Appendix F – Forecasting Report

REPORT N^{O} 4

LAKE LOTHING THIRD CROSSING

TRAFFIC FORECASTING REPORT

CONFIDENTIAL

DECEMBER 2015

WSP | PARSONS BRINCKERHOFF

LAKE LOTHING THIRD CROSSING

TRAFFIC FORECASTING REPORT

Suffolk County Council

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1 INTRODUCTION

1.1.1 PROJECT BACKGROUND

1.1.2 WSP | Parsons Brinckerhoff has been commissioned by Suffolk County Council (SCC) to undertake traffic modelling in support of a Transport Business Case (TBC) for a third crossing of Lake Lothing in Suffolk.

1.1.3 WSP | Parsons Brinckerhoff have rebuilt and validated the Lowestoft Traffic Model (LTM) to a base year of 2015. The development of this model is outlined in the associated Local Model Validation Report (LMVR), dated December 2015. The base year model is compliant with the latest Department for Transport (DfT) Transport Analysis Guidance (TAG).

1.1.4 The base year model formed the basis for the forecast models detailed within this report. Forecast models were built for 2020, representing the proposed opening year for the third crossing, and 2035, the design year.

1.1.5 The forecast models detailed in this report and have been built in compliance with TAG Unit M4 (November 2014)

1.2 REPORT STRUCTURE

1.2.1 This Forecasting Report sets out information relating to the development and assignment of the updated highway assignment model. It is structured as follows:

- Section 2 – Study overview
- Section 3 – Forecasting approach
- Section 4 – Forecast network development
- Section 5 – Forecast reference case demand
- Section 6 – Variable demand
- Section 7 – Forecast assignments
- Section 8 - Summary

1.3 DISCLAIMER

1.3.1 This report, and information or advice which it contains, has been prepared for the purposes set out in the instructions commissioning it (June 2015) and has been prepared with reasonable skill, care and diligence. This report has been prepared by WSP | Parsons Brinckerhoff in their professional capacity as Consultants and in performance of WSP | Parsons Brinckerhoff's duties and liabilities under its contract with Suffolk County Council. Any advice, opinions, or recommendations within this report should be read and relied upon only in the context of the report as a whole. The advice and opinions in this report are based upon the information made available to WSP | Parsons Brinckerhoff at the date of this report and on current UK standards, codes, technology and construction practices as at the date of this report. The contents of the report do not, in any way, purport to include any manner of legal advice or opinion.

1.3.2 The transport modelling that has been carried out under the terms of our appointment (June 2015) and described in this report has been carried out using SATURN (version 11.3.12F). Transport modelling software of this type provides predictions of transport flows on the basis of a number of assumptions. The assumptions made in developing the transport model have been identified within this report.

1.3.3 The liability of WSP | Parsons Brinckerhoff in respect of the information contained in the report will not extend to any third party. WSP | Parsons Brinckerhoff accept no responsibility for any costs or losses howsoever incurred as a result of the use of the output from this report unless it is proved to have failed to exercise the degree of skill and care embodied in the terms and conditions of the governing appointment (June 2015) having regard to the use of the software and the assumptions made.

2 STUDY OVERVIEW

2.1 STUDY AREA

2.1.1 This model has been developed and validated for the sole purpose of assessing a third crossing of Lake Lothing in Lowestoft. The town centre currently has two river crossings as shown in Figure 2.1.

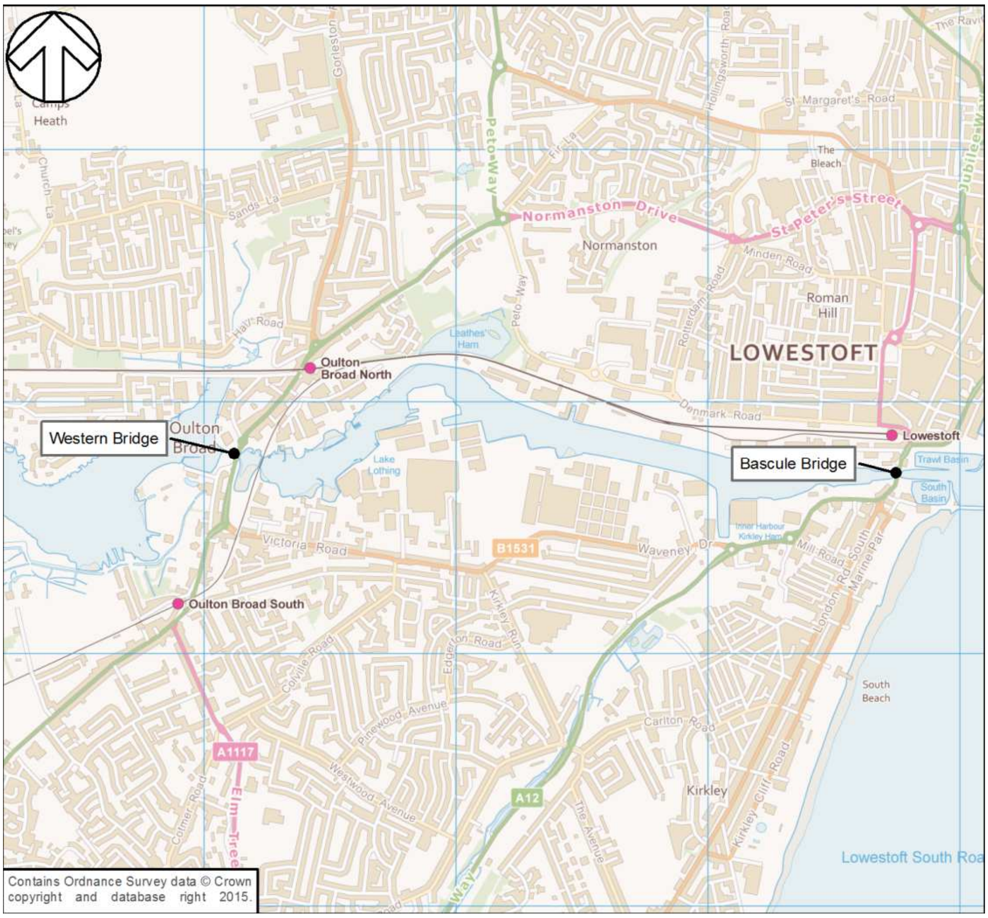


Figure 2.1 - Bridge locations

2.2 SCHEME OPTIONS

2.2.1 Four different options were put forward for the third crossing, the options included:

- Swing bridge in the centre of the existing bridges (C6)
- Swing bridge in the centre of the existing bridges (C11)
- Tunnel in the centre of the existing bridges (T3)
- Swing bridge near the existing western bridge (W4)

2.2.2 For the purpose of this report each scheme will be referred to using the numeric-alpha codes T3, W4, C6 and C11. Scheme drawings of each option can be seen in Appendix A.

3 FORECASTING APPROACH

3.1 FORECAST YEARS

3.1.1 A minimum of two forecast years are required to enable the economic benefits of the scheme to be calculated. The forecast years to be developed are as follows:

- 2020 (scheme opening year)
- 2035 (final forecast year)

3.2 GROWTH SCENARIOS

3.2.1 TAG Unit M4 (November 2014) stipulates a “Core Scenario” should be defined which is based on the most “unbiased and realistic set of assumptions” that will form the central case for appraising a scheme. Alternative scenarios are also required which have different demand assumptions from the core scenario. The differences in the alternative scenarios reflect the uncertainties in assumptions made within the core scenario.

3.2.2 Three different growth scenarios were produced:

- 1. Core scenario
- 2. High growth scenario
- 3. Low growth scenario

3.2.3 These three scenarios reflect uncertainty over development assumptions, as well as exogenous assumptions about GDP growth and demographic changes.

3.2.4 The high and low growth scenarios were only run for the Do Minimum and the preferred Do Something option, C11. C11 is the preferred option for the third crossing of Lake Lothing in Lowestoft.

3.3 METHODOLOGY

3.3.1 The methodology adopted for developing the forecast models is as follows:

1. Obtain information on local developments and schemes and summarise in uncertainty log
2. Develop Do Minimum networks, based on validated base networks, that take account of entries in uncertainty log
3. Develop Reference Case trips based on validated base matrices that include forecast developments in uncertainty log, and background growth taken from the National Trip End Model (NTEM) and the National Road Traffic Forecasts (NRTF)
4. Develop DIADEM incremental demand model, calibrated according to TAG criteria.
5. Use DIADEM model and Reference Case trips to create Do Minimum models (pivot off base)
6. Create Do Something networks, adding scheme into Do Minimum networks
7. Use DIADEM model and Do Minimum trips to create Do Something models (pivot off DM)

