1.276	1.263
Monmouthshire 00PP2	Abergavenny	1.091	1.084	1.110	1.110	1.112	1.115	1.189	1.203	1.246	1.242	1.270	1.272
Monmouthshire 00PP3	Caldicot	1.067	1.082	1.096	1.095	1.101	1.096	1.125	1.195	1.206	1.201	1.240	1.217
Monmouthshire 00PP4	Monmouth	1.081	1.083	1.106	1.105	1.108	1.108	1.167	1.201	1.236	1.231	1.259	1.254
Monmouthshire 00PP5	Magor	1.007	1.059	1.047	1.046	1.063	1.043	0.991	1.134	1.087	1.084	1.139	1.085
Cardiff		1.112	1.103	1.117	1.119	1.121	1.121	1.274	1.246	1.276	1.278	1.305	1.308
Torfaen		1.084	1.070	1.089	1.089	1.093	1.098	1.127	1.099	1.136	1.136	1.171	1.178
Blaenau Gwent		1.102	1.126	1.116	1.115	1.123	1.118	1.196	1.236	1.222	1.225	1.270	1.260
Caerphilly		1.088	1.069	1.091	1.093	1.096	1.103	1.157	1.106	1.156	1.161	1.191	1.208
Merthyr Tydfil		1.107	1.107	1.112	1.111	1.107	1.109	1.190	1.175	1.193	1.191	1.205	1.212
Rhondda Cynon Taff		1.110	1.112	1.121	1.122	1.118	1.120	1.208	1.216	1.230	1.232	1.246	1.250
Vale of Glamorgan		1.082	1.101	1.108	1.105	1.103	1.098	1.183	1.243	1.246	1.239	1.255	1.239
Bridgend		1.085	1.089	1.098	1.097	1.093	1.094	1.174	1.182	1.202	1.200	1.206	1.211
Neath Port Talbot		1.088	1.100	1.107	1.107	1.106	1.104	1.185	1.211	1.223	1.223	1.242	1.237
Swansea		1.085	1.071	1.085	1.086	1.090	1.092	1.184	1.150	1.176	1.178	1.208	1.215
Carmarthenshire		1.094	1.113	1.116	1.114	1.112	1.108	1.210	1.258	1.255	1.252	1.270	1.260
Pembrokeshire		1.116	1.113	1.130	1.131	1.121	1.121	1.214	1.217	1.247	1.247	1.259	1.257
Mid Wales		1.071	1.068	1.087	1.087	1.073	1.075	1.132	1.124	1.167	1.166	1.155	1.159
North Wales		1.064	1.065	1.081	1.081	1.075	1.074	1.119	1.120	1.153	1.153	1.161	1.160
South West England		1.109	1.109	1.124	1.124	1.103	1.103	1.265	1.265	1.305	1.305	1.243	1.243
West Midlands		1.084	1.084	1.095	1.095	1.086	1.086	1.193	1.193	1.219	1.219	1.200	1.200
South East England		1.090	1.090	1.103	1.103	1.093	1.094	1.213	1.211	1.249	1.248	1.208	1.212
Greater London		1.115	1.106	1.115	1.116	1.103	1.103	1.276	1.260	1.288	1.290	1.241	1.238
East England		1.128	1.136	1.146	1.145	1.126	1.125	1.315	1.333	1.363	1.362	1.299	1.297
East Midlands		1.111	1.111	1.125	1.125	1.108	1.108	1.270	1.270	1.308	1.308	1.251	1.251
North West England		1.067	1.067	1.078	1.078	1.074	1.074	1.152	1.152	1.180	1.180	1.159	1.159
Yorkshire & Humberside		1.127	1.127	1.138	1.138	1.120	1.120	1.301	1.301	1.327	1.327	1.286	1.286
North East England		1.089	1.089	1.101	1.101	1.088	1.088	1.209	1.209	1.238	1.238	1.201	1.201
Scotland		1.081	1.081	1.093	1.093	1.084	1.084	1.157	1.157	1.188	1.188	1.185	1.185

Does not include fuel and income growth factors

		Car Other											
		2012 to 2022						2012 to 2037					
		AM Peak		Inter Peak		PM Peak		AM Peak		Inter Peak		PM Peak	
		origin	destination	origin	destination	origin	destination	origin	destination	origin	destination	origin	destination
Newport 00PR0	Rural	1.157	1.165	1.154	1.156	1.167	1.166	1.278	1.281	1.265	1.269	1.318	1.323
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Monmouthshire 00PP5	Magor	1.007	1.059	1.047	1.046	1.063	1.043	0.991	1.134	1.087	1.084	1.139	1.085
Cardiff		1.112	1.103	1.117	1.119	1.121	1.121	1.274	1.246	1.276	1.278	1.305	1.308
Torfaen		1.084	1.070	1.089	1.089	1.093	1.098	1.127	1.099	1.136	1.136	1.171	1.178
Blaenau Gwent		1.102	1.126	1.116	1.115	1.123	1.118	1.196	1.236	1.222	1.225	1.270	1.260
Caerphilly		1.088	1.069	1.091	1.093	1.096	1.103	1.157	1.106	1.156	1.161	1.191	1.208
Merthyr Tydfil		1.107	1.107	1.112	1.111	1.107	1.109	1.190	1.175	1.193	1.191	1.205	1.212
Rhondda Cynon Taff		1.110	1.112	1.121	1.122	1.118	1.120	1.208	1.216	1.230	1.232	1.246	1.250
Vale of Glamorgan		1.082	1.101	1.108	1.105	1.103	1.098	1.183	1.243	1.246	1.239	1.255	1.239
Bridgend		1.085	1.089	1.098	1.097	1.093	1.094	1.174	1.182	1.202	1.200	1.206	1.211
Neath Port Talbot		1.088	1.100	1.107	1.107	1.106	1.104	1.185	1.211	1.223	1.223	1.242	1.237
Swansea		1.085	1.071	1.085	1.086	1.090	1.092	1.184	1.150	1.176	1.178	1.208	1.215
Carmarthenshire		1.094	1.113	1.116	1.114	1.112	1.108	1.210	1.258	1.255	1.252	1.270	1.260
Pembrokeshire		1.116	1.113	1.130	1.131	1.121	1.121	1.214	1.217	1.247	1.247	1.259	1.257
Mid Wales		1.071	1.068	1.087	1.087	1.073	1.075	1.132	1.124	1.167	1.166	1.155	1.159
North Wales		1.064	1.065	1.081	1.081	1.075	1.074	1.119	1.120	1.153	1.153	1.161	1.160
South West England		1.109	1.109	1.124	1.124	1.103	1.103	1.265	1.265	1.305	1.305	1.243	1.243
West Midlands		1.084	1.084	1.095	1.095	1.086	1.086	1.193	1.193	1.219	1.219	1.200	1.200
South East England		1.090	1.090	1.103	1.103	1.093	1.094	1.213	1.211	1.249	1.248	1.208	1.212
Greater London		1.115	1.106	1.115	1.116	1.103	1.103	1.276	1.260	1.288	1.290	1.241	1.238
East England		1.128	1.136	1.146	1.145	1.126	1.125	1.315	1.333	1.363	1.362	1.299	1.297
East Midlands		1.111	1.111	1.125	1.125	1.108	1.108	1.270	1.270	1.308	1.308	1.251	1.251
North West England		1.067	1.067	1.078	1.078	1.074	1.074	1.152	1.152	1.180	1.180	1.159	1.159
Yorkshire & Humberside		1.127	1.127	1.138	1.138	1.120	1.120	1.301	1.301	1.327	1.327	1.286	1.286
North East England		1.089	1.089	1.101	1.101	1.088	1.088	1.209	1.209	1.238	1.238	1.201	1.201
Scotland		1.081	1.081	1.093	1.093	1.084	1.084	1.157	1.157	1.188	1.188	1.185	1.185

Does not include fuel and income growth factors

Appendix B

Uncertainty Log

B1 Uncertainty Log

Uncertainty Log for M4 Corridor Around Newport Traffic Forecasts

Input	Forecast Year	Description of Model Central Assumption	Uncertainty Assumption (Alternative Scenario Options)	Comments
Model Parameter Uncertainty				
Sensitivity of VDM to λ value	2022 and 2037	Values given in LMVR	λ Values uplifted by 50%	As in WebTAG unit M2. Impact on BCR to be assessed.
National Uncertainty				
Growth in Demand	2022	NTEM	+ or – 7.91%	Able to apply quantitative range
	2037	NTEM	+ or – 12.50%	
Local Uncertainty: Factors Affecting Underlying Demand				
Future Land Use and Development Assumptions	2022	As described in Chapter 3	Uncertainty relating to this encapsulated within low and high growth forecasts.	
	2037			
Local Uncertainty: Factors Affecting Supply for Transport				
Highway schemes within study area	2022	As described in Chapter 3	All schemes included in the forecast ‘Do Minimum’ scenario are considered highly likely to happen. No other potential highway schemes within study area that are considered significant/likely to happen	
	2037			

Appendix C

VDM Results and Analysis for Core Scenario

C1 VDM Results and Analysis for Core Scenario

C1.1 Total Demand by Scenario

The variable demand model affects trip totals through its frequency response and total vehicle-kilometres through the combination of frequency and redistribution response. The effect of VDM on trip totals is shown in Tables C1 to C6. The effect of VDM on vehicle-kilometres is shown in Tables C7 to C12.

Table C1: Network-wide Vehicle Trips in 2022 AM Peak

Trip Purpose	Vehicles in 2022, AM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	8,799	8,819	8,836
Car, Other	14,899	15,014	15,032
Car, Commute	25,542	25,900	25,928
Light Goods Vehicles	6,900	6,900	6,900
Heavy Goods Vehicles	3,158	3,158	3,158
Total	**59,298**	**59,791**	**59,853**

Table C2: Network-wide Vehicle Trips in 2022 Interpeak

Trip Purpose	Vehicles in 2022, Interpeak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	6,234	6,247	6,254
Car, Other	21,994	22,111	22,133
Car, Commute	6,624	6,704	6,708
Light Goods Vehicles	5,523	5,523	5,523
Heavy Goods Vehicles	3,284	3,284	3,284
Total	**43,658**	**43,868**	**43,902**

Table C3: Network-wide Vehicle Trips in 2022 PM Peak

Trip Purpose	Vehicles in 2022, PM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	10,008	10,018	10,034
Car, Other	23,588	23,741	23,781
Car, Commute	21,413	21,673	21,700
Light Goods Vehicles	5,280	5,280	5,280
Heavy Goods Vehicles	1,830	1,830	1,830
Total	**62,119**	**62,542**	**62,624**

Table C4: Network-wide Vehicle Trips in 2037 AM Peak

Trip Purpose	Vehicles in 2037, AM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	10,315	10,286	10,333
Car, Other	16,199	16,334	16,389
Car, Commute	30,162	30,689	30,796
Light Goods Vehicles	9,790	9,790	9,790
Heavy Goods Vehicles	3,745	3,745	3,745
Total	**70,212**	**70,844**	**71,053**

Table C5: Network-wide Vehicle Trips in 2037 Interpeak

Trip Purpose	Vehicles in 2037, Interpeak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	7,276	7,317	7,332
Car, Other	23,998	24,307	24,348
Car, Commute	7,691	7,852	7,860
Light Goods Vehicles	7,839	7,839	7,839
Heavy Goods Vehicles	3,896	3,896	3,896
Total	**50,698**	**51,210**	**51,274**

Table C6: Network-wide Vehicle Trips in 2037 PM Peak

Trip Purpose	Vehicles in 2037, PM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	11,775	11,741	11,770
Car, Other	26,314	26,529	26,605
Car, Commute	24,938	25,350	25,403
Light Goods Vehicles	7,493	7,493	7,493
Heavy Goods Vehicles	2,171	2,171	2,171
Total	**72,691**	**73,285**	**73,443**

C1.2 Vehicle Kilometres Travelled by Scenario

Table C7: Network-wide Vehicle-Kilometres in 2022 AM Peak

Trip Purpose	Vehicle-kilometres in 2022, AM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	615,271	627,216	628,959
Car, Other	372,416	429,261	434,290
Car, Commute	639,009	661,094	666,757
Light Goods Vehicles	282,041	281,947	281,001
Heavy Goods Vehicles	325,155	325,133	324,172
Total	**2,233,892**	**2,324,652**	**2,335,179**

Table C8: Network-wide Vehicle-Kilometres in 2022 Interpeak

Trip Purpose	Vehicle-kilometres in 2022, Interpeak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	397,950	415,952	415,367
Car, Other	642,960	739,958	743,080
Car, Commute	126,978	131,216	131,722
Light Goods Vehicles	239,547	239,531	238,780
Heavy Goods Vehicles	316,016	316,019	314,968
Total	**1,723,451**	**1,842,676**	**1,843,917**

Table C9: Network-wide Vehicle-Kilometres in 2022 PM Peak

Trip Purpose	Vehicle-kilometres in 2022, PM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	589,214	605,211	607,204
Car, Other	620,970	704,831	709,117
Car, Commute	509,921	526,135	529,573
Light Goods Vehicles	216,304	216,277	215,833
Heavy Goods Vehicles	203,503	203,504	202,699
Total	**2,139,912**	**2,255,957**	**2,264,426**

Table C10: Network-wide Vehicle-Kilometres in 2037 AM Peak

Trip Purpose	Vehicle-kilometres in 2037, AM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	676,690	686,518	693,418
Car, Other	412,535	517,228	530,838
Car, Commute	729,672	760,218	779,509
Light Goods Vehicles	402,590	402,157	401,657
Heavy Goods Vehicles	389,197	389,115	387,875
Total	**2,610,683**	**2,755,237**	**2,793,297**

Table C11: Network-wide Vehicle-Kilometres in 2037 Interpeak

Trip Purpose	Vehicle-kilometres in 2037, Interpeak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	439,806	479,962	480,525
Car, Other	725,257	942,540	949,126
Car, Commute	144,791	153,970	154,671
Light Goods Vehicles	341,586	341,538	340,659
Heavy Goods Vehicles	377,049	377,043	375,744
Total	**2,028,489**	**2,295,053**	**2,300,725**

Table C12: Network-wide Vehicle-Kilometres in 2037 PM Peak

Trip Purpose	Vehicle-kilometres in 2037, PM Peak Hour		
	Reference Case	Do Minimum	Do Something
Car, Employers Business	652,405	670,459	678,801
Car, Other	695,724	865,045	881,777
Car, Commute	579,908	604,647	613,952
Light Goods Vehicles	309,432	309,363	308,550
Heavy Goods Vehicles	241,805	241,683	240,768
Total	**2,479,273**	**2,691,196**	**2,723,847**

C1.3 Effect of Changing Fuel Cost and Average Income

A separate traffic forecast VDM run has been created to separate the demand response resulting from changes in congestion levels in the forecast Do Minimum from other effects. A reduction in fuel cost (due to improved fuel efficiency and a higher proportion of electric vehicles) and an increase in average income levels over time in real terms generally lead to an increase in trip numbers and trip length. On the other hand, traffic growth generally leads to increasing traffic congestion in the forecast traffic model and therefore has the opposite effect. Section 6.4 of this report includes results for the combined effect.