3.3.2 The approach to developing the forecasts is shown in Figure 3.1

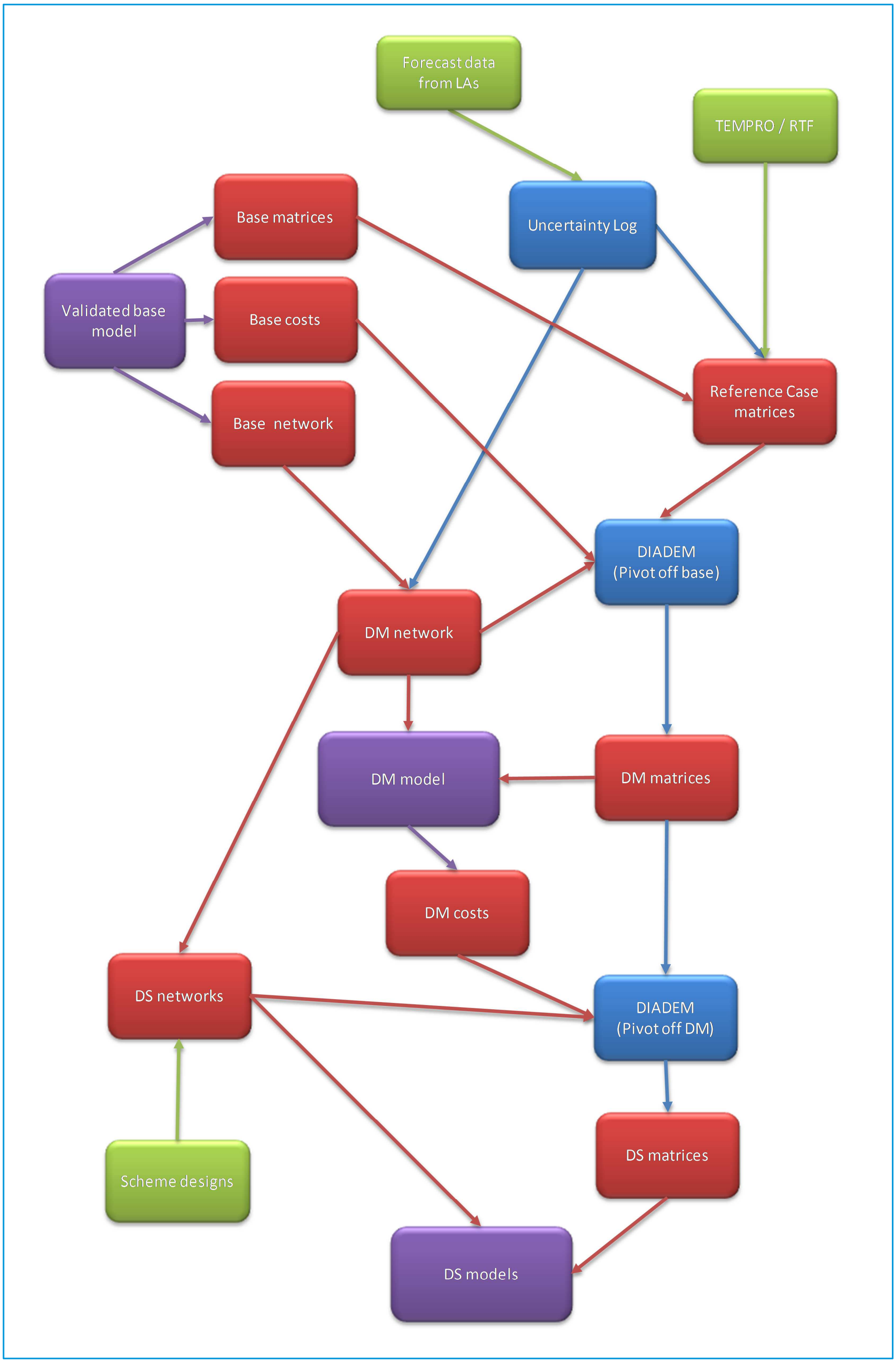


Figure 3.1 - Forecasting methodology

3.4 UNCERTAINTY LOG

3.4.1 WSP | Parson Brinckerhoff were provided with an uncertainty log by Mouchel which was agreed with Waveney District Council. The uncertainty log provide details of the following:

- Developments
  - Number of households (for developments with a residential element)
  - Size and type of land-use (for non-residential developments)
  - Proposed year of completion
  - Car trip generation
- Transport infrastructure improvements

3.4.2 Developments and infrastructure improvements were categorised by uncertainty in line with TAG Unit M4:

- Near Certain
- More Than Likely
- Reasonably Foreseeable
- Hypothetical

3.4.3 Detailed definitions of these categories are shown in Table 3.1.

Table 3.1 – Uncertainty classification definitions

PROBABILITY	DESCRIPTION	STATUS
Near certain	The outcome will happen, or there is a high probability that it will happen	→ Intent announced by proponent to regulatory agencies → Approved development proposals → Projects under construction
More than likely	The outcome is likely to happen, but there is some uncertainty	→ Submissions of planning or consent application imminent → Development application within the consent process
Reasonably foreseeable	The outcome may happen, but there is significant uncertainty	→ Identified within a development plan → Not directly associated with the transport strategy/scheme, but may occur if the transport strategy/scheme is implemented → Development conditional on the transport strategy/scheme proceeding → A committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty
Hypothetical	There is considerable uncertainty whether the outcome will ever happen	→ Conjecture based on currently available information → Discussed on a conceptual basis → One of a number of possible inputs in an initial consultation process → A policy aspiration

3.4.4 Developments contained with the uncertainty log were filtered according to the following criteria:

- Residential developments
  - 500 or more dwellings – allocated to a new zone within the model with the internal site network and development accesses included in the model network
  - Between 10 and 500 dwellings – allocated to a base year zone
  - Less than 10 dwellings – not included; assumed to be included within TEMPRO background growth
- Non-residential developments
  - Developments with less than 10 two-way trips across all three peaks were not included and assumed to be included within TEMPRO background growth

3.4.5 For the core scenario, developments and transport infrastructure deemed to be 'Near Certain' or 'More Than Likely' were included as well as developments which had a formal planning application reference.

3.4.6 For the high growth scenario, developments categorised as 'Reasonably Foreseeable' and 'Hypothetical' were also included.

3.4.7 The transport infrastructure changes remained the same across the core; high and low growth scenarios ensuring the supply side remained the same and only the demand side altered in accordance with guidance in TAG Unit M4 (November 2014).

4 FORECAST NETWORK DEVELOPMENT

4.1 INTRODUCTION

4.1.1 Within the uncertainty log various transport infrastructure improvements were detailed. Improvements for which a sufficient level of detail was provided were included in the forecast model network.

4.1.2 For larger developments amendments were made to the network to ensure suitable loading points, access and the site network was replicated.

4.2 DO MINIMUM NETWORKS

TRANSPORT INFRASTRUCTURE CHANGES

4.2.1 The following network improvements schemes were included in the Do Minimum networks:

- Denmark Road / Station Square / Bevan Way East
  - One-way on Bevan Way East reversed
- A12 Waveney Road / Suffolk Road
  - Additional lane added at the A12 southern approach
- A12 Pier Terrace / London Road South
  - Right turn from London Road South banned
- A1117 Bridge Road / Harbour Road
  - Right turn from Harbour Road banned

DEVELOPMENT NETWORK CHANGES

4.2.2 The following network changes were made for specific larger developments:

- Kirkley Waterfront
  - Three separate access points including the following
    - School Road
    - Heath Road
    - New A146 Waveney Drive priority junction access, between Kimberley Road and Waveney Crescent
- Woods Meadow, Oulton
  - Link road included between Lime Avenue and Hall Lane, linking to Dunston Drive
  - Two separate priority access junctions onto the new link road for the development
- LOW2 - Land south of South Lowestoft Industrial Estate, Gisleham
  - Access included onto Hadenham Road

4.3 DO SOMETHING NETWORKS

4.3.1 The Do Something networks took the Do Minimum network as a starting point, with the scheme for the associated crossing option added.

4.3.2 All options were coded in with the same swing bridge delay used for the eastern Bascule Bridge, detailed in Table 4.1.

4.3.3 As detailed in the base year LMVR (December 2015) the eastern Bascule Bridge was taken from observations carried out on Tuesday 14 April 2015 to Thursday 16 April 2015. Table 4.1 details the observed data for the eastern bridge.

Table 4.1 – Swing bridge timings used for scheme options

Peak Hour	Green Time (Seconds)	Red Time (Seconds)
AM peak	3,373	227
Inter peak	3,344	256
PM peak	3,186	414

4.3.4 For each Do Something option, coding specific to the scheme was included in the model network.

OPTION C6

4.3.5 The Option C6 crossing design was coded into the network with the following amendments:

- Length of crossing coded in as 736m
- Three-arm roundabout at Denmark Road at northern end of crossing
- No access to crossing from Rotterdam Road
- Four-arm roundabout replacing A146 Waveney Drive / Riverside Road / Durban Road at the southern end of the crossing
- New priority junction on A146 Waveney Drive to allow access to/from Riverside Business Park

OPTION C11

4.3.6 The Option C11 crossing design was coded into the network with the following alterations to the network:

- Length of crossing coded in as 680m
- Three-arm roundabout with Denmark Road at northern end of crossing
- Crossing accessible directly from Rotterdam Road
- Four-arm roundabout replacing A146 Waveney Drive / Riverside Road / Durban Road at the southern end of the crossing
- Left in / left out priority junction at southern end of crossing for Riverside Business Park car showroom access
- New signalised junction on A146 Waveney Drive to allow access to/from Riverside Business Park

OPTION T3

4.3.7 Option T3 crossing design was coded into the network with the following amendments:

- Length of crossing coded in as 1,050m
- Three arm roundabout at northern end of crossing with Peto Way
- Three arm signalised junction at southern end of crossing with A146 Waveney Drive
- No swing bridge delay included

OPTION W4

4.3.8 Option W4 crossing design was coded into the network with the following amendments:

- Length of crossing coded in as 984m
- Three arm roundabout at northern end of crossing with Peto Way
- Three arm signalised junction at southern end of crossing with A146 Waveney Drive

4.4 GENERALISED COST PARAMETERS

4.4.1 Generalised cost is defined in keeping with the guidance in section 2.8 of WebTAG Unit M3.1, and is as follows:

$$Generalised\ cost = Time + \left(\frac{Vehicle\ operating\ cost}{Value\ of\ time}\right) Distance$$

4.4.2 Value of time is calculated in pence per minute (PPM) and vehicle operating cost is calculated in pence per kilometre (PPK). The adopted parameters were calculated from the TAG databook published in November 2014.

4.4.3 The parameters adopted are shown in Table 4.2**Error! Reference source not found.** for 2020 and Table 4.3 for 2035. For the HGV class, local ATC data was used to determine the split of vehicles which could be classified as OGV1 and OGV2 by peak hour. This split was used to calculate average generalised cost parameters for HGVs.

Table 4.2 – Generalised cost parameters 2020

User Class	AM		IP		PM	
	PPM	PPK	PPM	PPK	PPM	PPK
Car Commuting	15.05	6.00	14.94	6.00	14.75	6.00
Car Business	51.07	12.77	49.95	12.77	49.11	12.77
Car Other	18.99	6.00	19.74	6.00	20.36	6.00
LGV	23.08	13.14	23.08	13.14	23.08	13.14
HGV	23.38	38.32	23.38	38.64	23.38	40.56

Table 4.3 – Generalised cost parameters 2035

User Class	AM		IP		PM	
	PPM	PPK	PPM	PPK	PPM	PPK
Car Commuting	19.93	5.83	19.81	5.83	19.60	5.83
Car Business	67.79	12.47	66.48	12.47	65.21	12.47
Car Other	24.52	5.83	25.45	5.83	26.40	5.83
LGV	30.93	13.68	30.93	13.68	30.93	13.68
HGV	31.33	44.23	31.33	44.60	31.33	46.82

5 FORECAST REFERENCE CASE DEMAND

5.1 METHODOLOGY

5.1.1 Developments were allocated to zones in the model, with adjacent zones of a similar land-use (and the allocated zone if located within a base year zone) used to determine the distribution of traffic for the development.

5.1.2 Trip rates for the developments were devised from the TRICS database of observed trip rates, with the majority of trip rates based on sites with East Anglia. Others were based on a UK-wide sample of sites.

5.1.3 Job and housing totals were compiled for the committed developments and taken away from the planning data totals with NTEM version 6.2 datasets accessed via TEMPRO to produced adjusted background traffic growth factors.

5.1.4 Adjusted background growth factors were applied to the base year matrix, with development trips then added on top. The overall matrix was constrained to NTEM planning data.

5.2 TRIP GENERATION

5.2.1 Trip rates from TRICs formed the basis of the trip generation for the developments. Appendix B contains the trip totals for each individual development. Table 5.1 and Table 5.2 show the overall development trips by user class.

Table 5.1 – Development trip totals 2020

USER CLASS	AM PEAK (08:00-09:00)	INTER PEAK (10:00-16:00)	PM PEAK (17:00-18:00)
UC1	2,507	509	1,590
UC2	312	200	252
UC3	1,091	1,505	1,814
Total	**3,909**	**2,214**	**3,656**

Table 5.2 – Development trip totals 2035

USER CLASS	AM PEAK (08:00-09:00)	INTER PEAK (10:00-16:00)	PM PEAK (17:00-18:00)
UC1	2,704	539	1,661
UC2	336	212	264
UC3	1,176	1,596	1,895
Total	**4,216**	**2,347**	**3,820**

5.3 BACKGROUND GROWTH

5.3.1 Background growth factors were devised from the NTEM version 6.2 datasets. Zones within the model were categorised into one of the following areas:

- Waveney District
- Rest of Suffolk (excluding Waveney District)
- Norfolk
- Essex
- Cambridgeshire
- South East England
- Rest of the UK (excluding South East England)

5.3.2 Trip purposes were output individually from TEMPRO and related to the car user classes in the matrix in the following way:

- Car commuting:
  - Home-Based Work
  - Home-Based Education
- Car employers business:
  - Home-Based Employers Business
  - Non-Home-Based Employers Business
- Car other:
  - Home-Based Shopping
  - Home-Based Recreation / Social
  - Home-Based Personal Business
  - Home-Based Visiting Friends & Relatives
  - Home-Based Holiday / Day Trip
  - Non-Home-Based Work
  - Non-Home-Based Education
  - Non-Home-Based Shopping
  - Non-Home-Based Recreation / Social
  - Non-Home-Based Personal Business
  - Non-Home-Based Holiday / Day Trip

5.3.3 The planning data within TEMPRO was obtained for 2015, 2020 and 2035 showing households and jobs in Waveney and the rest of Suffolk (excluding Waveney) detailed in Table 5.3 and Table 5.4.

Table 5.3 – NTEM housing planning data comparison

Locality	2015 HHs	2020 HHs	Difference 2020 vs 2015	2035 HHs	Difference 2035 vs 2015
Waveney	54,391	56,270	1,878	60,282	5,891
Rest of Suffolk	278,651	293,792	15,140	334,847	56,196

Table 5.4 – NTEM job total planning data comparison

Locality	2015 Jobs	2020 Jobs	Difference 2020 vs 2015	2035 Jobs	Difference 2035 vs 2015
Waveney	49,436	49,611	174	48,825	-611
Rest of Suffolk	317,885	324,186	6,301	334,524	16,639

5.3.4 The total number of households and jobs associated with the committed developments was derived for each forecast year and used to adjust the planning assumptions within TEMPRO to produce revised background growth factors, see Table 5.5. Appendix B contains housing and job totals by development.

Table 5.5 – Committed development housing and job totals up for 2015-2020 and 2015-2035

User Class	2015 to 2020	2015 to 2035
Households	3,070	3,304
Jobs	3,157	3,157

5.3.5 Given the committed development growth in households and jobs was substantially higher than the projected growth in TEMPRO for Waveney District; the planning data within Waveney was adjusted to the base year level, with the difference then taken from the 'Rest of Suffolk' planning data totals. For 2035, there is a projected decrease in jobs in TEMPRO between 2015 and 2035, in this instance the Waveney jobs total was kept at the base year level, the 3,157 jobs were taken away from the Rest of Suffolk jobs total.

5.3.6 The adjusted planning data totals are shown in Table 5.6 and Table 5.7.

Table 5.6 – Adjusted NTEM housing planning data

Locality	2015 HHs	2020 HHs Adj	Difference 2020 vs 2015	2035 HHs Adj	Difference 2035 vs 2015
Waveney	54,391	54,391	0	56,978	2,587
Rest of Suffolk	278,651	292,601	13,950	334,847	56,196

Table 5.7 – Adjusted NTEM jobs planning data

Locality	2015 Jobs	2020 Jobs Adj	Difference 2020 vs 2015	2035 Jobs Adj	Difference 2035 vs 2015
Waveney	49.436	49.436	0	49.436	0
Rest of Suffolk	317.885	321.204	3.319	331.367	13.482

5.3.7 Following the adjustments to the planning data the revised TEMPRO factors were calculated and are shown in Table 5.8 to Table 5.13.

Table 5.8 – Adjusted TEMPRO factors 2015 to 2020 – AM peak

Locality	UC1 Origin Factor	UC1 Destination Factor	UC2 Origin Factor	UC2 Destination Factor	UC3 Origin Factor	UC3 Destination Factor
Waveney	0.981	1.007	0.987	1.003	1.031	1.038
Rest of Suffolk	1.022	1.019	1.017	1.015	1.057	1.055
Norfolk	1.039	1.039	1.037	1.037	1.074	1.075
Cambridgeshire	1.050	1.049	1.047	1.046	1.082	1.081
Essex	1.028	1.037	1.029	1.037	1.062	1.064
SE England	1.027	1.029	1.028	1.032	1.048	1.048
Rest of UK	1.029	1.028	1.031	1.030	1.050	1.050

Table 5.9 – Adjusted TEMPRO factors 2015 to 2035 – AM peak

Locality	UC1 Origin Factor	UC1 Destination Factor	UC2 Origin Factor	UC2 Destination Factor	UC3 Origin Factor	UC3 Destination Factor
Waveney	0.975	1.033	0.986	1.018	1.177	1.192
Rest of Suffolk	1.089	1.078	1.070	1.063	1.256	1.250
Norfolk	1.131	1.135	1.123	1.125	1.299	1.307
Cambridgeshire	1.163	1.159	1.148	1.144	1.327	1.325
Essex	1.094	1.129	1.097	1.123	1.253	1.262
SE England	1.075	1.082	1.079	1.089	1.186	1.184
Rest of UK	1.104	1.101	1.112	1.109	1.193	1.193

Table 5.10 – Adjusted TEMPRO factors 2015 to 2020 – Inter peak

Locality	UC1 Origin Factor	UC1 Destination Factor	UC2 Origin Factor	UC2 Destination Factor	UC3 Origin Factor	UC3 Destination Factor
Waveney	0.999	0.992	1.002	1.002	1.036	1.037
Rest of Suffolk	1.022	1.023	1.019	1.018	1.059	1.059
Norfolk	1.041	1.040	1.040	1.040	1.077	1.078
Cambridgeshire	1.049	1.050	1.049	1.049	1.085	1.085
Essex	1.036	1.033	1.036	1.036	1.066	1.066
SE England	1.026	1.026	1.031	1.032	1.050	1.050
Rest of UK	1.026	1.027	1.031	1.031	1.051	1.051

Table 5.11 – Adjusted TEMPRO factors 2015 to 2035 – Inter peak

Locality	UC1 Origin Factor	UC1 Destination Factor	UC2 Origin Factor	UC2 Destination Factor	UC3 Origin Factor	UC3 Destination Factor
Waveney	1.026	1.008	1.026	1.023	1.197	1.198
Rest of Suffolk	1.095	1.097	1.080	1.078	1.272	1.271
Norfolk	1.145	1.143	1.138	1.140	1.318	1.319
Cambridgeshire	1.168	1.171	1.159	1.158	1.347	1.347
Essex	1.129	1.118	1.125	1.123	1.275	1.275
SE England	1.076	1.074	1.090	1.093	1.199	1.198
Rest of UK	1.091	1.092	1.113	1.113	1.201	1.201

Table 5.12 – Adjusted TEMPRO factors 2015 to 2020 – PM peak

Locality	UC1 Origin Factor	UC1 Destination Factor	UC2 Origin Factor	UC2 Destination Factor	UC3 Origin Factor	UC3 Destination Factor
Waveney	1.004	0.981	1.004	0.989	1.025	1.022
Rest of Suffolk	1.018	1.021	1.017	1.019	1.048	1.048
Norfolk	1.038	1.038	1.038	1.039	1.066	1.066
Cambridgeshire	1.048	1.049	1.048	1.049	1.073	1.074
Essex	1.035	1.027	1.037	1.030	1.054	1.054
SE England	1.029	1.026	1.032	1.030	1.042	1.043
Rest of UK	1.027	1.028	1.031	1.031	1.044	1.044

Table 5.13 – Adjusted TEMPRO factors 2015 to 2035 – PM peak

Locality	UC1 Origin Factor	UC1 Destination Factor	UC2 Origin Factor	UC2 Destination Factor	UC3 Origin Factor	UC3 Destination Factor
Waveney	1.026	0.976	1.024	0.992	1.144	1.138
Rest of Suffolk	1.076	1.087	1.073	1.079	1.215	1.216
Norfolk	1.131	1.128	1.131	1.132	1.266	1.262
Cambridgeshire	1.156	1.159	1.154	1.155	1.285	1.287
Essex	1.122	1.091	1.126	1.101	1.217	1.219
SE England	1.080	1.074	1.090	1.084	1.157	1.160
Rest of UK	1.099	1.101	1.111	1.113	1.168	1.168

5.3.8 LGV and HGV growth factors were taken from the Road Transport Forecast 2015 – Scenario 1 produced by the DfT from the National Transport Model as detailed in Table 5.14:

Table 5.14 – LGV and HGV growth factors

Locality	LGV Growth (2015-2020)	LGV Growth (2015-2035)	HGV (Rigid + Arctic) Growth (2015-2020)	HGV (Rigid + Arctic) Growth (2015-2035)
East of England	15.17%	57.32%	4.74%	23.58%
UK	15.12%	57.39%	3.58%	18.23%

5.4 REFERENCE CASE MATRICES

5.4.1 The final matrix totals for the core scenario are shown below in Table 5.15 to Table 5.20.

Table 5.15 – 2020 unconstrained matrix development – AM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Final Matrix
UC1	5,447	5,460	2,507	7,967
UC2	622	623	312	935
UC3	3,474	3,619	1,091	4,710
UC4	2,855	3,288	0	3,288
UC5	868	909	0	909
Total	**13,267**	**13,900**	**3,909**	**17,809**

Table 5.16 – 2035 unconstrained matrix development – AM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Final Matrix
UC1	5,447	5,601	2,704	8,304
UC2	622	636	336	972
UC3	3,474	4,187	1,176	5,363
UC4	2,855	4492	0	4492
UC5	868	1,071	0	1,071
Total	**13,267**	**15,986**	**4,216**	**20,202**

Table 5.17 – 2020 unconstrained matrix development – Inter peak

User Class	Base Year Matrix	Background Growth	Development Trips	Final Matrix
UC1	1,696	1,703	509	2,212
UC2	658	665	200	864
UC3	5,954	6,210	1,505	7,715
UC4	2,919	3362	0	3362
UC5	825	864	0	864
Total	**12,052**	**12,803**	**2,214**	**15,017**