Table C13 shows the values from the 2022 & 2037 Do Minimum relative to the Reference case and compares them to the sensitivity test with generalised cost coefficients kept unchanged from the base year, in effect therefore excluding the impact of fuel cost and income changes included. The results show a logical trend, in that the forecast VDM run which only takes into account increasing traffic congestion from the traffic assignment has a slight reduction in trip demand and kilometres travelled compared to the reference case. From this sensitivity test it can be concluded that the effect of reducing travel costs due to income and fuel cost changes significantly outweigh the increase in travel times in the network between the base year and the horizon year of the model.

Table C13: Results of Fuel Cost and Income Adjustment Sensitivity Test

Year	Scenario	Fuel Cost and Income Adjustment	AM Peak Hour		Interpeak Hour		PM Peak Hour	
			Trips (Vehicles)	Vehicle -Kms	Trips (Vehicles)	Vehicle -Kms	Trips (Vehicles)	Vehicle -Kms
2022	Reference Case to Do Minimum	Not Included	-0.3%	-2.1%	-0.4%	-1.0%	-0.4%	-2.3%
		Included	+0.8%	+4.1%	+0.5%	+6.9%	+0.7%	+5.4%
2037	Reference Case to Do Minimum	Not Included	-1.0%	-5.1%	-0.6%	-2.8%	-1.1%	-5.4%
		Included	+0.9%	+5.5%	+1.0%	+13.1%	+0.8%	+8.5%

C1.4 Trip Length Analysis

The combined frequency and redistribution response in VDM alters the trip length distribution between scenarios either by increasing or reducing trips for specific O-D pairs or by shifting demand from one O-D pair to another. This change needs to be monitored to ensure that the shift in trip length distribution follows logical trends and is not excessive.

Figures C1 to C6 show the average trip length by scenario, year and time period. Generally there is no notable distortion of trip lengths that results from the variable demand model responses

Figure C1: Trip Length Distribution in 2022 AM Peak

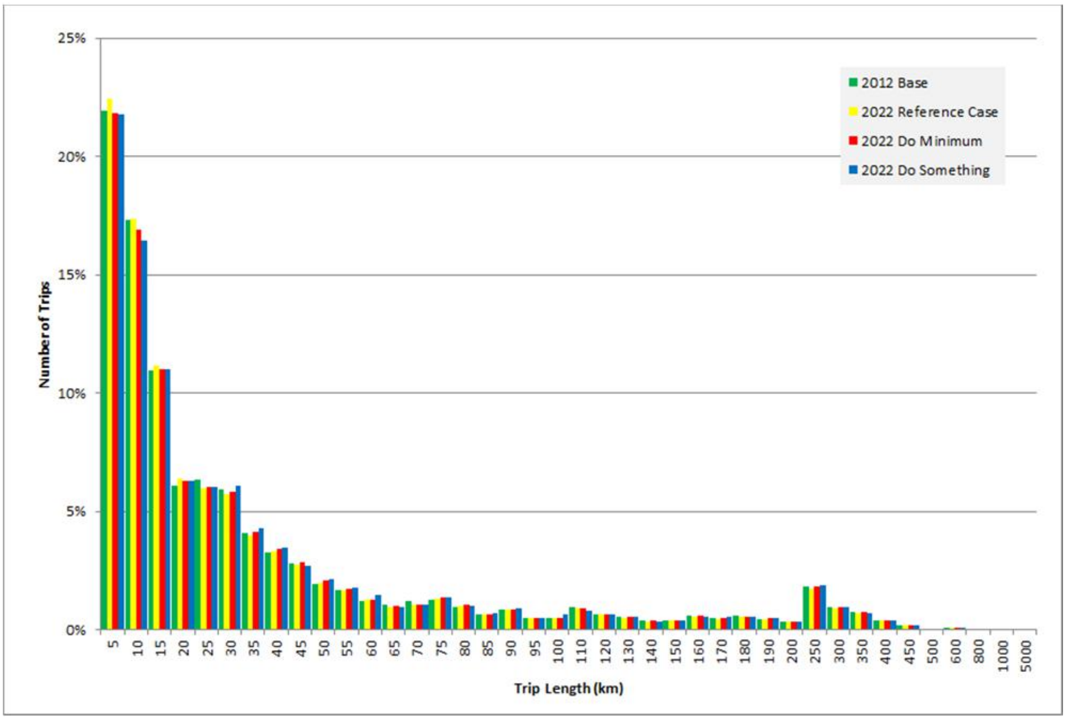


Figure C2: Trip Length Distribution in 2022 Interpeak

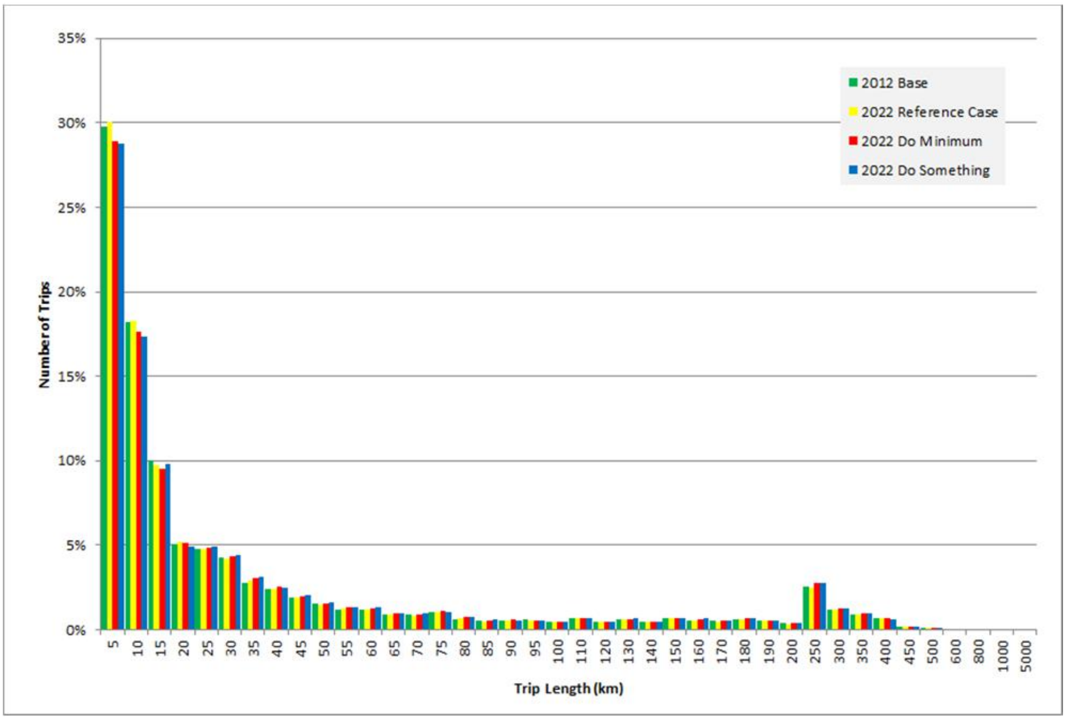


Figure C3: Trip Length Distribution in 2022 PM Peak

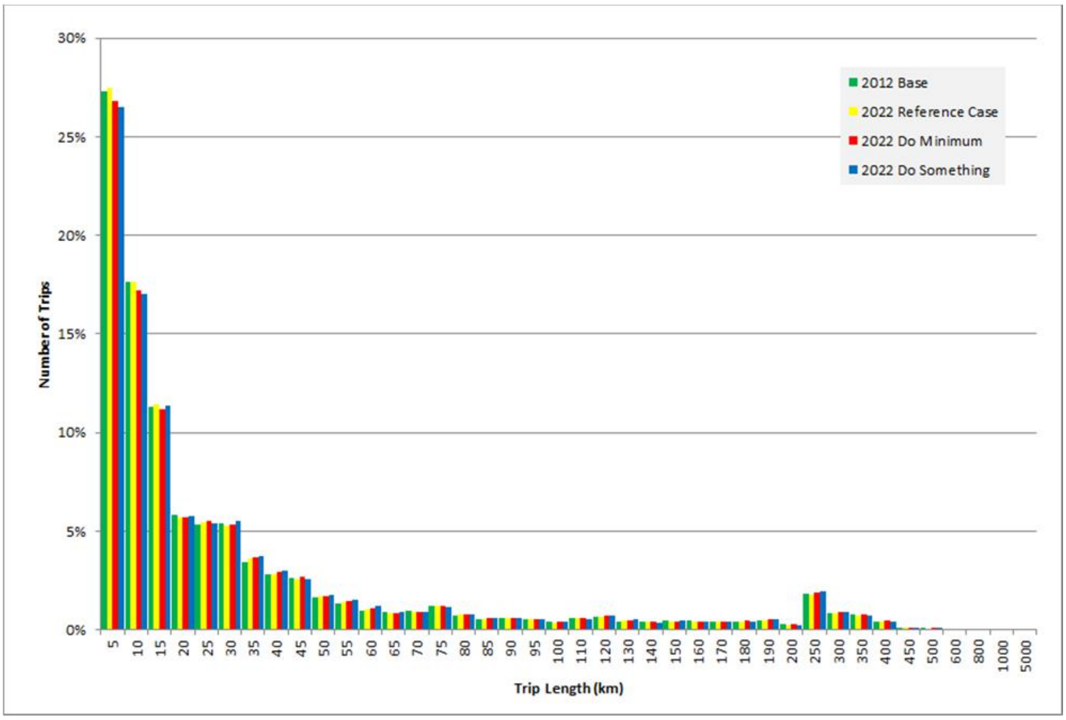


Figure C4: Trip Length Distribution in 2037 AM Peak

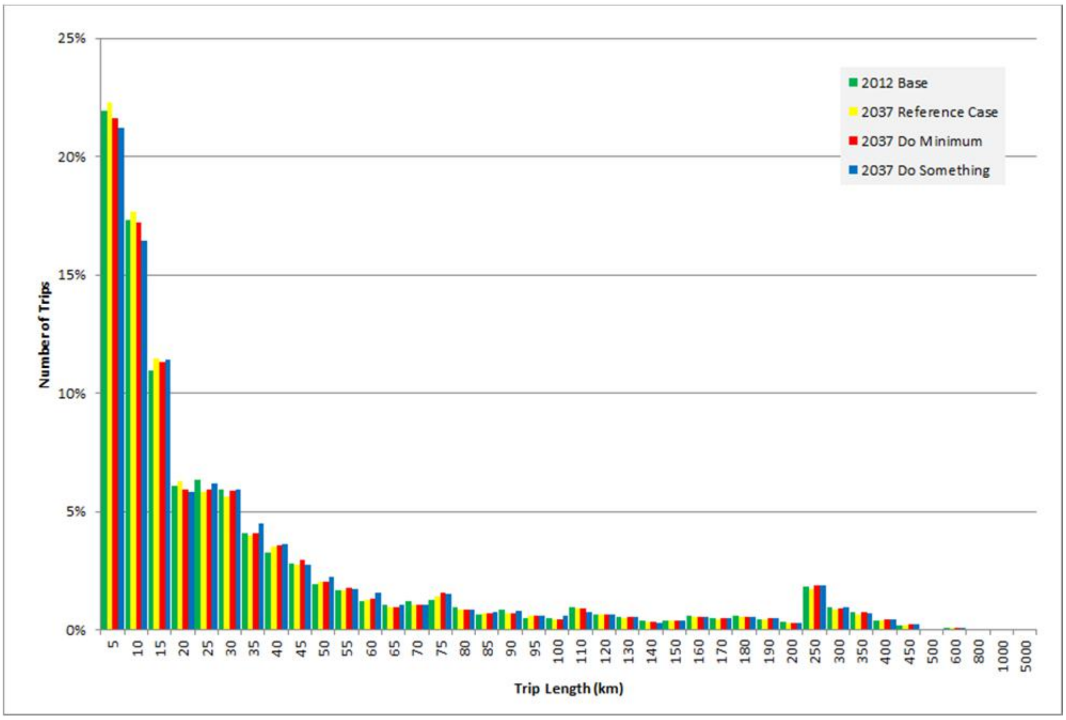


Figure C5: Trip Length Distribution in 2037 Interpeak

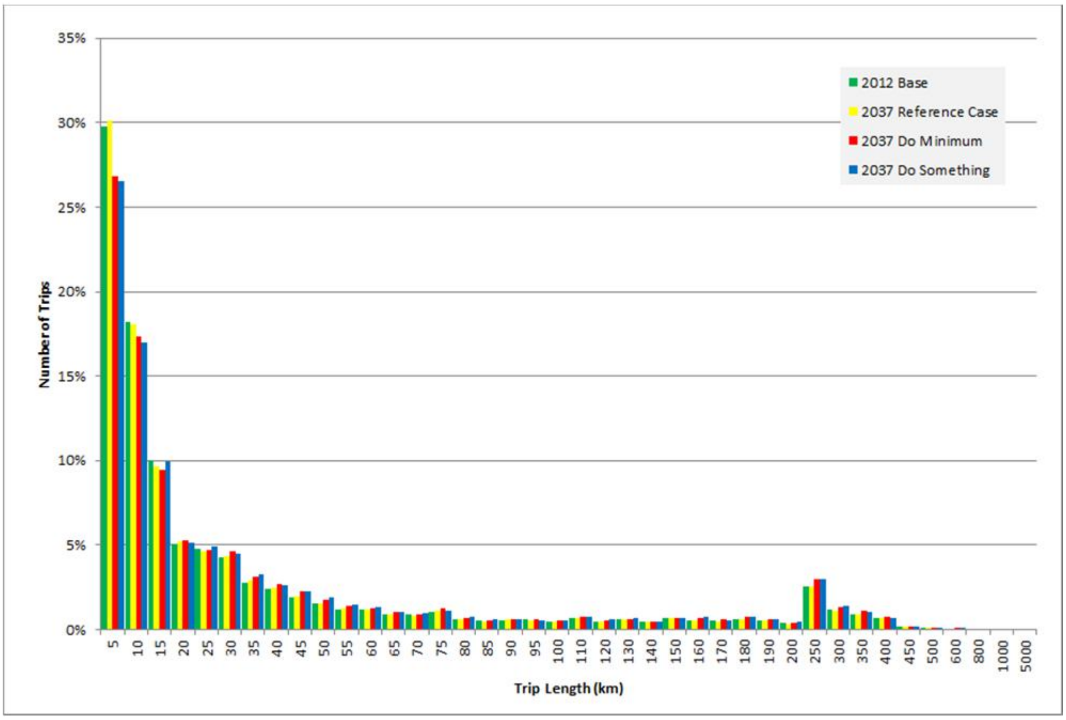
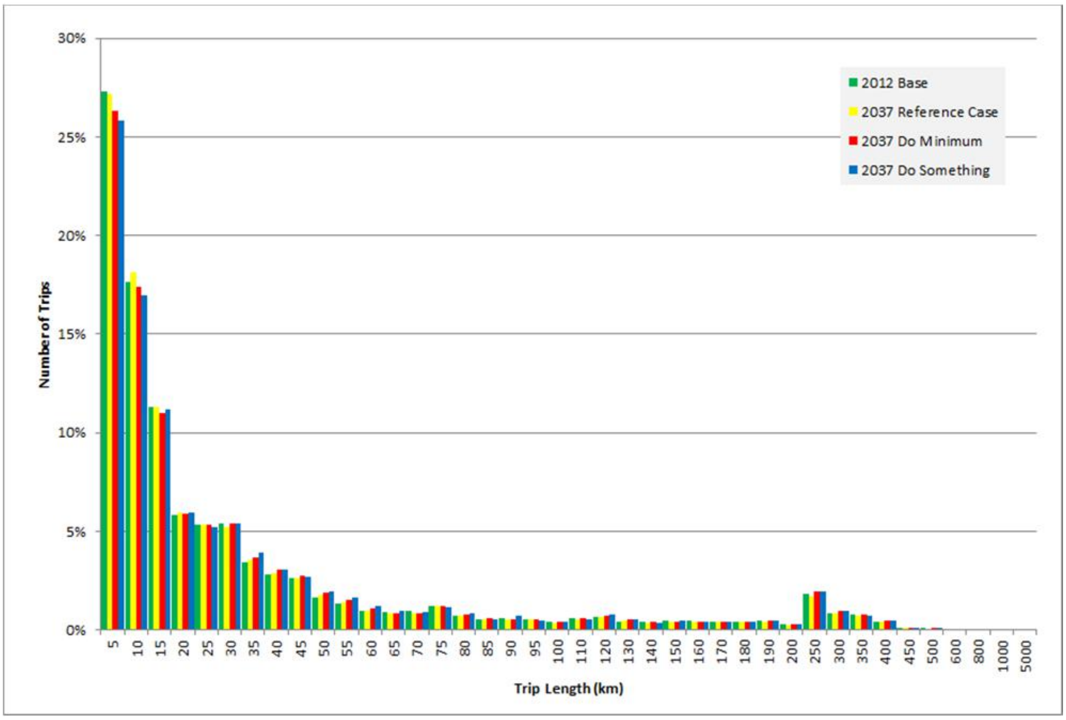


Figure C6: Trip Length Distribution in 2037 PM Peak



C1.5 Spatial Impact of VDM

Forecast demand responses have been analysed using a sector system as shown in Figure C7. The analysis illustrates the spatial shift in travel demand patterns between Forecast Reference Case, core Do Minimum and core Do Something.

A twelve by twelve sector system was used to carry out the analysis, but results included in this note have been summarised into 3 broader sectors to give an indication of the spatial shift between the core study area, a peripheral outer area within 30 kms of the simulation network (the 'buffer') and an area which is considered external to the study area. It should be noted that the external sector in this context does not refer to the area of the model which has been frozen in VDM.

Total changes in trips and kilometres travelled between scenarios in this section match the global changes in trips and kilometres travelled presented in Tables C1 to C6, with minor differences due to rounding.

The results shown in Tables C14 to C21 illustrate that between the Reference and the Do Minimum there is a significant shift of trips internal to the core area that become core to buffer or buffer to core trips. There is also an increase in trips to and from external areas.

Trends in kilometres travelled generally show an increase, apart from movements internal to the core area. This reduction in kilometres travelled within the core area is caused by trips that were previously travelling within the core lengthening to extend beyond the core as part of the redistribution response. There is also a general increase in trip numbers throughout the model as a result of the trip frequency response, which contributes to an uplift in kilometres travelled network-wide.

Between the Do Minimum and Do Something there is a similar shift in trips which were originally internal to the core or buffer and then become longer distance trips between core and buffer or core and external areas. There is generally a slight reduction in trips between the buffer and external areas and an increase in core to external movements, thereby resulting in a lengthening of journeys that are affected by the scheme. The scale of changes between Do Minimum and Do Something scenario is generally substantially lower than the changes between the Reference and the Do Minimum. The VDM indicates that the changes in travel costs over time are more significant in inducing traffic than are the impacts of the scheme.

Figure C7: Sector System for VDM Response Check

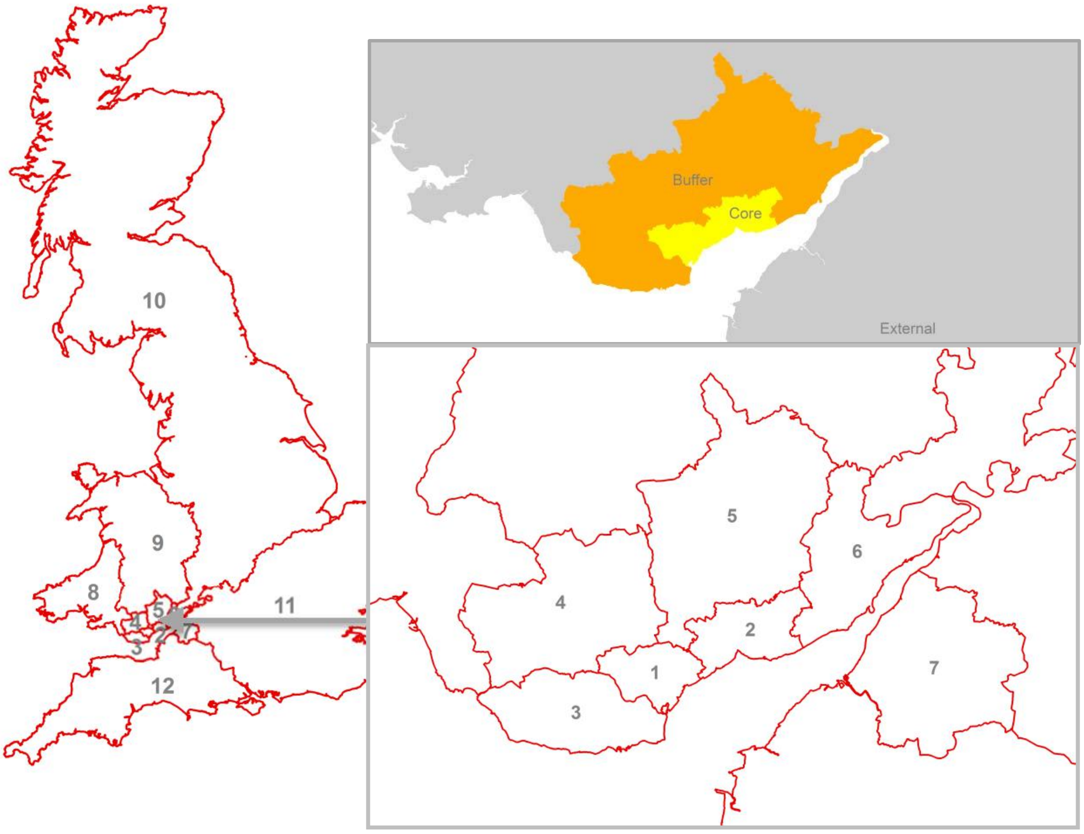


Table C14: Summary of Demand Matrix Changes in Forecast VDM in 2022

	Sector	AM Peak Core	AM Peak Buffer	AM Peak Ext	AM Peak Total	Inter Peak Core	Inter Peak Buffer	Inter Peak Ext	Inter Peak Total	PM Peak Core	PM Peak Buffer	PM Peak Ext	PM Peak Total
Reference to Do Minimum	Core	-292	202	299	209	-575	216	383	24	-410	-45	5	-450
	Buffer	122	-26	97	192	-79	-19	187	88	246	-66	21	201
	Ext	84	35	-10	109	23	44	28	95	370	259	41	669
	Total	-87	211	386	510	-631	241	597	206	205	148	68	421
Do Minimum to Do Something	Core	-124	83	65	24	-84	62	37	15	-102	47	25	-30
	Buffer	54	-21	-8	26	12	-2	1	11	84	5	-18	71
	Ext	49	-25	-11	13	23	-15	0	7	61	-24	3	41
	Total	-21	37	47	62	-49	44	38	34	43	28	11	81

Table C15: Relative Change in Forecast Demand Matrix in 2022

	Sector	AM Peak Core	AM Peak Buffer	AM Peak Ext	AM Peak Total	Inter Peak Core	Inter Peak Buffer	Inter Peak Ext	Inter Peak Total	PM Peak Core	PM Peak Buffer	PM Peak Ext	PM Peak Total
Reference to Do Minimum	Core	-1.1%	3.1%	11.2%	0.6%	-2.5%	4.9%	21.5%	0.1%	-1.3%	-0.5%	0.2%	-1.1%
	Buffer	1.3%	-0.7%	3.2%	1.2%	-1.6%	-0.7%	10.1%	0.9%	3.9%	-1.9%	1.1%	1.7%
	Ext	2.9%	1.8%	-0.4%	1.5%	1.3%	2.6%	1.3%	1.7%	15.6%	8.1%	1.9%	8.6%
	Total	-0.2%	1.8%	4.8%	0.9%	-2.2%	2.7%	10.5%	0.5%	0.5%	0.9%	1.1%	0.7%
Do Minimum to Do Something	Core	-0.5%	1.2%	2.2%	0.1%	-0.4%	1.3%	1.7%	0.1%	-0.3%	0.5%	1.1%	-0.1%
	Buffer	0.6%	-0.6%	-0.2%	0.2%	0.2%	-0.1%	0.1%	0.1%	1.3%	0.1%	-0.9%	0.6%
	Ext	1.6%	-1.3%	-0.4%	0.2%	1.3%	-0.9%	0.0%	0.1%	2.2%	-0.7%	0.2%	0.5%
	Total	-0.1%	0.3%	0.5%	0.1%	-0.2%	0.5%	0.6%	0.1%	0.1%	0.2%	0.2%	0.1%

Table C16: Summary of Changes in Vehicle Kilometres in 2022 Forecast VDM

		AM Peak				Inter Peak				PM Peak			
	Sector	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total
Reference to Do Minimum	Core	177	7,251	42,805	50,234	-1,632	7,373	57,348	63,089	-146	459	-160	152
	Buffer	5,055	2,435	18,773	26,264	-787	1,819	36,110	37,142	8,212	991	5,526	14,728
	Ext	6,270	2,951	6,080	15,301	4,021	5,935	9,037	18,994	47,938	37,159	16,068	101,165
	Total	11,502	12,638	67,658	91,799	1,602	15,127	102,495	119,225	56,003	38,609	21,433	116,045
Do Minimum to Do Something	Core	1,602	1,983	5,635	9,220	442	1,110	2,232	3,784	1,796	1,833	1,922	5,552
	Buffer	2,075	1,158	-1,437	1,795	484	189	-980	-307	2,559	769	-1,648	1,681
	Ext	3,269	-1,838	-1,921	-490	1,409	-1,657	-1,988	-2,236	5,319	-1,918	-2,165	1,236
	Total	6,945	1,303	2,276	10,525	2,335	-357	-736	1,242	9,674	685	-1,890	8,469