Table 5.18 – 2035 unconstrained matrix development – Inter peak

User Class	Base Year Matrix	Background Growth	Development Trips	Final Matrix
UC1	1,696	1,764	539	2,304
UC2	658	689	212	901
UC3	5,954	7,239	1,596	8,835
UC4	2,919	4,592	0	4,592
UC5	825	1,018	0	1,018
Total	**12,052**	**15,303**	**2,347**	**17,650**

Table 5.19 – 2020 unconstrained matrix development – PM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Final Matrix
UC1	3,964	3,978	1,590	5,567
UC2	904	907	252	1159
UC3	6,141	6,331	1,814	8,145
UC4	3,215	3,703	0	3,703
UC5	456	477	0	477
Total	**14,680**	**15,395**	**3,656**	**19,052**

Table 5.20 – 2035 unconstrained matrix development – PM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Final Matrix
UC1	3,964	4,086	1,661	5,747
UC2	904	929	264	1193
UC3	6,141	7,135	1,895	9,031
UC4	3,215	5,058	0	5,058
UC5	456	563	0	563
Total	**14,680**	**17,772**	**3,820**	**21,592**

5.4.2 The information presented above demonstrates a clear difference in the level of forecast development within the study area as set out in NTEM and the expectations of the district and county. In order to adjust background growth factors to constrain growth to NTEM, adjustment has taken place at the higher county-wide level. Since the whole of Suffolk is not modelled, it is only to be expected that this will have a minimal impact on trips within the study area. The Reference Case matrices have therefore been constrained to NTEM in accordance with TAG Unit M4 (November 2014), and no further adjustment of the Reference Case matrices is considered necessary.

5.5 ALTERNATIVE GROWTH MATRICES

5.5.1 As detailed in section 4.2 of TAG Unit M4 (November 2014), high and low growth forecasts should be based on a proportion of base year demand. This proportion should be added to the core scenario demand for the high growth scenario, and subtracted for the low growth scenario.

5.5.2 The proportion of the base year demand to add or subtract from the core scenario matrix is calculated as the square root of the number of years between the base year and forecast year, multiplied by 2.5, shown in Table 5.21.

Table 5.21 – Proportion of base year used for alternative growth scenarios.

Growth Scenario	2020	2035
High Growth	+5.5%	+11.2%
Low Growth	-5.5%	-11.2%

5.5.3 Local adjustment should be accommodated through variations to the developments input, but overall growth should be controlled to these totals. Modelled developments were unchanged from the core scenario when creating the low growth scenario, and for the high growth scenario the reasonably foreseeable and hypothetical developments from the uncertainty log were also modelled.

5.5.4 Appendix C contains the matrix totals for the high and low growth scenarios.

6 VARIABLE DEMAND

6.1 INTRODUCTION

6.1.1 The Department for Transport guidance on variable demand modelling presented in the web-based Transport Analysis Guidance (TAG) Unit M2 (January 2014) states that a Variable Demand Model (VDM) is not required if the scheme capital cost is below £5m, or both the following criteria are true:

- There is no crowding or congestion on the network in the forecast year, in the absence of the scheme
- The scheme will have no appreciable effect on travel choices in the corridor containing the scheme

6.1.2 The capital cost of any bridge option will be well in excess of £5m, and there is significant congestion in the base year network which is only exacerbated in the forecast Do Minimum scenario. A variable demand model is therefore considered necessary to assess the impacts of changing costs on travel demand.

6.1.3 The DIADEM software (Dynamic Integrated Assignment and DEmand Modelling) has been selected for undertaking variable demand modelling, as it has been developed by the Department for Transport for undertaking this type of analysis, and it provides a direct interface with the SATURN model.

6.2 MODEL STRUCTURE

6.2.1 As recommended by TAG, the form of the demand model is an incremental hierarchical logit model, adjusting reference demand to changes between forecast travel costs and input reference costs. TAG Unit M2 (January 2014) sets out guidance on the choice of behavioural responses to include in the model, and this is discussed below.

TRIP FREQUENCY

6.2.2 The trip frequency response is the least elastic response, so should be placed at the top of the hierarchy. Since no mode choice model has been included (as discussed below), it is important to allow variability in trip frequency as a substitute for these effects.

MODE CHOICE

6.2.3 Analysis of 2011 Census Journey to Work data (see Table 6.1) has shown that, at 4%, public transport usage in Lowestoft, located in Waveney District, is low in comparison to Suffolk, the East region and England as a whole.

Table 6.1 - Journey to work % mode share

AREA	CAR	PUBLIC TRANSPORT	SLOW MODES
Ipswich	67%	11%	22%
Waveney	77%	4%	19%
Suffolk Coastal	80%	5%	14%
Suffolk	78%	6%	16%
EAST	73%	13%	14%
ENGLAND	67%	19%	14%

6.2.4 The impacts of a third crossing are likely to primarily affect car trips, so given the above, it is likely that demand responses will be limited. Transfer to slow modes is typically not captured by a mode choice model, as decisions to walk or cycle tend not to be based on the generalised cost of travel but by less tangible factors such as physical fitness, journey ambience, weather, etc.

6.2.5 TAG sets out guidance on testing the significance of modal shift based on the anticipated relative cost changes between modes. The schemes likely to be assessed with this model will all have the same impact on cars as they do on buses, so the net impact on the relative costs between modes is nil. TAG sets out a series of logical tests to determine the scope of the model. These are set out in Table 6.2.

Table 6.2 - Logical tests for provisional model scope

TEST	DESCRIPTION	RESULT	COMMENT
Test 1	Do the set of schemes to be appraised relate to only one of the modes; public transport and highway?	YES	Highway only
Test 2	If the scheme is highway only, does the application of the mode shift test suggest that there will be a significant impact on public transport demand?	NO	Time savings will be the same for car and bus users
Test 3	If the scheme is public transport only, does the application of the mode shift test suggest that there will be a significant impact on highway demand?	NO	Not relevant
Test 4	If the scheme is highway only, and a mode choice model is not required, then a public transport assignment model is not required	YES	Public transport model not required
Test 5	If the scheme is public transport only, and a mode choice model is not required, then a highway assignment model is not required.	NO	Not relevant
Test 6	If the scheme is public transport only, then, even if a mode choice model is required, it may be proportional to manage without a highway assignment model and use the techniques described in TAG Unit A5.	NO	Not relevant

6.2.6 For the reasons outlined above, mode shift has not been included as a response in the demand model, and no public transport assignment model has been created.

TRIP DISTRIBUTION

6.2.7 The trip distribution response is the minimum requirement set out in TAG for a variable demand model. As such, this response has been included in the DIADEM model.

6.2.8 Matrices have been input into the trip distribution model in Origin-Destination (OD) format. Although TAG recommends home-based trips be modelled in Production-Attraction (PA) format to ensure consistency of travel behaviour between the outbound and return legs, there is insufficient data available to allow demand to be specified in PA format.

6.2.9 In keeping with recommendations in TAG, the Commuting purpose matrices have been doubly-constrained, while Business and Other purpose matrices have been singly-constrained.

TIME OF DAY

6.2.10 Time of day choices are categorised into the following:

- **Macro -** choice between broad modelled time periods
- **Micro** – choice between individual time slices within modelled time periods (peak spreading)

6.2.11 It is unlikely that any schemes tested using this model will lead to a significant change in the cost differential between different time periods, so macro time of day choice has not been modelled.

6.2.12 Micro time of day choice is less well understood, and although DIADEM incorporates some level of functionality through HADES, it only exists in beta form, so is considered less robust than other responses. Furthermore, it is only supported for absolute models, whereas the DfT's preferred approach is for demand models to be incremental in nature. For these reasons, micro time of day has not been included as a response in the variable demand model.

6.3 MODEL PARAMETERS

6.3.1 LGV and HGV are assumed to make trips that are not significantly influenced by changes in the cost of travel, so user class 4 and user class 5 are fixed. Parameters relating to the three car user classes are described below.

GENERALISED COST

6.3.2 In keeping with recommendations from TAG, generalised cost parameters were initially drawn directly from the SATURN highway assignment model. However, during realism testing it was found that the Business and Other purposes were exhibiting overly sensitive behaviour in response to changes in costs, so a cost damping method was required. In this case, DIADEM does not allow generalised costs to be taken from the assignment model, so appropriate values for Value of Time and Vehicle Operating Cost for an average weekday were derived from the TAG databook (November 2014), consistent with the values derived for the assignment model, discussed in section 4.4.

6.3.3 For the Business and Other purposes, cost damping was applied via the Power Function of Utility method as set out in WebTAG Unit M2 section 3.3 (January 2014). The functional form applied to the generalised cost (G) is as follows:

$$G'' = \mu G^{\beta}$$

6.3.4 The two sensitivity parameters, μ and β, should be calibrated to best match the requirements of the realism tests, with β lying between 0 and 1. The adopted generalised cost parameters are shown in Table 6.3. The Value of Time (VOT) and Vehicle Operating Costs (VOC) are given in pence per minute (PPM) and pence per kilometre (PPK) respectively.

Table 6.3 - Generalised cost parameters in DIADEM model

Parameter		Commuting	Business	Other
2015	VOT	As assignment model	45.75	18.97
	VOC		13.38	6.70
2020	VOT		50.20	20.62
	VOC		12.77	6.00
2035	VOT		66.74	26.67
	VOC		12.27	5.60
μ		1	0.5	0.6
β		1	0.5	0.5

SENSITIVITY PARAMETERS

6.3.5 When defining composite costs for a hierarchical logit model, it is necessary to specify a spread parameter (λ) for the choice at the bottom of the hierarchy, with a scaling parameter (θ) applied to choices higher in the hierarchy. As such, λ should always be negative and θ should always be positive.

6.3.6 In this model, trip distribution is at the bottom of the hierarchy, with trip frequency at the top. TAG does not provide any empirical values for the most suitable value of θ to be applied for trip frequency. Since this response is expected to be relatively inelastic, a value of 0.02 has been assumed for all purposes.

6.3.7 TAG provides more guidance on the choice of λ for the trip distribution response, setting out the mean value calculated from a range of studies, and specifying in 5.6.14 that although these are not proscriptive, any deviations outside ±25% of these values require further investigation. The adopted values are shown in Table 6.4.