Table C17: Relative Change in Vehicle Kilometres in 2022 Forecast VDM

		AM Peak				Inter Peak				PM Peak			
	Sector	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total
Reference to Do Minimum	Core	0.1%	4.9%	14.8%	7.9%	-1.2%	7.7%	26.7%	14.0%	-0.1%	0.2%	-0.1%	0.0%
	Buffer	2.2%	2.5%	5.9%	4.1%	-0.7%	2.7%	14.7%	8.7%	5.9%	1.1%	2.2%	3.1%
	Ext	2.0%	1.2%	1.5%	1.6%	1.9%	2.8%	2.2%	2.2%	19.2%	11.5%	3.7%	10.0%
	Total	1.6%	2.6%	6.7%	4.1%	0.3%	4.0%	11.7%	6.9%	9.4%	6.2%	2.3%	5.4%
Do Minimum to Do Something	Core	0.8%	1.3%	1.7%	1.3%	0.3%	1.1%	0.8%	0.7%	0.9%	0.9%	0.8%	0.9%
	Buffer	0.9%	1.2%	-0.4%	0.3%	0.4%	0.3%	-0.3%	-0.1%	1.7%	0.8%	-0.6%	0.3%
	Ext	1.0%	-0.7%	-0.5%	-0.1%	0.6%	-0.8%	-0.5%	-0.3%	1.8%	-0.5%	-0.5%	0.1%
	Total	0.9%	0.3%	0.2%	0.5%	0.5%	-0.1%	-0.1%	0.1%	1.5%	0.1%	-0.2%	0.4%

Table C18: Summary of Demand Matrix Changes in Forecast VDM in 2037

		AM Peak				Inter Peak				PM Peak			
	Sector	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total
Reference to Do Minimum	Core	-626	343	501	217	-1,213	488	853	128	-973	-193	1	-1,165
	Buffer	122	-25	171	268	-158	-32	368	178	529	-124	57	463
	Ext	132	106	-76	163	68	102	28	199	707	553	33	1,293
	Total	-372	424	596	648	-1,304	558	1,250	504	264	236	91	591
Do Minimum to Do Something	Core	-224	171	170	116	-114	84	67	37	-257	64	45	-149
	Buffer	125	-18	-46	61	20	-5	1	16	147	16	-32	131
	Ext	122	-59	-34	29	34	-23	0	10	197	-31	6	172
	Total	23	93	90	207	-60	56	68	64	87	48	19	154

Table C19: Relative Change in Forecast Demand Matrix in 2037

		AM Peak				Inter Peak				PM Peak			
	Sector	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total
Reference to Do Minimum	Core	-1.9%	4.4%	15.9%	0.5%	-4.7%	9.4%	40.1%	0.4%	-2.6%	-1.8%	0.0%	-2.3%
	Buffer	1.1%	-0.6%	5.1%	1.4%	-2.7%	-1.0%	17.1%	1.6%	7.2%	-3.0%	2.5%	3.4%
	Ext	4.1%	4.6%	-2.8%	2.0%	3.3%	5.2%	1.2%	3.1%	25.7%	15.5%	1.3%	14.8%
	Total	-0.8%	3.0%	6.5%	0.9%	-3.9%	5.4%	18.8%	1.0%	0.6%	1.3%	1.2%	0.8%
Do Minimum to Do Something	Core	-0.7%	2.1%	4.7%	0.3%	-0.5%	1.5%	2.3%	0.1%	-0.7%	0.6%	1.8%	-0.3%
	Buffer	1.1%	-0.4%	-1.3%	0.3%	0.4%	-0.2%	0.0%	0.1%	1.9%	0.4%	-1.3%	0.9%
	Ext	3.6%	-2.5%	-1.3%	0.3%	1.6%	-1.1%	0.0%	0.2%	5.7%	-0.8%	0.2%	1.7%
	Total	0.1%	0.6%	0.9%	0.3%	-0.2%	0.5%	0.9%	0.1%	0.2%	0.3%	0.3%	0.2%

Table C20: Summary of Changes in Vehicle Kilometres in 2037 Forecast VDM

		AM Peak				Inter Peak				PM Peak			
	Sector	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total
Reference to Do Minimum	Core	-1,881	10,801	78,002	86,923	-4,172	16,352	134,734	146,915	-6,181	-3,807	-1,531	-11,519
	Buffer	5,604	3,893	32,409	41,906	-1,360	3,941	76,853	79,434	15,909	1,580	11,188	28,676
	Ext	7,137	7,738	7,527	22,402	9,826	12,996	17,392	40,215	91,967	73,314	29,457	194,738
	Total	10,861	22,432	117,937	151,230	4,294	33,290	228,979	266,564	101,694	71,087	39,114	211,895
Do Minimum to Do Something	Core	5,144	6,614	15,049	26,807	1,322	1,833	5,004	8,158	3,724	3,464	3,832	11,020
	Buffer	6,034	3,111	-2,684	6,461	577	334	-886	25	6,023	1,717	-1,990	5,751
	Ext	10,243	-3,045	-5,803	1,395	2,305	-2,280	-2,536	-2,511	19,436	222	-3,772	15,887
	Total	21,421	6,679	6,563	34,663	4,203	-113	1,581	5,672	29,183	5,404	-1,929	32,658

Table C21: Relative Change in Vehicle Kilometres in 2037 Forecast VDM

		AM Peak				Inter Peak				PM Peak			
	Sector	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total	Core	Buffer	Ext	Total
Reference to Do Minimum	Core	-0.8%	6.1%	22.7%	11.4%	-2.5%	14.2%	52.4%	27.4%	-2.4%	-1.5%	-0.6%	-1.5%
	Buffer	2.1%	3.3%	9.0%	5.6%	-1.0%	4.8%	27.0%	15.9%	9.6%	1.5%	3.9%	5.1%
	Ext	2.1%	2.6%	1.6%	2.0%	3.8%	5.3%	3.6%	4.1%	32.2%	19.9%	5.9%	16.9%
	Total	1.3%	3.8%	10.1%	5.8%	0.8%	7.5%	22.2%	13.1%	14.4%	9.8%	3.7%	8.5%
Do Minimum to Do Something	Core	2.1%	3.5%	3.6%	3.1%	0.8%	1.4%	1.3%	1.2%	1.5%	1.4%	1.5%	1.5%
	Buffer	2.2%	2.5%	-0.7%	0.8%	0.4%	0.4%	-0.2%	0.0%	3.3%	1.6%	-0.7%	1.0%
	Ext	2.9%	-1.0%	-1.2%	0.1%	0.9%	-0.9%	-0.5%	-0.2%	5.1%	0.1%	-0.7%	1.2%
	Total	2.5%	1.1%	0.5%	1.3%	0.8%	0.0%	0.1%	0.2%	3.6%	0.7%	-0.2%	1.2%

Appendix D

Convergence Statistics

D1 Convergence Statistics

Table D1: M4 Corridor Around Newport Model Convergence Statistics for Core Scenario

AM Peak	**2012**	**2022**		**2037**	
		Do Minimum	Do Something	Do Minimum	Do Something
Number of Iterations	55	34	32	88	89
'Delta' Function	0.0024	0.0018	0.0018	0.0045	0.0081
Percentage of Link Flows changing by <5% - final four iterations	99.2 99.4 98.1 98.9	99.2 99.1 99.3 99.4	99.1 99.2 99.3 99.3	99.1 99.1 99.1 99.2	99.4 99.3 99.4 99.5
Inter Peak					
Number of Iterations	10	11	10	13	12
'Delta' Function	0.00001	0.00001	0.00000	0.00007	0.00001
Percentage of Link Flows changing by <5% - final four iterations	98.7 99.3 99.8 99.7	99.4 99.5 99.6 99.7	99.1 99.4 99.7 99.8	99.3 99.2 99.5 99.4	99.4 99.8 100.0 99.9
PM Peak					
Number of Iterations	14	18	14	100	26
'Delta' Function	0.0013	0.00043	0.00038	0.0077	0.0024
Percentage of Link Flows changing by <5% - final four iterations	98.4 98.5 98.7 98.9	99. 99.3 99.3 99.5	99.0 99.4 99.5 99.7	97.6 98.6 98.9 99.4	99.1 99.3 99.5 99.5

Table D2: M4 Corridor Around Newport Model Convergence Statistics for Low Growth Scenario

	2022 Low Growth		2037 Low Growth	
AM Peak	Do Minimum	Do Something	Do Minimum	Do Something
Number of Iterations	21	21	45	32
'Delta' Function	0.0014	0.0011	0.0032	0.0017
Percentage of Link Flows changing by <5% - final four iterations	99.5 99.3 99.2 99.3	99.2 99.7 99.3 99.4	99.4 99.5 99.2 99.5	99.2 99.2 99.4 99.3
Inter Peak				
Number of Iterations	10	10	11	11
'Delta' Function	0.00000	0.00000	0.00001	0.00001
Percentage of Link Flows changing by <5% - final four iterations	99.3 99.6 99.7 99.8	99.6 99.8 99.9 100.0	99.5 99.8 99.9 99.9	99.2 99.6 99.6 99.8
PM Peak				
Number of Iterations	16	13	23	16
'Delta' Function	0.00046	0.00025	0.00055	0.00027
Percentage of Link Flows changing by <5% - final four iterations	99.1 99.1 99.2 99.3	99.4 99.7 99.8 99.9	99.2 99.1 99.4 99.2	99.5 99.6 99.8 99.8

Table D3: M4 Corridor Around Newport Model Convergence Statistics for High Growth Scenario

	2022 High Growth		2037 High Growth	
AM Peak	Do Minimum	Do Something	Do Minimum	Do Something
Number of Iterations	63	65	100	63
'Delta' Function	0.0087	0.0026	0.087	0.0090
Percentage of Link Flows changing by <5% - final four iterations	99.2 99.0 99.1 99.1	99.4 99.5 99.5 99.1	98.0 97.7 97.6 97.5	99.3 99.2 99.4 99.3
Inter Peak				
Number of Iterations	13	12	29	13
'Delta' Function	0.00001	0.00000	0.0021	0.00003
Percentage of Link Flows changing by <5% - final four iterations	99.2 99.5 99.7 99.7	99.4 99.7 99.7 99.9	99.2 99.0 99.2 99.0	99.5 99.7 99.8 99.8
PM Peak				
Number of Iterations	22	16	97	100
'Delta' Function	0.00064	0.00054	0.0054	0.0079
Percentage of Link Flows changing by <5% - final four iterations	99.0 99.1 99.3 99.1	99.4 99.6 99.6 99.9	99.2 99.3 99.2 99.1	98.8 98.7 98.0 98.4

Table D4: M4 Corridor Around Newport Model Convergence Statistics for Severn Tolls Removed Scenario

	2022 No Severn Tolls		2037 No Severn Tolls	
AM Peak	Do Minimum	Do Something	Do Minimum	Do Something
Number of Iterations	30	28	88	55
'Delta' Function	0.0021	0.0018	0.0052	0.0084
Percentage of Link Flows changing by <5% - final four iterations	99.3 99.2 99.2 99.2	99.4 99.2 99.4 99.3	99.1 99.4 99.2 99.4	99.1 99.4 99.1 99.0
Inter Peak				
Number of Iterations	11	11	13	12
'Delta' Function	0.00001	0.00000	0.00026	0.00002
Percentage of Link Flows changing by <5% - final four iterations	99.2 99.3 99.3 99.7	99.4 99.6 99.7 99.9	99.2 99.3 99.3 99.4	99.5 99.7 99.9 99.9
PM Peak				
Number of Iterations	16	14	100	41
'Delta' Function	0.00074	0.00036	0.0015	0.00037
Percentage of Link Flows changing by <5% - final four iterations	99.0 99.1 99.2 99.1	99.3 99.6 99.5 99.7	98.2 98.1 98.7 99.3	99.2 99.5 99.6 99.8

Table D5: M4 Corridor Around Newport Model Convergence Statistics for Central Growth Scenario with No Docks Junction

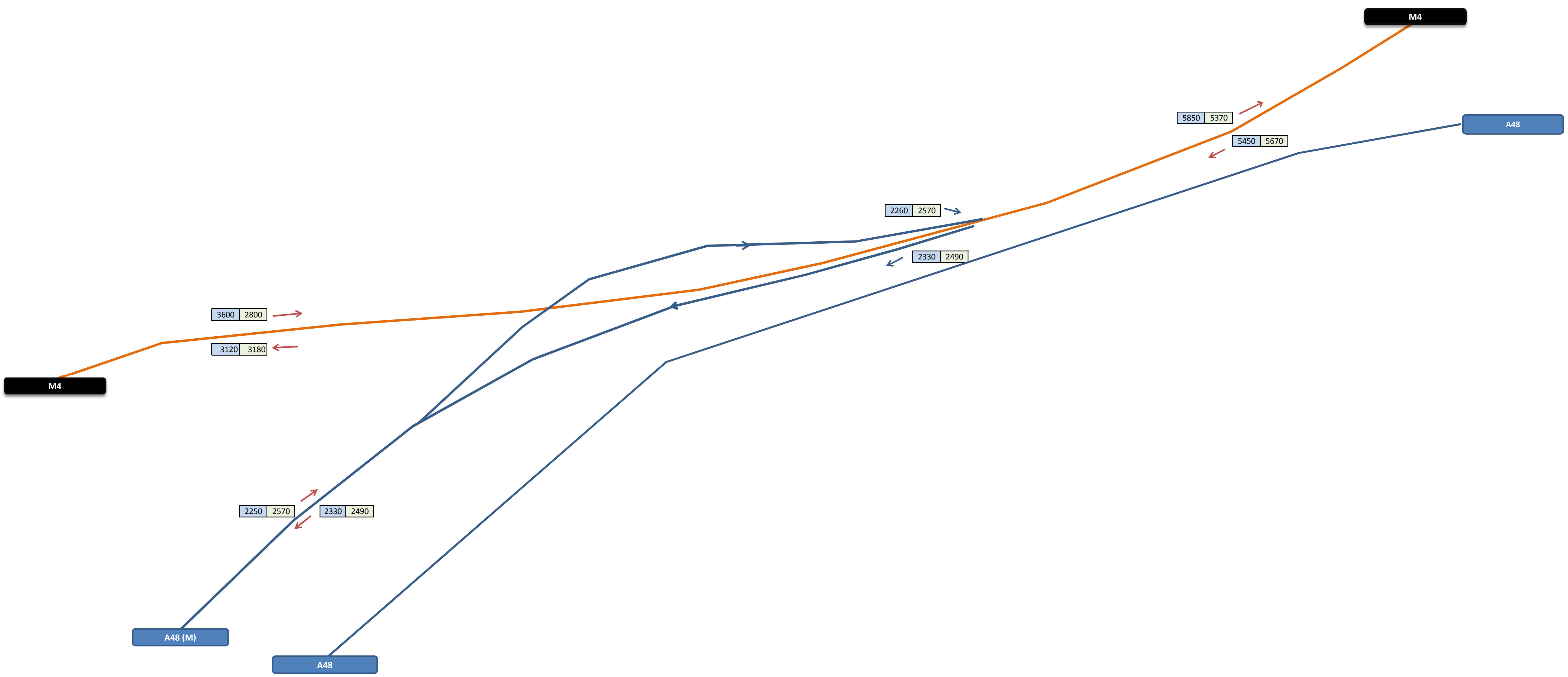
	2022 No Docks Junction		**2037 No Docks Junction**	
AM Peak	Do Minimum	Do Something	Do Minimum	Do Something
Number of Iterations	34	32	88	48
'Delta' Function	0.0018	0.0018	0.0045	0.011
Percentage of Link Flows changing by <5% - final four iterations	99.2 99.1 99.3 99.4	99.1 99.3 99.6 99.4	99.1 99.1 99.1 99.2	99.2 99.0 99.0 99.1
Inter Peak				
Number of Iterations	11	11	13	12
'Delta' Function	0.00001	0.00000	0.00007	0.00002
Percentage of Link Flows changing by <5% - final four iterations	99.4 99.5 99.6 99.7	99.1 99.3 99.5 99.7	99.3 99.2 99.5 99.4	99.4 99.8 99.8 100.0
PM Peak				
Number of Iterations	18	49	100	100
'Delta' Function	0.00043	0.011	0.0077	0.0019
Percentage of Link Flows changing by <5% - final four iterations	99. 99.3 99.3 99.5	99.0 99.4 99.4 99.5	97.6 98.6 98.9 99.4	99.2 99.3 99.6 99.6

Appendix E

Core Scenario – Junction Turning Movements on New Section of Motorway

E1 Core Scenario – Junction Turning Movements on New Section of Motorway

Junction 29 Castleton



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
T +44(0)29 20473727 F +44(0)29 20472277
www.arup.com

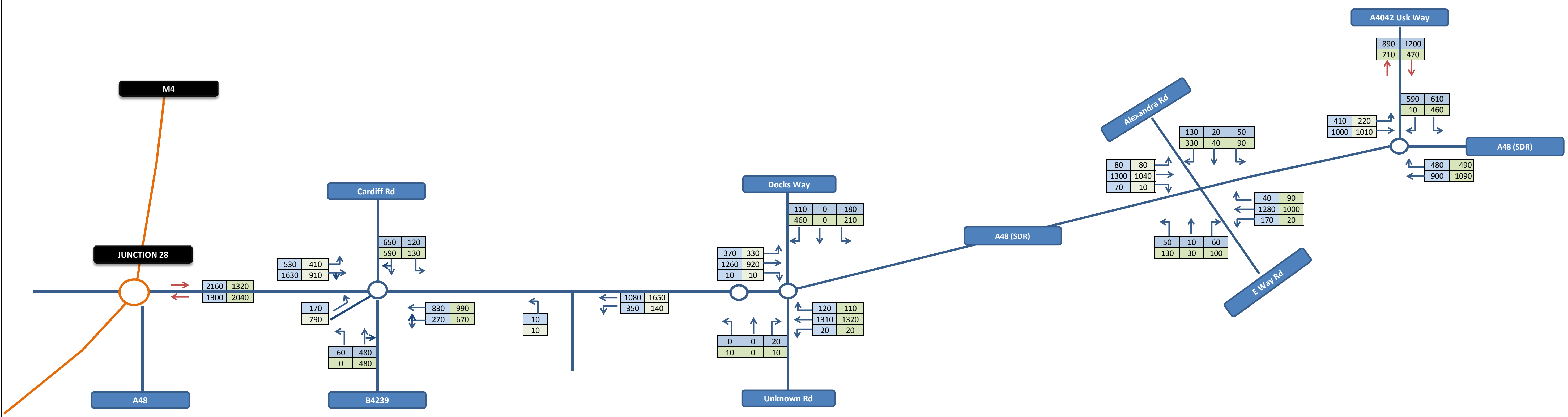
Drawing Title

Central Growth
Do Minimum 2022
Peak Hour Flows (vehs)

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
Figure E1	P0

Southern Distributor Road (West)



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
T +44(0)29 20473727 F +44(0)29 20472277
www.arup.com

Drawing Title

Central Growth
Do Minimum 2022
Peak Hour Flows (vehs)

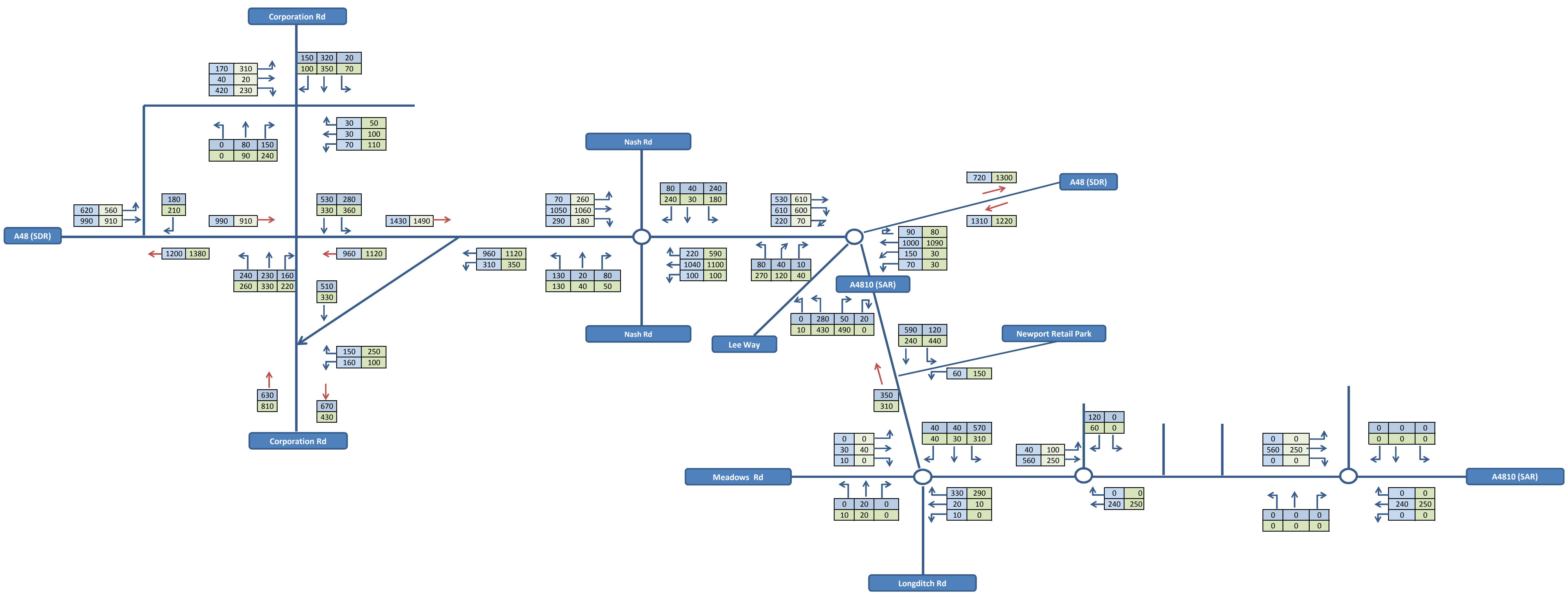
Job No: **117300-01**

Drawing Status: **Preliminary**

Drawing No: **Figure E2**

Issue: **P0**

Southern Distributor Road (East) / Steelworks Access Road



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3
Not to scale

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4 Pierhead Street, Capital Waterside
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Drawing Title

Central Growth
Do Minimum 2022
Peak Hour Flows (vehs)

Job No
117300-01

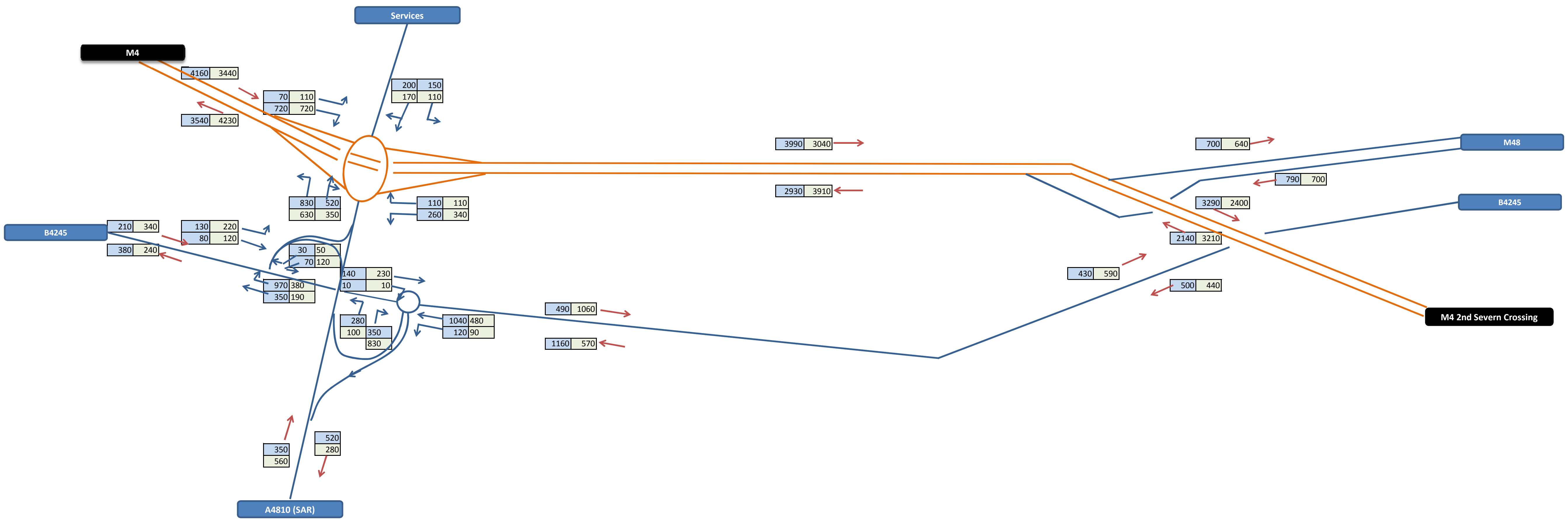
Drawing Status
Preliminary

Drawing No
Figure E3

Issue
P0

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

East of Magor



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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Drawing Title

Central Growth
Do Minimum 2022
Peak Hour Flows (vehs)

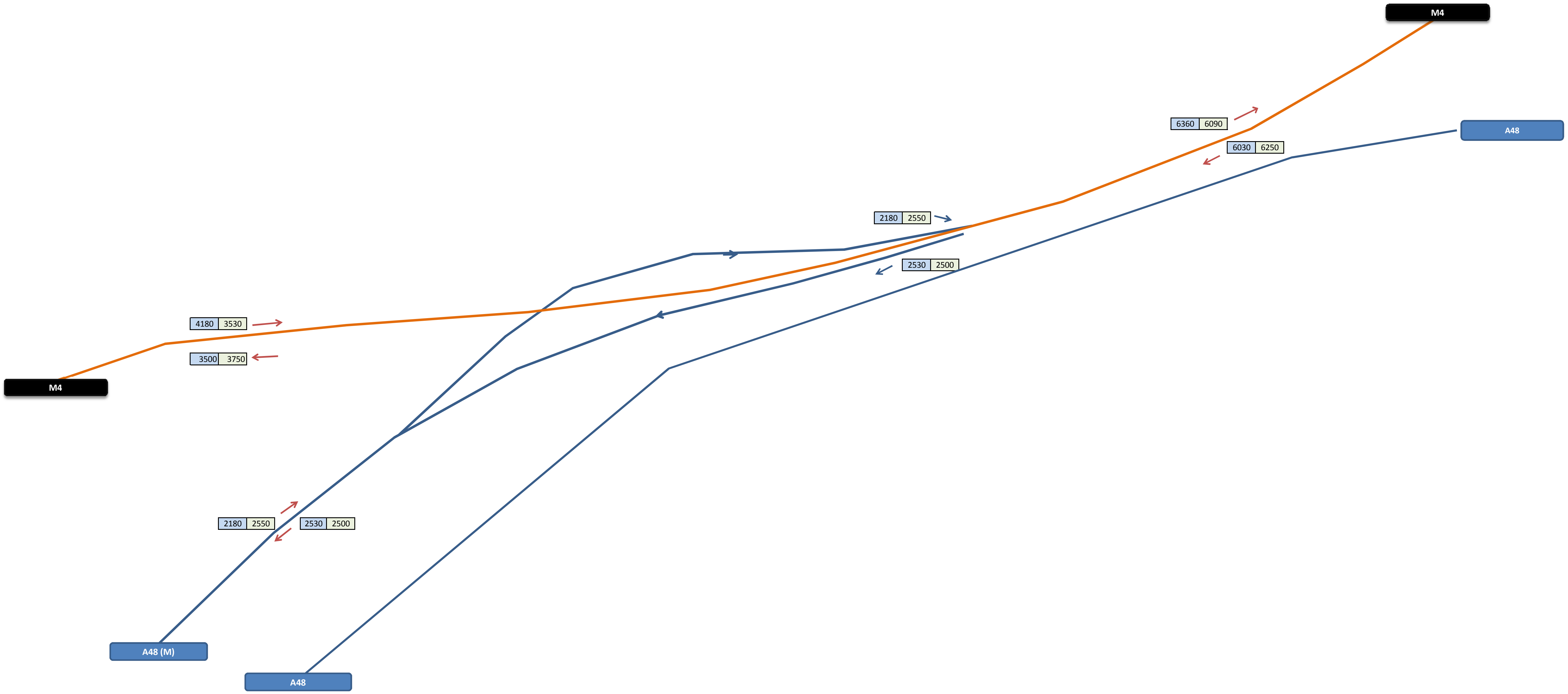
Job No: **117300-01**

Drawing Status: **Preliminary**

Drawing No: **Figure E4**

Issue: **P0**

Junction 29 Castleton



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

P0	2014-06-24	MB	SP	SP
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

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Drawing Title

Central Growth
Do Minimum 2037
Peak Hour Flows (vehs)