Table 6.4 - Trip distribution lambda values

Purpose	Adopted Value	Median HB	Median NHB	-25%	+25%
Commuting	-0.065	-0.065		-0.049	-0.081
Business	-0.062	-0.067	-0.081	-0.050	-0.101
Other	-0.085	-0.090	-0.077	-0.058	-0.113

6.3.8 All adopted values are close to the TAG median value, and well within the ±25% range.

6.4 CONVERGENCE

6.4.1 It is important to demonstrate that the demand model converges to a satisfactory degree so that noise in the model is minimised. The measure of convergence recommended in TAG and implemented in DIADEM is the relative gap, defined as follows:

$$\frac{\sum_a C(X_a^n)\left|D\left(C(X_a^n)\right) - X_a^n\right|}{\sum_a C(X_a^n)\, X_a^n} * 100$$

6.4.2 X_a^n is cell a in the previous assignment for iteration n; $C(X_a^n)$ is cell a in the generalised costs resulting from assigning that matrix; and $D(C(X_a^n))$ is cell a in the matrix output by the demand model based on costs $C(X_a^n)$.

6.4.3 A gap of 0.1%, as specified in TAG Unit M2 section 6.3.8 (January 2014) has been set in DIADEM, and has been achieved in all model scenarios. The base model converges in 7 iterations with a gap of 0.06%. Results for all forecast scenarios are shown in Table 6.5.

Table 6.5 - DIADEM convergence statistics

Scenario	2020		2035	
	Iterations	Gap	Iterations	Gap
Do Minimum	11	0.08%	9	0.07%
Option C6	6	0.08%	7	0.08%
Option C11	6	0.09%	7	0.08%
Option T3	6	0.08%	8	0.09%
Option W4	6	0.07%	7	0.08%

6.4.4 The DIADEM demand model is therefore sufficiently converged to allow for meaningful option testing.

6.5 REALISM TESTING

REQUIREMENTS

6.5.1 TAG Unit M2 6.4 sets out the realism tests required to verify that the scale of responses being modelled is realistic. This is determined through assessment of demand elasticities which is defined as:

$$\varepsilon = \frac{\log\left(\frac{T^1}{T^0}\right)}{\log\left(\frac{C^1}{C^0}\right)}$$

6.5.2 The superscripts 0 and 1 indicate values of demand (T) and cost (C), before and after the change in cost, respectively. The required tests for a highway only demand model are:

- Car fuel cost elasticity

→ Car journey time elasticity

CAR FUEL COST ELASTICITY

6.5.3 The car fuel cost elasticity is the percentage change in car vehicle-kms with respect to the percentage change in fuel cost. The elasticities have been calculated based on a 10% increase in fuel cost, as recommended in TAG, from a converged DIADEM model.

6.5.4 Overall fuel cost elasticity should lie between -0.25 and -0.35, greater than -0.30 if there is a significant proportion of discretionary trips (as there is in this model). Values should be broadly similar across modelled time periods, and are considered more realistic if Commuting trips are close to -0.3, Business trips are close to -0.1, and Other trips are close to -0.4.

6.5.5 Guidance presented in the DIADEM manual has been followed. The generalised cost parameters have been adjusted by increasing the fuel cost component from the TAG databook (November 2014), following the same principles adopted when deriving the base cost parameters. The original and adjusted VOC parameters are shown in Table 6.6.

Table 6.6 - Adjusted VOC parameters for fuel cost elasticity test (pence per kilometre)

PURPOSE	BASE VOC	ADJUSTED VOC
Commuting	6.70	7.37
Business	13.38	13.94
Other	6.70	7.37

6.5.6 The elasticities have been calculated for all time periods and all purposes, then aggregated for each time period and across all time periods. Both matrix-based and network-based calculations have been produced. For the matrix-based calculations, external to external movements have been excluded from the analysis, as these trips are modelled in a very approximate manner, so are not fully responsive.

6.5.7 The results of the matrix-based calculations are presented in Table 6.7.

Table 6.7 – Car fuel cost elasticity - matrix-based

PURPOSE	AM	IP	PM
Commuting	-0.307	-0.353	-0.302
Business	-0.069	-0.119	-0.106
Other	-0.291	-0.398	-0.386
TOTAL	*-0.288*	*-0.360*	*-0.332*
OVERALL		**-0.334**	

6.5.8 These results are all consistent with the requirements set out in WebTAG, both in terms of the overall elasticity and the individual purposes and time periods.

6.5.9 The same calculations have been produced based on information obtained from the assignment summary statistics. Since it is not possible to exclude external to external trips from these calculations, the fuel cost elasticities are expected to be underestimated. Network-based elasticities are shown in Table 6.8.

Table 6.8 – Car fuel cost elasticity - network-based

PURPOSE	AM	IP	PM
Commuting	-0.167	-0.182	-0.174
Business	-0.069	-0.110	-0.099
Other	-0.294	-0.376	-0.378
TOTAL	*-0.206*	*-0.305*	*-0.272*
OVERALL		**-0.271**	

6.5.10 Taking this point into account, the network-based fuel cost elasticities are broadly in line with the matrix-based calculations.

6.5.11 Overall, the DIADEM model exhibits realistic behaviour in response to changes in fuel cost.

CAR JOURNEY TIME ELASTICITY

6.5.12 In addition to the car fuel cost elasticity, the car journey time elasticity is required as a diagnostic tool to verify that the model does not produce very high elasticities, so should be no stronger than -2.0.

6.5.13 It is not possible to directly calculate the car journey time elasticity using DIADEM. Instead, the DIADEM manual recommends that this value is estimated from available data using the following function:

$$\varepsilon^{time} = \varepsilon^{fuel} \frac{VOT * T}{VOC * K}$$

6.5.14 The parameter *T* represents total vehicle hours and *K* represents total vehicle kilometres. Applying this estimate generates the elasticities shown in Table 6.9

Table 6.9 – Car journey time elasticity

PURPOSE	AM	IP	PM
Commuting	-0.009	-0.010	-0.008
Business	-0.003	-0.005	-0.005
Other	-0.011	-0.015	-0.015
TOTAL	*-0.009*	*-0.013*	*-0.011*
OVERALL		**-0.009**	

6.5.15 These results demonstrate that the DIADEM demand model is not unduly sensitive with regards to changes in car journey time, so represent realistic responses to changes in cost.

6.6 APPLICATION TO FORECAST MODELS

6.6.1 Having established that the model parameters represent realistic behavioural responses in the base year, these were then applied to create the forecast models, with different approaches for the Do Minimum and Do Something scenarios. For both scenarios, generalised cost parameters were updated to match those derived for the relevant forecast year.

DO MINIMUM

6.6.2 The Do Minimum scenario was created by running the demand model with forecast reference case trips as outlined in section 5, and reference costs taken from the validated base model. This is known as pivoting off the base, and is illustrated in Figure 6.1.

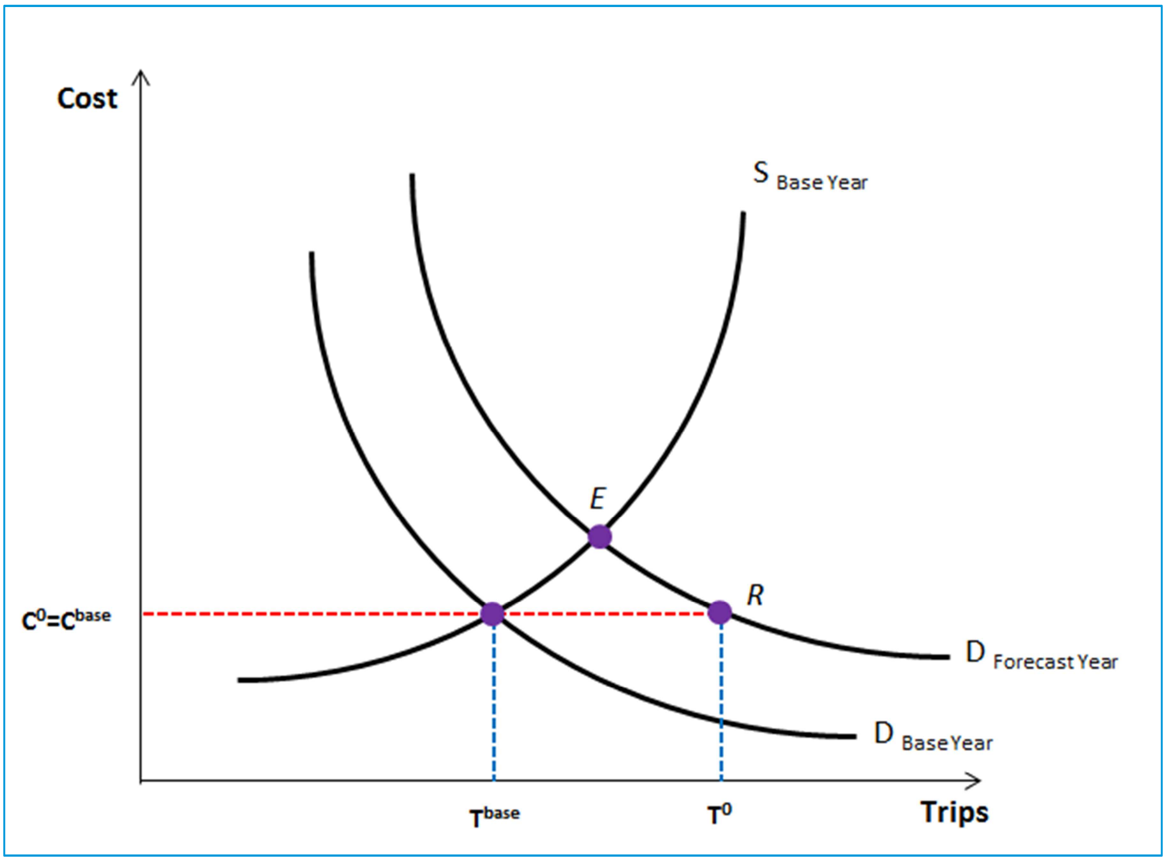


Figure 6.1 - Pivoting off base

DO SOMETHING

6.6.3 Each Do Something scenario was created by running the demand model with reference trips and costs taken from the converged Do Minimum model, outlined above. This is known as pivoting off the Do Minimum, and is illustrated in Figure 6.2.