Job No
117300-01

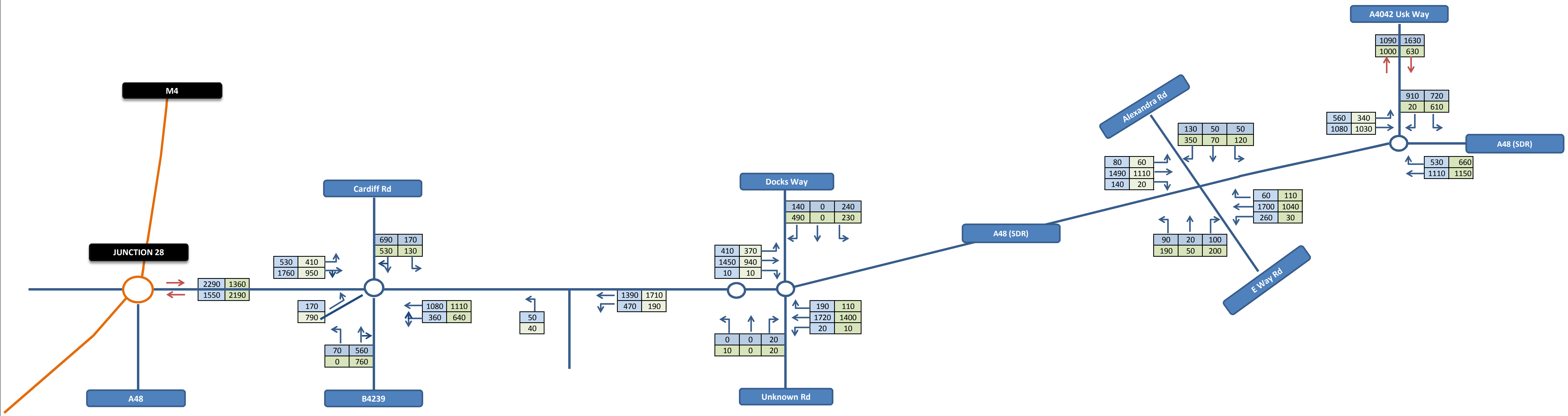
Drawing Status
Preliminary

Drawing No
Figure E5

Issue
P0

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Southern Distributor Road (West)



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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Drawing Title

Central Growth
Do Minimum 2037
Peak Hour Flows (vehs)

Job No: **117300-01**

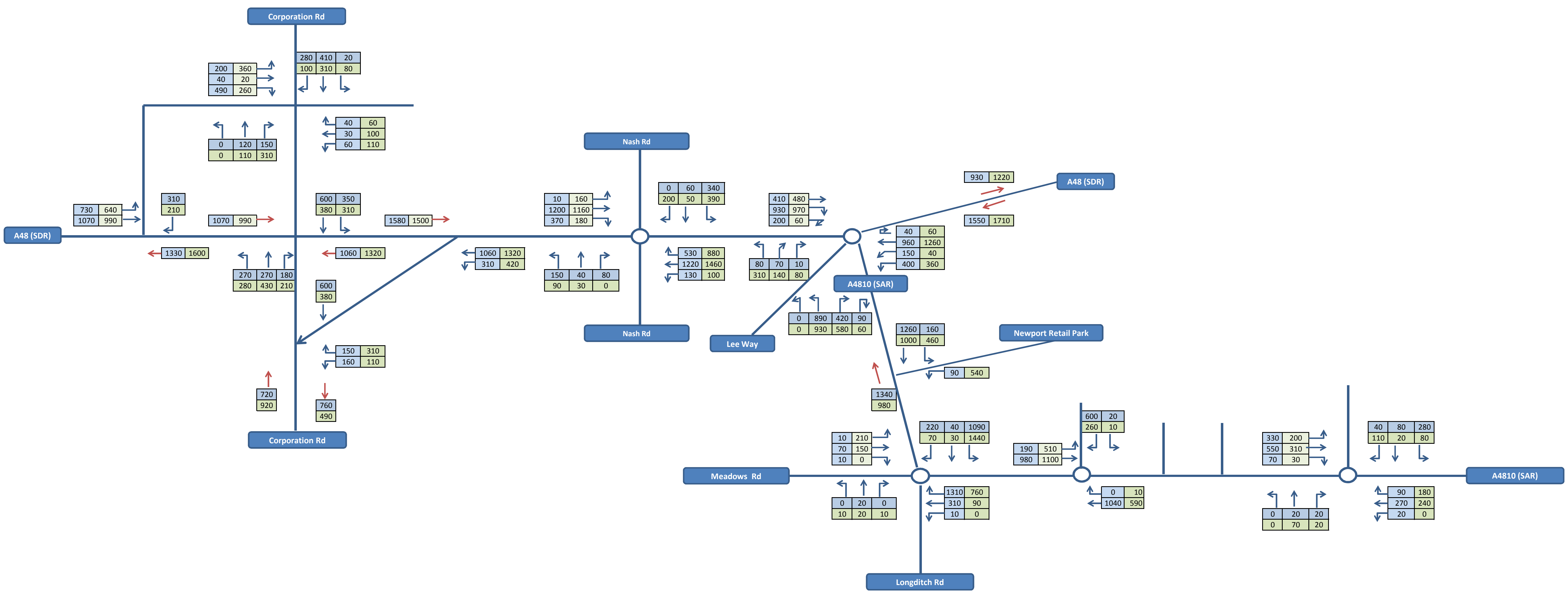
Drawing Status: **Preliminary**

Drawing No: **Figure E6**

Issue: **P0**

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Southern Distributor Road (East) / Steelworks Access Road



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Llywodraeth Cymru
Welsh Government

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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www.arup.com

Drawing Title

Central Growth
Do Minimum 2037
Peak Hour Flows (vehs)

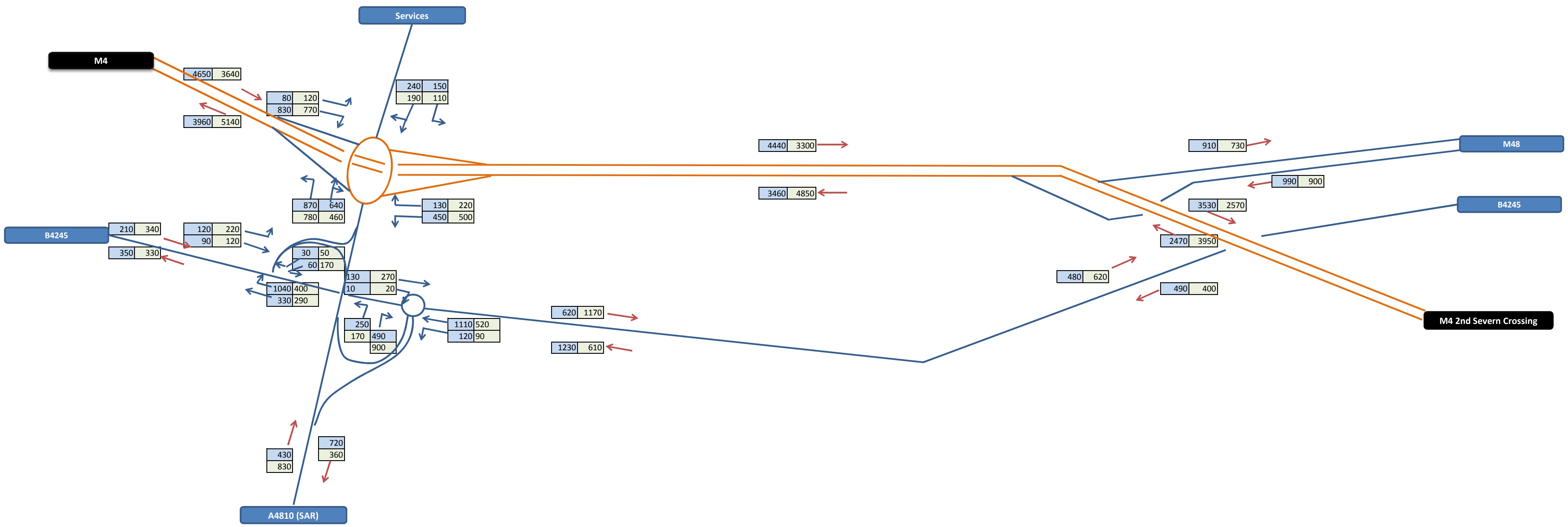
Job No
117300-01

Drawing Status
Preliminary

Drawing No
Figure E7

Issue
P0

East of Magor



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

P0	2014-06-24	MB	SP	SP
Issue	Date	By	Chkd	Appd

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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Drawing Title

Central Growth
Do Minimum 2037
Peak Hour Flows (vehs)

Job No

117300-01

Drawing Status

Preliminary

Drawing No

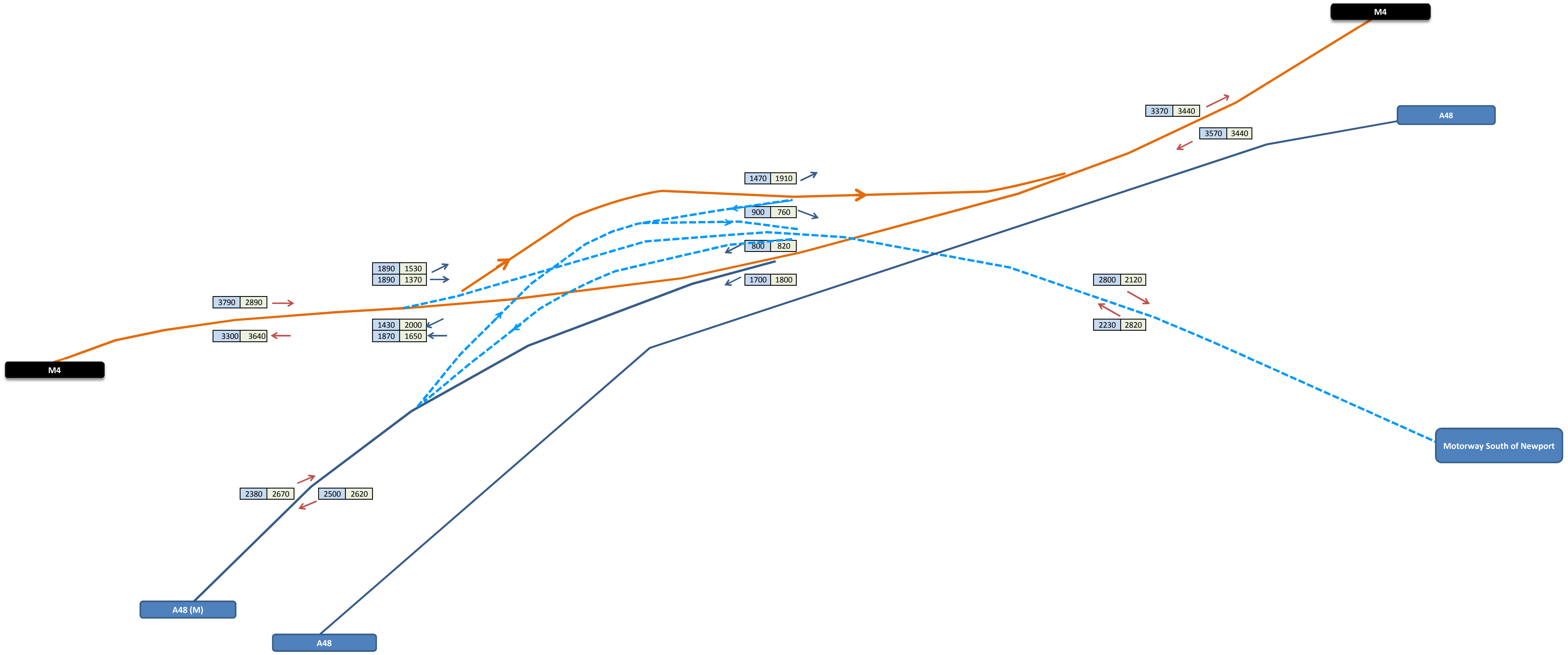
Figure E8

Issue

P0

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Castleton Interchange



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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Drawing Title

Central Growth Core Scenario
Do Something 2022
Peak Hour Flows (vehs)

Job No: **117300-01**

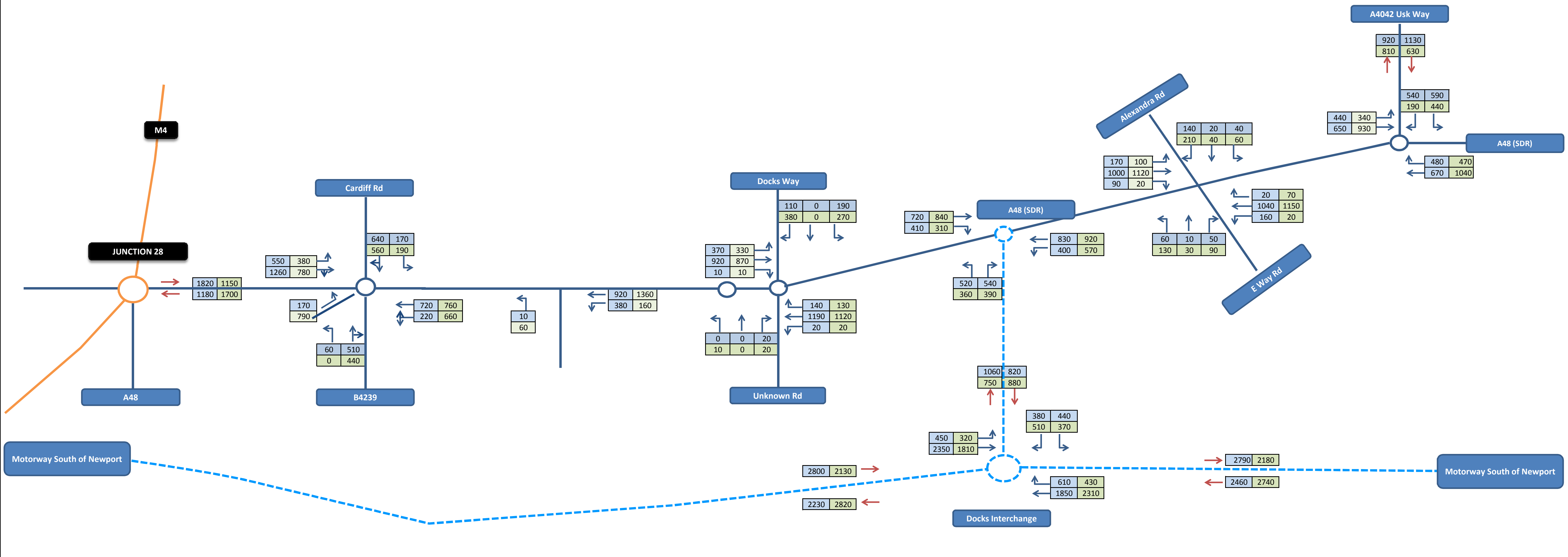
Drawing Status: **Preliminary**

Drawing No: **Figure E9**

Issue: **P0**

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Southern Distributor Road (West)



Legend

- AM Peak Hour Flows
- PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3
Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
T +44(0)29 20473727 F +44(0)29 20472277
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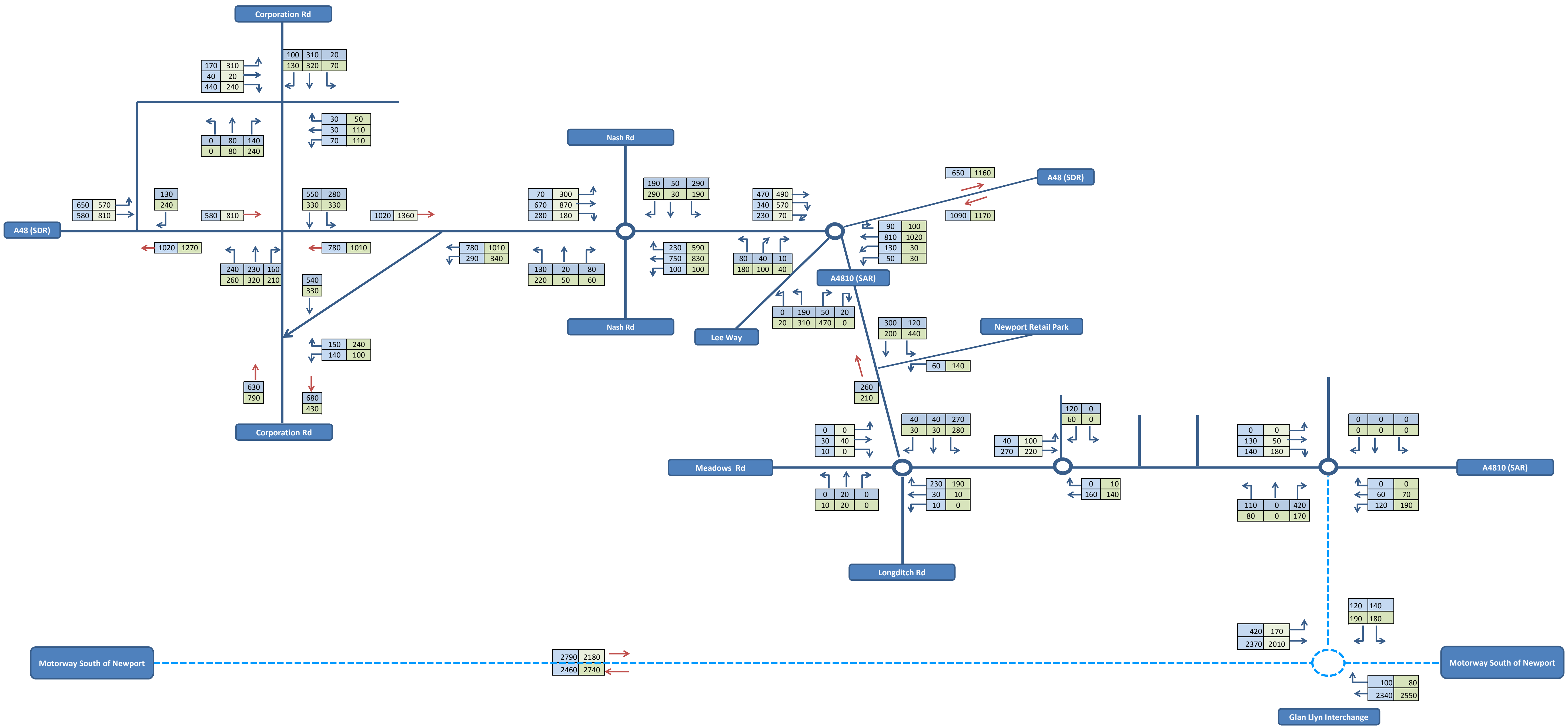
Drawing Title

Central Growth Core Scenario
Do Something 2022
Peak Hour Flows (vehs)

Job No: **117300-01**
Drawing Status: **Preliminary**
Drawing No: **Figure E10**
Issue: **P0**

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Southern Distributor Road (East) / Steelworks Access Road



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3
Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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www.arup.com

Drawing Title

Central Growth Core Scenario
Do Something 2022
Peak Hour Flows (vehs)

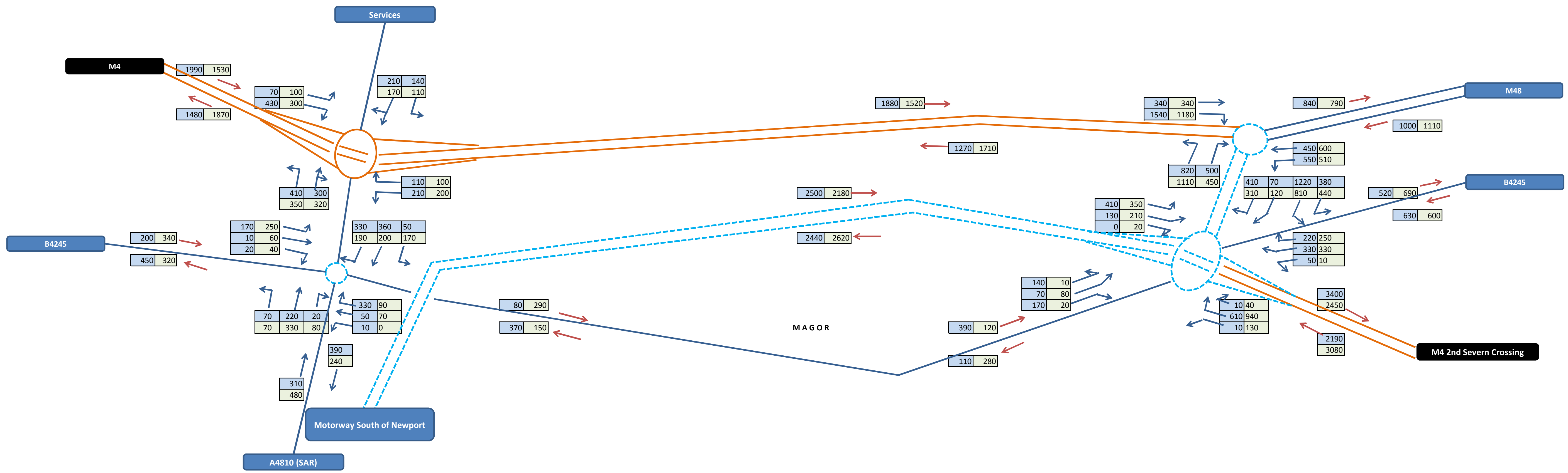
Job No
117300-01

Drawing Status
Preliminary

Drawing No
Figure E11

Issue
P0

East of Magor



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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Drawing Title

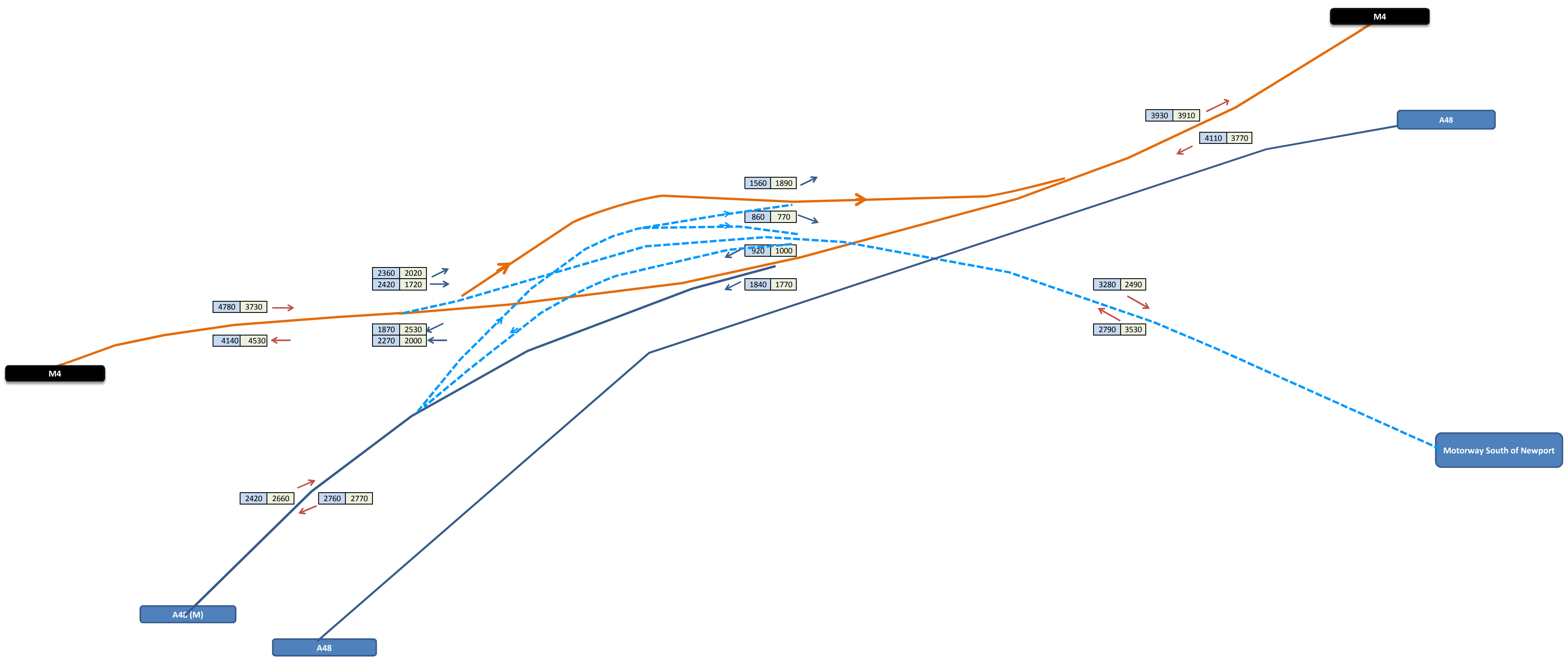
Central Growth Core Scenaio
Do Something 2022
Peak Hour Flows (vehs)

Job No	Drawing Status
117300-01	Preliminary

Drawing No	Issue
Figure E12	P0

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Castleton Interchange



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
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CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

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www.arup.com

Drawing Title

Central Growth Core Scenario
Do Something 2037
Peak Hour Flows (vehs)

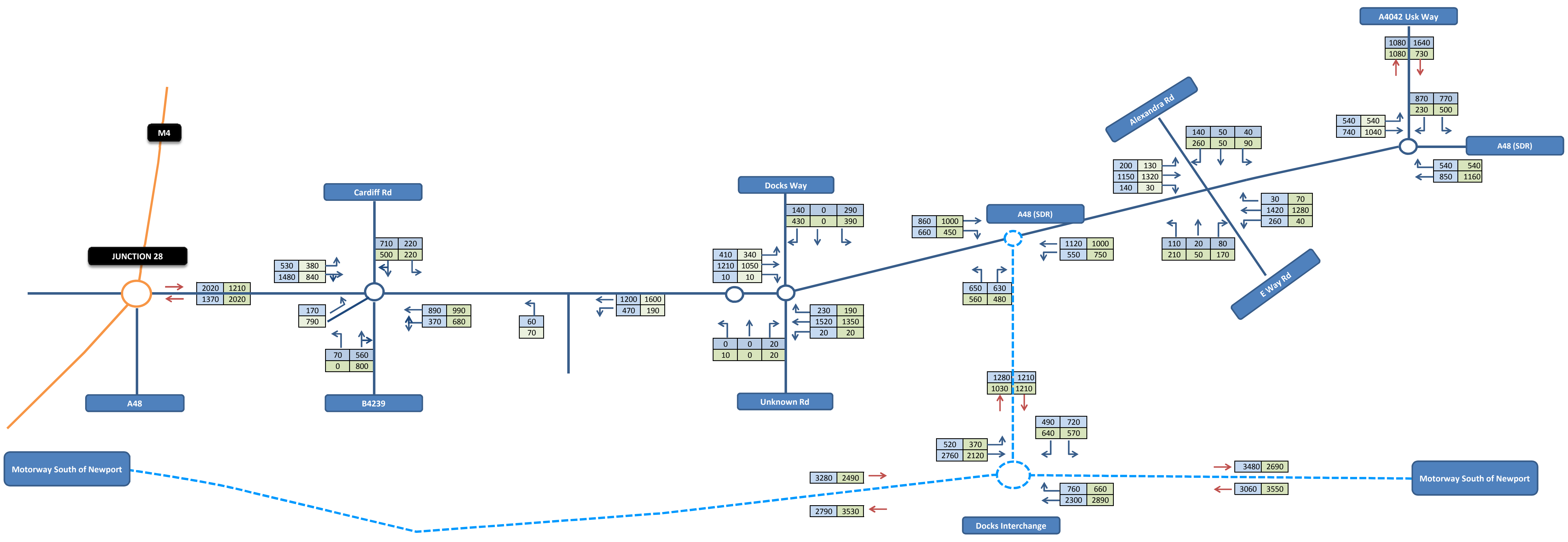
Job No: **117300-01**

Drawing Status: **Preliminary**

Drawing No: **Figure E13**

Issue: **P0**

Southern Distributor Road (West)