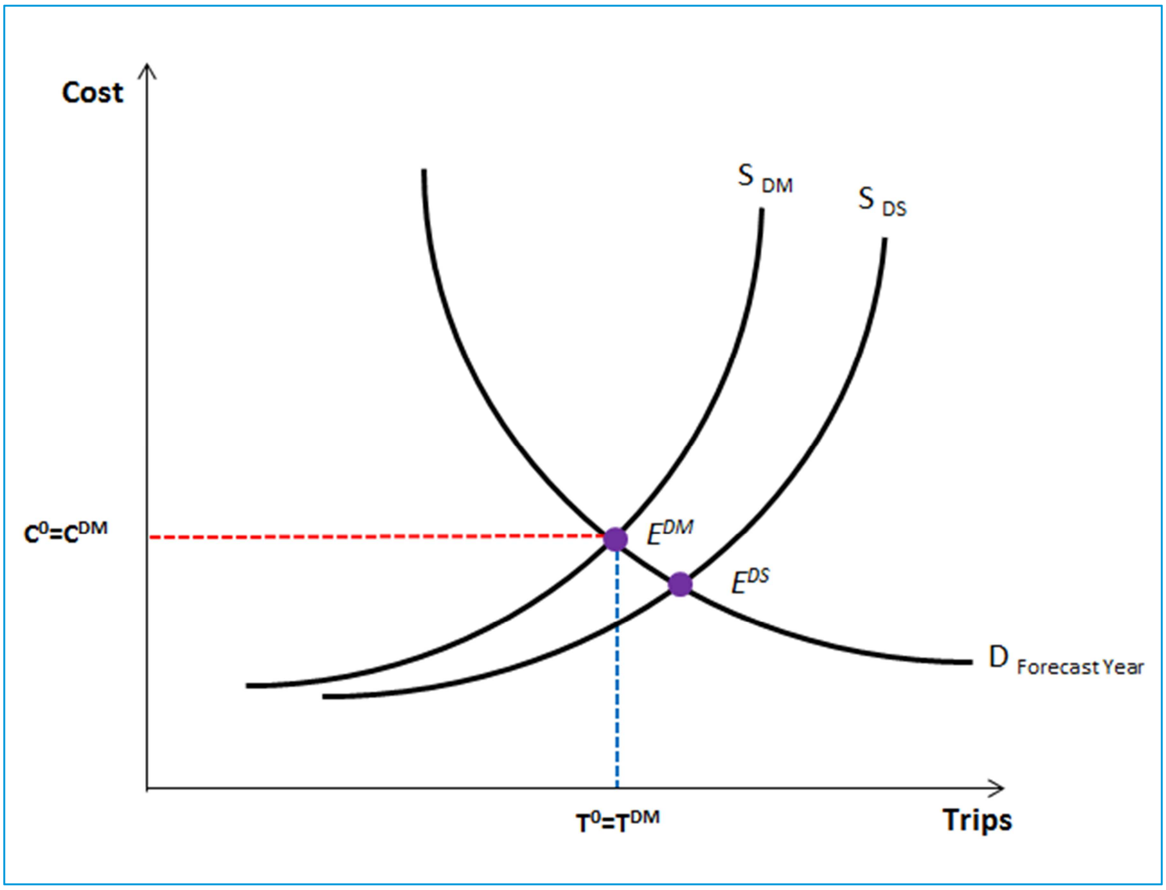


Figure 6.2 - Pivoting off Do Minimum

6.7 IMPACT ON FORECASTS

6.7.1 The totals of the matrices output by the DIADEM demand model are shown in Table 6.10.

6.7.2 As trip frequency is only modelled with a very low sensitivity, and trip distribution is the only other response modelled, it is to be expected that the overall totals do not change significantly. However, there are changes in the distribution of trips within the matrix. Appendix D contains plots showing the difference between assignments of the Reference Case trips and the final converged demand model output matrices.

Table 6.10 - Output matrix totals by user class

Scenario	2020			2035		
	Commuting	Business	Other	Commuting	Business	Other
AM Peak						
Ref Case	7,967	935	4,710	8,304	972	5,363
DM	7,978	936	4,717	8,328	974	5,385
C6	7,983	936	4,717	8,337	974	5,385
C11	7,984	936	4,718	8,338	974	5,385
T3	7,983	936	4,718	8,336	974	5,385
W4	7,983	936	4,718	8,336	974	5,385
Interpeak						
Ref Case	2,212	864	7,715	2,304	901	8,835
DM	2,217	865	7,727	2,314	903	8,870
C6	2,218	865	7,727	2,317	903	8,870
C11	2,219	865	7,727	2,317	903	8,871
T3	2,218	865	7,728	2,317	903	8,870
W4	2,218	865	7,728	2,317	903	8,871
PM Peak						
Ref Case	5,567	1,159	8,145	5,747	1,193	9,031
DM	5,569	1,160	8,157	5,756	1,195	9,067
C6	5,572	1,159	8,145	5,763	1,195	9,067
C11	5,573	1,159	8,146	5,764	1,195	9,068
T3	5,572	1,159	8,145	5,763	1,195	9,067
W4	5,572	1,159	8,145	5,763	1,195	9,067

7 FORECAST ASSIGNMENTS

7.1 MODEL CONVERGENCE

7.1.1 Model convergence is needed to ensure traffic flows remain stable between successive iterations of the model. This is particularly important when model outputs are used to inform the economic benefits of scheme appraisal, as it is critical that calculated benefits arise from the impact of the scheme and not as a result of difference in convergence.

7.1.2 In accordance with criteria set out in TAG Unit M3.1 (January 2014), the parameters %Flow, %GAP and Delta (δ) have been monitored to determine the level of convergence. %Flow measures the proportion of links in the network with flows changing by less than 1% from the previous iteration. δ is the difference between costs on chosen routes and costs on minimum cost paths. %GAP is a generalisation of the δ function to include the interaction effects within the simulation.

7.1.3 The convergence criteria used to assess when a model is considered to have converged is shown in table 7.1.

Table 7.1 - Convergence criteria

Measure of Convergence	Acceptable Value
'Delta' and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change < 1%	Four consecutive iterations greater than 98%
Percentage of links with cost change < 1%	Four consecutive iterations greater than 98%
Percentage change in total user costs	Four consecutive iterations less than 0.1%

7.1.4 TAG Unit M3.1 (January 2014) indicates that delta (δ) and %GAP values of less than 0.1% is the most fundamental indicator of model convergence and should be achieved as a minimum. In the LMVR (December 2015), the base year model was shown to converge satisfactorily in all three peaks.

7.1.5 Appendix E contains details of the convergence statistics for the post-DIADEM model runs. This indicates a high level of convergence is achieved across nearly every model run.

7.1.6 The exception to this is the 2035 Do Something T3 interpeak model which reaches the upper limit of 99 iterations and does not converge. In this model run the %GAP value reached around 0.6% and Delta value reached 0.2%. The percentage of links with a flow change less than 1% reached 92%

7.2 NETWORK SUMMARY STATISTICS

7.2.1 Network summary statistics were output from SATURN comparing the Do Minimum to each of the Do Something scenarios. These figures can be used to given an impression of how the overall network is performing between different mitigation scenarios.

7.2.2 Appendix F contains tables comparing the network summary statistics across the various model runs in the core scenario.

7.2.3 The network summary statistics show that over-capacity queues (pcu.hrs/hr) between the Do Minimum and Do Something typically reduce by around 75% in the AM peak and 33% in the PM peak in 2020 and 2035 across the majority of model runs. In 2035, C6 and C11 show the greatest reduction in queues of between 74%-76%, whereas for the T3 and W4 options the reduction is less at around 64%. In the interpeak, the reduction in over-capacity queues is more variable between the various Do Something options. In 2020, the C6 and C11 show reductions of around 90%, whereas the T3 and W4 see decreases of around 78%. In 2035, the C6 and C11 options show a decrease of 85%, whereas for the T3 and W4 options the difference is between 68%-70%.

7.2.4 Total travel time (pcu.hrs/hr) is shown to reduce the most in the C11 option, with travel time reducing by between 6-10%. For the C6 option this reduction is between 5%-8%. The T3 and W4 options show reductions between 4%-7%.

7.2.5 Average speed (kph) is provided as a summary statistic. Higher average speeds indicate traffic is more free-flowing and there is less congestion. Options C6 and C11 show the highest increase in average speed, with increases of 7%-11% (speeds reaching 36kph-45kph). For the T3 and W4 options the increase in average speed is less marked, between 5%-8% (speeds rising to 35kph-44kph).

7.2.6 Overall the network summary statistics suggest the two central options (C6 and C11) show the most significant improvements to network performance compared to the Do Minimum. Of these two options, C11 performs marginally better.

7.3 FORECAST FLOW CHANGES

7.3.1 Appendix G contains flow difference figures comparing the Do Minimum to the various Do Something options.

7.3.2 Table 7.2 to Table 7.4 show the difference in flow on each of the river crossings in 2035 across each of the scenarios. The figures show the C11 crossing option attracts the highest level of traffic, reaching around 1,350 pcus northbound and 1,300 pcus southbound. The C11 crossing option also leads to the most significant transfer of traffic away from the western Mutford Bridge and eastern Bascule Bridge crossings.

Table 7.2 – AM peak 2035 river crossing flow difference

Scenario	Northbound			Southbound		
	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing
DM	1,514	0	1,780	1,382	0	1,143
C6	1,230	1,211	1,572	1,053	951	739
C11	1,218	1,354	1,470	976	1193	591
T3	1,322	908	1,695	1,053	825	856
W4	1,316	908	1,700	1,075	782	872

Table 7.3 – Inter peak 2035 river crossing flow difference

Scenario	Northbound			Southbound		
	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing
DM	1,525	0	1,065	1,407	0	1,681
C6	839	1,183	1,009	1,018	1,061	1,148
C11	792	1,301	950	983	1,287	971
T3	1,018	910	1,057	1,058	840	1,310
W4	1,039	908	1,061	1,078	792	1,337

Table 7.4 – PM peak 2035 river crossing flow difference

Scenario	Northbound			Southbound		
	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing
DM	1,521	0	1,140	1,523	0	2,161
C6	1,222	1,016	937	1,396	1,067	1,583
C11	1,238	1,170	777	1,305	1,278	1,517
T3	1,180	898	1,091	1,330	990	1,721
W4	1,217	854	1,087	1,362	858	1,806

Figure 7.1 to Figure 7.6 show the variation in flow on the bridge crossings in 2035 by peak period and direction.