Legend

	AM Peak Hour Flows
	PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Llywodraeth Cymru
Welsh Government

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Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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www.arup.com

Drawing Title

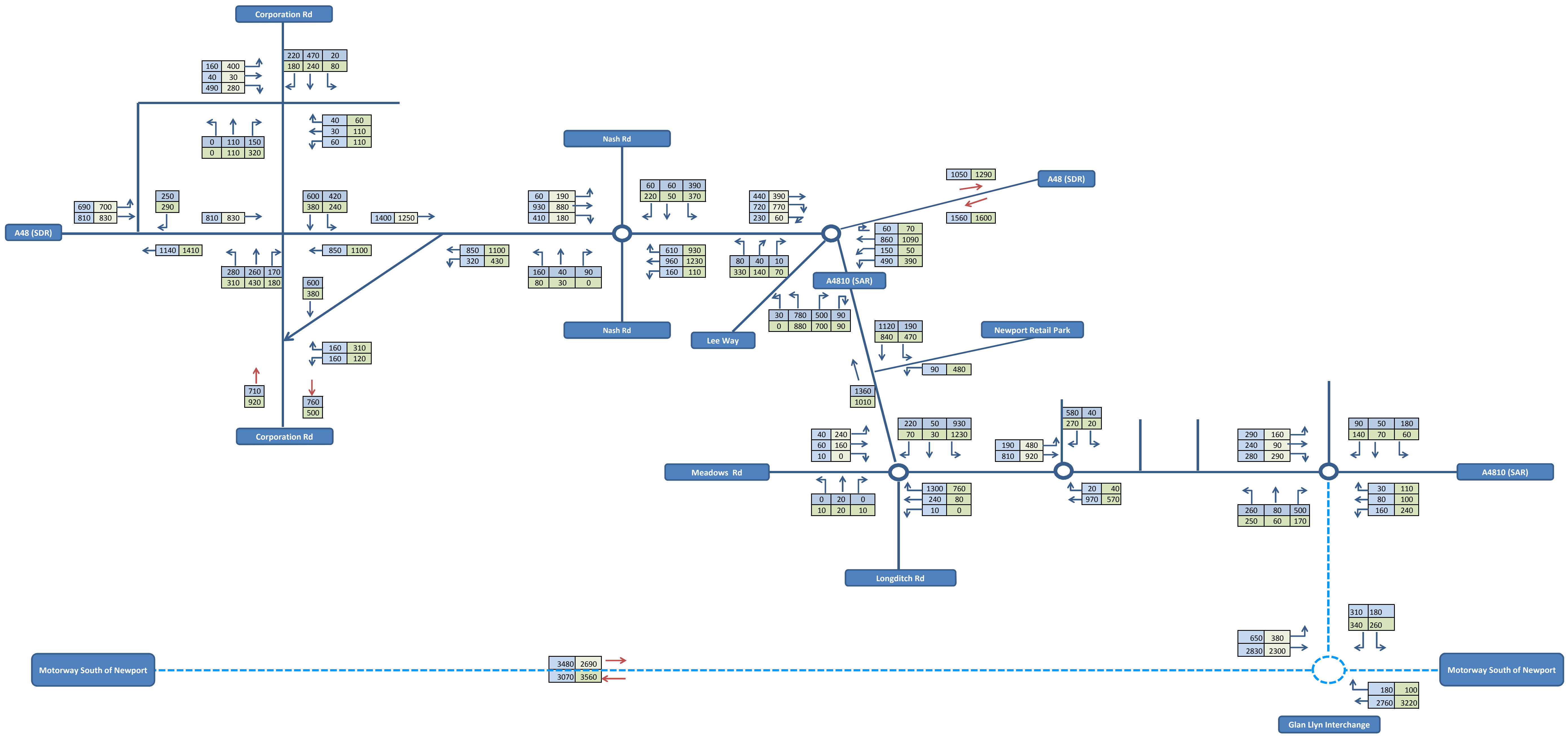
Central Growth Core Scenaio
Do Something 2037
Peak Hour Flows (vehs)

Job No	Drawing Status
117300-01	**Preliminary**

Drawing No	Issue
Figure E14	**P0**

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Southern Distributor Road (East) / Steelworks Access Road



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Transport
Department for Economy, Science and Transport
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Llywodraeth Cymru
Welsh Government

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

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Drawing Title

Central Growth Core Scenario
Do Something 2037
Peak Hour Flows (vehs)

Job No
117300-01

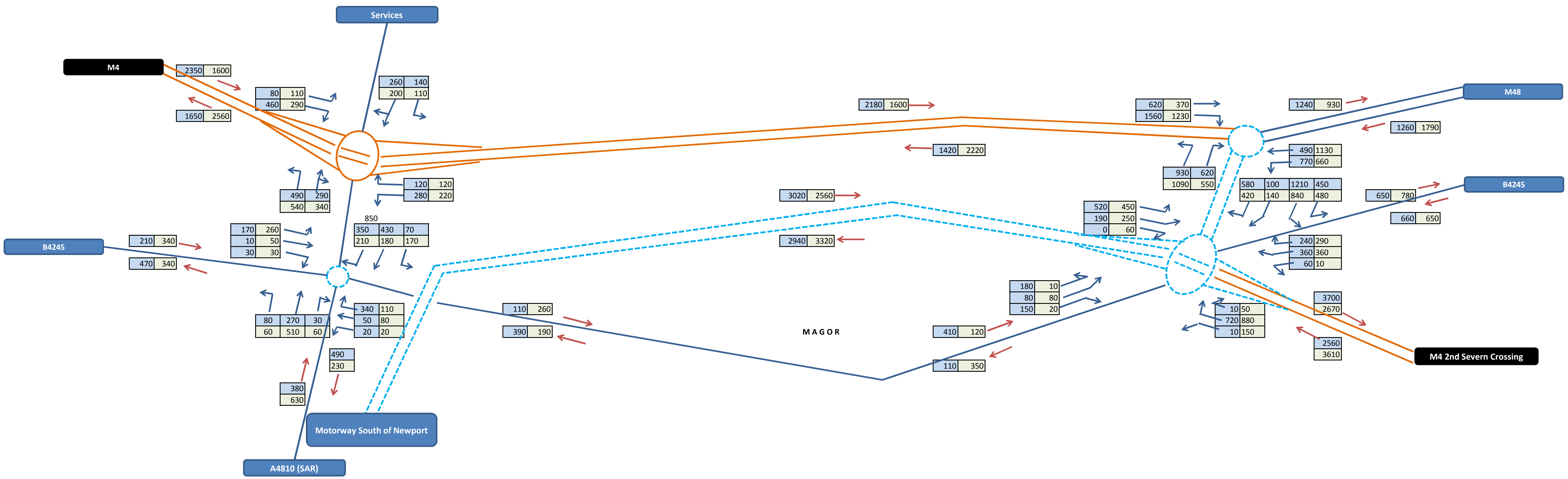
Drawing Status
Preliminary

Drawing No
Figure E15

Issue
P0

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

East of Magor



Legend

AM Peak Hour Flows

PM Peak Hour Flows

Note: Flows rounded to nearest 10 vehicles

Issue	Date	By	Chkd	Appd
P0	2014-06-24	MB	SP	SP

Client

Transport
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Welsh Government
Cathays Park
Cardiff
CF10 3NQ

Trafnidiaeth
Adran Economi, Gwyddoniaeth a Thrafnidiaeth
Llywodraeth Cymru
Parc Cathays
Caerdydd
CF10 3NQ

Llywodraeth Cymru
Welsh Government

Job Title

M4 Corridor Around Newport

Coridor yr M4 o amgylch Casnewydd

Scale at A3

Not to scale

ARUP

4 Pierhead Street, Capital Waterside
Cardiff, CF10 4QP
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www.arup.com

Drawing Title

Central Growth Core Scenario
Do Something 2037
Peak Hour Flows (vehs)

Job No: **117300-01**

Drawing Status: **Preliminary**

Drawing No: **Figure E16**

Issue: **P0**

J:\117000\117300-00\4 Int Proj Data\4-40 Tech & Survey Data, Calcs\4-42 Traffic, Economics\SATURN 2012\Analyses\2014-06-23 Turning Movement Diagrams

Appendix F

Journey Times

F1 Journey Times

Table F1: Journey Time between Junction 30 and M4 Toll Plaza (min:sec)

Central Growth

Direction	Time Period	Route	2022 Central Growth		2037 Central Growth	
			Do Minimum	Do Something	Do Minimum	Do Something
Eastbound	AM	Via M4	00:19:02	00:18:02	00:24:00	00:18:47
	IP	Via M4	00:16:52	00:17:10	00:18:08	00:17:25
	PM	Via M4	00:17:30	00:17:23	00:19:11	00:17:36
	AM	Via new motorway		00:14:36		00:15:00
	IP	Via new motorway		00:14:19		00:14:32
	PM	Via new motorway		00:14:22		00:14:33
Westbound	AM	Via M4	00:19:00	00:18:12	00:22:38	00:18:33
	IP	Via M4	00:17:09	00:17:41	00:17:57	00:17:55
	PM	Via M4	00:19:14	00:19:42	00:23:51	00:19:59
	AM	Via new motorway		00:14:30		00:14:47
	IP	Via new motorway		00:14:19		00:14:28
	PM	Via new motorway		00:14:35		00:14:59

Table F2: Journey Time between Junction 30 and M4 Toll Plaza (min:sec)

Low Growth

Direction	Time Period	Route	2022 Low Growth		2037 Low Growth	
			Do Minimum	Do Something	Do Minimum	Do Something
Eastbound	AM	Via M4	00:18:07	00:17:34	00:21:00	00:17:59
	IP	Via M4	00:16:40	00:17:07	00:17:26	00:17:17
	PM	Via M4	00:17:05	00:17:17	00:18:08	00:17:27
	AM	Via new motorway		00:14:30		00:14:46
	IP	Via new motorway		00:14:17		00:14:26
	PM	Via new motorway		00:14:19		00:14:26
Westbound	AM	Via M4	00:18:25	00:18:05	00:20:43	00:18:19
	IP	Via M4	00:16:59	00:17:38	00:17:32	00:17:48
	PM	Via M4	00:18:31	00:19:12	00:21:43	00:19:36
	AM	Via new motorway		00:14:26		00:14:38
	IP	Via new motorway		00:14:17		00:14:23
	PM	Via new motorway		00:14:30		00:14:47

Table F3: Journey Time between Junction 30 and M4 Toll Plaza (min:sec) High Growth

Direction	Time Period	Route	2022 High Growth		2037 High Growth	
			Do Minimum	Do Something	Do Minimum	Do Something
Eastbound	AM	Via M4	00:20:19	00:18:38	00:25:34	00:19:47
	IP	Via M4	00:17:04	00:17:14	00:19:34	00:17:55
	PM	Via M4	00:18:08	00:17:29	00:20:49	00:17:46
	AM	Via new motorway		00:14:42		00:15:29
	IP	Via new motorway		00:14:22		00:14:39
	PM	Via new motorway		00:14:25		00:14:41
Westbound	AM	Via M4	00:19:48	00:18:19	00:24:29	00:18:49
	IP	Via M4	00:17:20	00:17:44	00:18:35	00:18:05
	PM	Via M4	00:20:09	00:19:47	00:25:45	00:20:22
	AM	Via new motorway		00:14:34		00:14:57
	IP	Via new motorway		00:14:21		00:14:33
	PM	Via new motorway		00:14:40		00:15:07

Table F4: Journey Time between Junction 30 and M4 Toll Plaza (min:sec) Severn Tolls Removed, Central Growth

Direction	Time Period	Route	2022 Central Growth		2037 Central Growth	
			Do Minimum	Do Something	Do Minimum	Do Something
Eastbound	AM	Via M4	00:20:17	00:18:33	00:25:54	00:19:19
	IP	Via M4	00:17:06	00:17:13	00:19:30	00:18:02
	PM	Via M4	00:17:51	00:17:25	00:19:44	00:17:39
	AM	Via new motorway		00:14:43		00:15:23
	IP	Via new motorway		00:14:23		00:14:41
	PM	Via new motorway		00:14:25		00:14:38
Westbound	AM	Via M4	00:19:41	00:18:21	00:23:31	00:18:40
	IP	Via M4	00:17:27	00:17:55	00:18:36	00:18:37
	PM	Via M4	00:20:54	00:19:46	00:25:38	00:20:08
	AM	Via new motorway		00:14:35		00:14:55
	IP	Via new motorway		00:14:24		00:14:36
	PM	Via new motorway		00:14:44		00:15:07