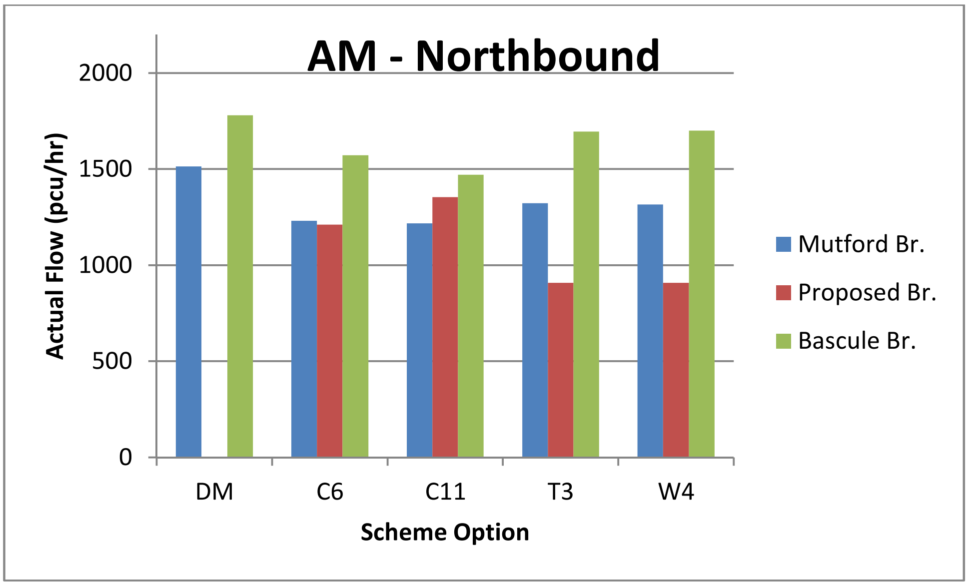


Figure 7.1 – AM 2035 core scenario bridge crossing flows - Northbound

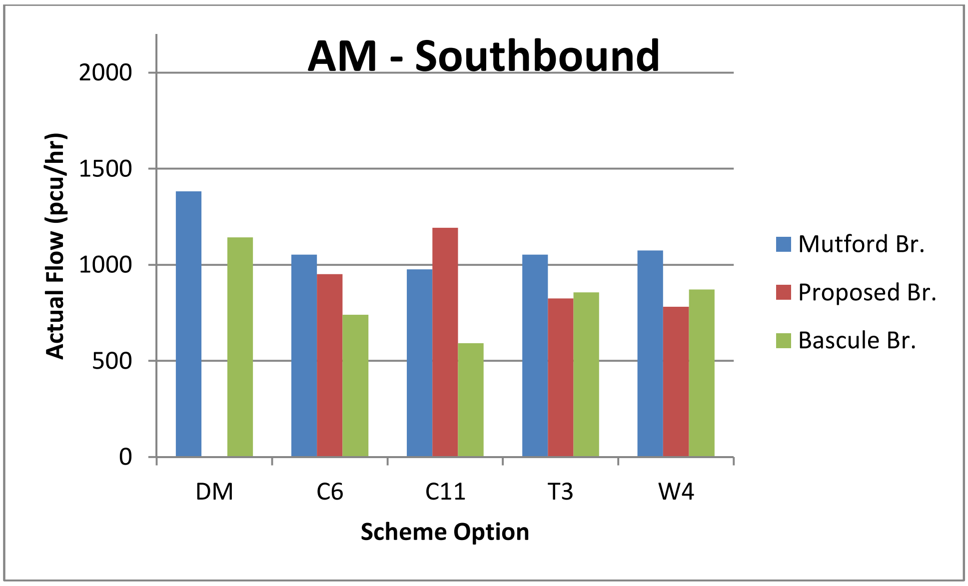


Figure 7.2 – AM 2035 core scenario bridge crossing flows - Southbound

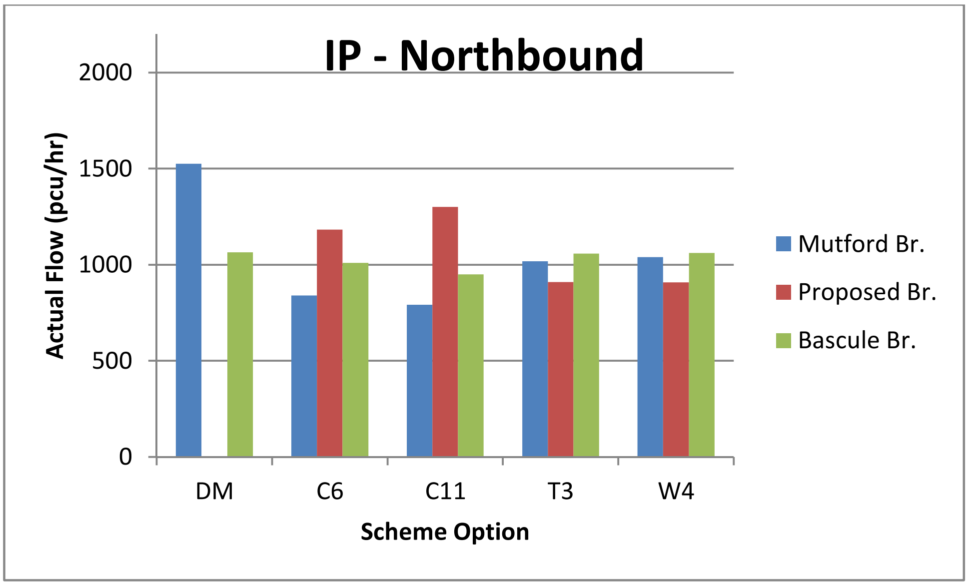


Figure 7.3 – IP 2035 core scenario bridge crossing flows - Northbound

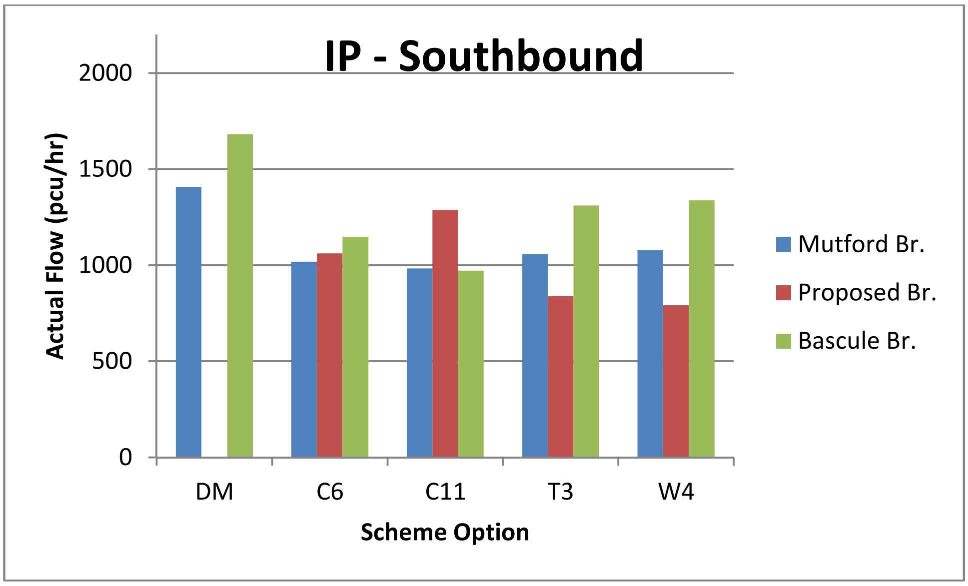


Figure 7.4 – IP 2035 core scenario bridge crossing flows - Southbound

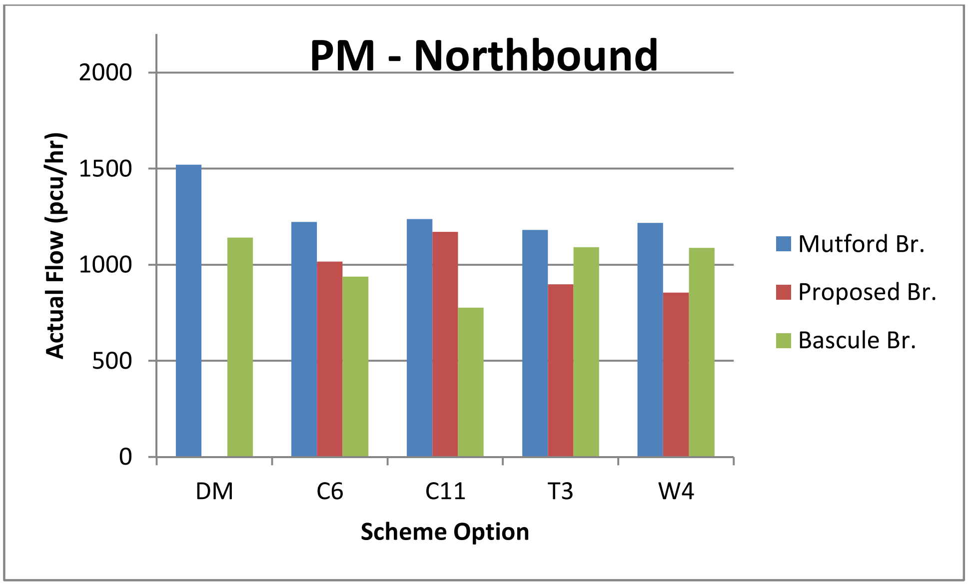


Figure 7.5 – PM 2035 core scenario bridge crossing flows - Northbound

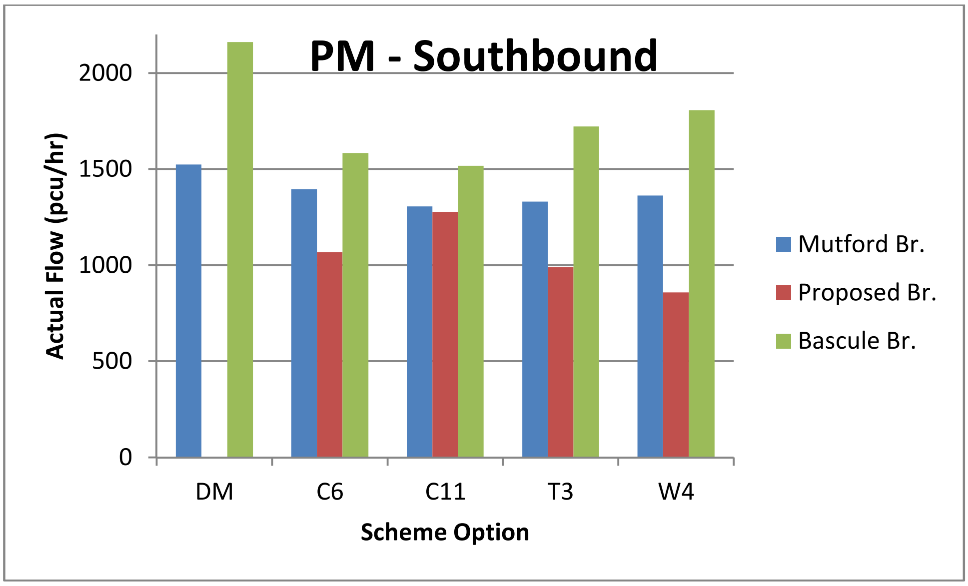


Figure 7.6 – PM 2035 core scenario bridge crossing flows - Southbound

7.4 FORECAST DELAY AND JOURNEY TIME CHANGES

7.4.1 Appendix H contains figures which show the overall volume to capacity (V/C) percentage for nodes within the 2035 model runs. These percentages highlight locations at which the modelled flow surpasses or is close to the maximum capacity of the junction and therefore indicate locations at which delays will occur.

VOLUME TO CAPACITY RATIO

DO MINIMUM

7.4.2 The volume to capacity plots (figures H.1 to H.3) show the following locations experience a V/C of over 100% across all three peaks:

- A146 Bridge Road / Commodore Road
- A146 Saltwater Way / Bridge Road
- A12 Station Square / Commercial Road
- A12 Belvedere Road / A12 Pier Terrace / London Road South
- London Road South / Mill Road

7.4.3 The following junction shows a V/C of over 100% in the AM peak (figure H.1), and also shows congestion problems in the other two peaks:

- A12 Horn Hill / A12 Belvedere Road / Mill Road / Kirkley Rise / Asda access

OPTION C6

7.4.4 Across all three peaks, the inclusion of the C6 crossing option reduces the V/C on junctions adjacent to the existing western and eastern river crossings, shown in figures H.4 to H.6. Junctions with a V/C of over 100% are shown to perform better, except for the following two junctions which still return a V/C of over 100%:

- A12 Horn Hill / A12 Belvedere Road / Mill Road / Kirkley Rise / Asda access (AM peak only)
- London Road South / Mill Road (all peaks)

7.4.5 The delay at the Bridge Road level crossing is shown to reduce from 85%-100% in the Do Minimum, to 75%-85% in the C6 option in the AM peak and PM peak (figures H.4 and H.6).

7.4.6 The southern roundabout for the C6 crossing is shown to experience a V/C of between 75%-85% highlighting there is congestion at this location.

OPTION C11

7.4.7 As with the other central option (C6), this option shows a similar alleviation of delay at junctions adjacent to the existing western and eastern river crossings (see figures H.7 to H.9). The delay at the Bridge Road level crossing is shown to reduce from 85%-100% in the Do Minimum, to 75%-85% in the C6 option in the AM peak and PM peak, shown in figure H.7 and H.9.

7.4.8 There is reduced congestion at the A12 / Horn Hill / A12 Belvedere Road / Mill Road / Kirkley Rise / Asda access roundabout. However, the A12 Tom Crisp Way / A12 Horn Hill / A146 Waveney Drive / Maconochie Way roundabout shows greater stress in the AM peak (figure H.7), reaching a V/C of 85%-100%, having been at 75%-85% in the Do Minimum and C6 model runs.

7.4.9 The southern roundabout for the C11 shows congestion issues, reaching 85%-100% in the AM and PM peak (figure H.7 and H.9), and 75%-85% in the interpeak (figure H.8). In the AM peak, the northern roundabout reaches a V/C of between 75%-85% (figure H.7).

OPTION T3

7.4.10 The T3 option is shown to alleviate the delays at junctions adjacent to the existing eastern and western river crossings (figures H.10 to H.12), though the following junctions still remain an issue:

- A12 Station Square / Commercial Road (100% V/C in AM peak & interpeak)
- A146 Bridge Road / Commodore Road (85% in the AM peak)

7.4.11 The southern signalised junction for the crossing is shown to experience major delays, reaching 100% V/C in the AM peak and interpeak, whereas in the PM peak the V/C is at 85%-100%.

7.4.12 The northern roundabout junction for this option is shown to experience issues, reaching 85%-100% in the PM peak, and 75-85% in the interpeak.

OPTION W4

7.4.13 In terms of V/C performance, Option W4 is shown to perform similarly compared to Option T3. One difference is the performance of the A146 Waveney Drive / Kirkley Run roundabout which shows less congestion in the Option W4 option (figures H.13 to H.15). The southern signalised junction shows similar problems in Option W4 compared to Option T3, however the delay at this junction does not lead to the same downstream delays to the A146 Waveney Drive / Kirkley Waterfront access which was at 100%+ V/C in Option T3 AM peak (figure H.13).

JOURNEY TIME COMPARISON

7.4.14 Journey time route analysis was carried out comparing the travel time between the:

- A12 Yarmouth Road / Lowestoft Relief Road / Corton Long Lane / Blundeston Road roundabout and
- A12 Tom Crisp Way / A12 Bloodmoor Road / A1117 Elm Tree Road / A1145 Castleton Avenue / Stadbroke Road / Ribblesdale

7.4.15 Figure 7.7 shows the different routes which were used for the analysis:

- Western route: via the Mutford Bridge using the Lowestoft Relief Road, A146 and A1117
- Central routes: via the Lowestoft Relief Road, proposed crossing option and A12 Tom Crisp Way
- Eastern route: via the Bascule Bridge using the A12 Yarmouth Road, Lowestoft town centre and A12 Tom Crisp Way

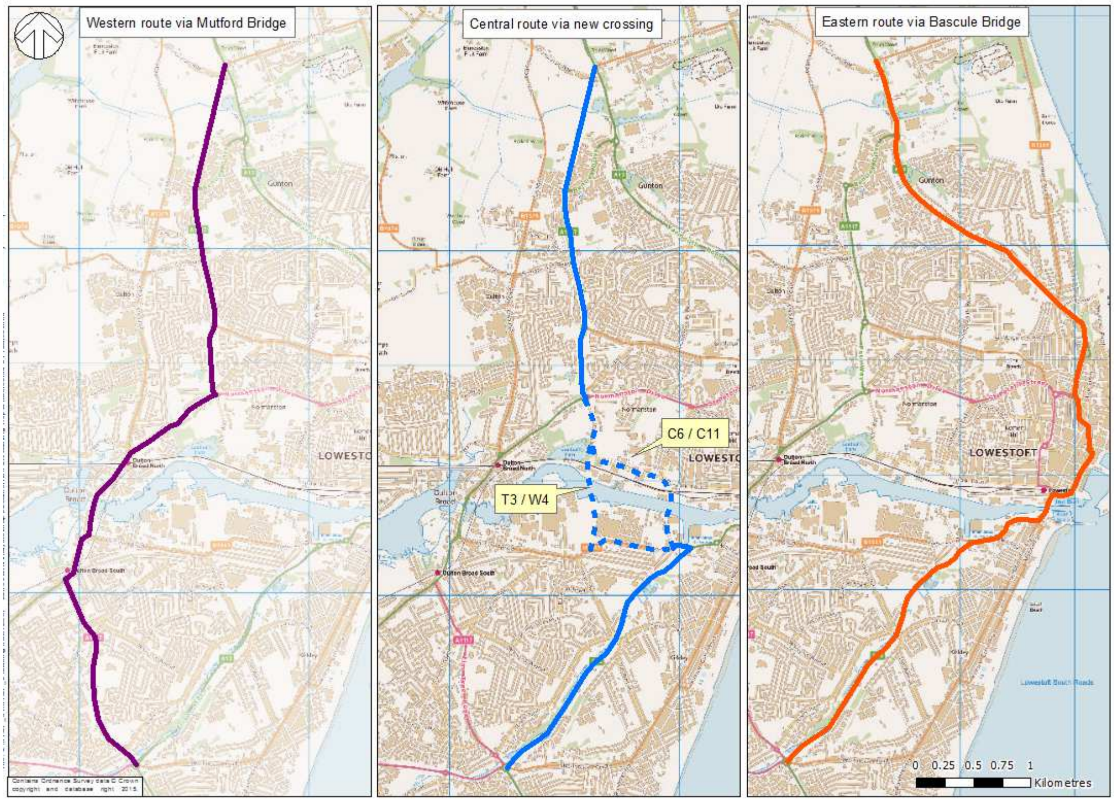


Figure 7.7 - Selected journey time routes

7.4.16 Table 7.5, Table 7.6 and Table 7.7 provide a comparison of the journey time in seconds between the selected routes across all three peaks for each scenario in 2035.

7.4.17 In the northbound direction, journey times on the western and eastern routes significantly improve compared to the Do Minimum due to the central crossing options easing congestion. Southbound journey times remain more or less constant, improving slightly in the Do Something options compared to the Do Minimum.

7.4.18 The central crossing options (C6 and C11) are shown to provide the fastest routes, with C6 marginally quicker than C11. In the northbound direction, the T3 and W4 options are shown to offer a slower route compared to the western route via the Mutford Bridge, but are faster than the eastern route via the Bascule Bridge.

Table 7.5 – AM peak 2035 journey time comparison

Scenario	Northbound			Southbound		
	Western route	Central route	Eastern route	Western route	Central route	Eastern route
DM	1,004	0	1,177	662	0	767
C6	710	673	864	626	613	746
C11	707	696	846	627	627	744
T3	696	858	897	635	650	732
W4	696	870	895	636	655	732

Table 7.6 – Inter peak 2035 journey time comparison

Scenario	Northbound			Southbound		
	Western route	Central route	Eastern route	Western route	Central route	Eastern route
DM	850	0	1,061	663	0	730
C6	681	656	866	637	626	758
C11	675	663	833	637	640	761
T3	708	870	918	644	644	734
W4	707	860	924	646	655	733

Table 7.7 – PM peak 2035 journey time comparison

Scenario	Northbound			Southbound		
	Western route	Central route	Eastern route	Western route	Central route	Eastern route
DM	1,032	0	1,189	763	0	893
C6	698	681	850	700	708	852
C11	704	693	832	672	734	853
T3	697	842	876	691	720	845
W4	702	838	872	700	746	847

7.5 ALTERNATIVE SCENARIOS

7.5.1 Table 7.8 and Table 7.9 detail the variation in flow on the river crossings, comparing the Do Minimum and C11 option in all three growth scenarios in the 2035 AM peak and PM peak.

7.5.2 As expected the high growth scenario leads to an increase in flow on the C11 crossing, increasing flow by between 50 pcu and 100 pcu compared to the core scenario. For the low growth scenario, flow decreases by between 70 pcu and 100 pcu compared to the low growth scenario.

Table 7.8 – AM peak 2035 alternative growth scenarios river crossing flow difference

Scenario	Northbound			Southbound		
	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing
DM	1,514	0	1,780	1,382	0	1,143
C11	1,218	1,354	1,470	976	1,193	591
DM High	1,511	0	1,794	1,446	0	1,209
C11 High	1,377	1,433	1,523	1,035	1,250	639
DM Low	1,517	0	1,779	1,334	0	1,036
C11 Low	1,048	1,263	1,330	875	1,132	509

Table 7.9 – PM peak 2035 alternative growth scenarios river crossing flow difference

Scenario	Northbound			Southbound		
	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing	Mutford Bridge Crossing	Central Crossing	Bascule Bridge Crossing
DM	1,521	0	1,140	1,523	0	2,161
C11	1,238	1,170	777	1,305	1,278	1,517
DM High	1,521	0	1,167	1,561	0	2,297
C11 High	1,357	1,210	860	1,391	1,393	1,724
DM Low	1,508	0	1,136	1,478	0	1,948
C11 Low	1,113	1,104	703	1,182	1,169	1,326

7.5.3 Figure 7.8 to Figure 7.11 graphs the variation in flow across the bridge crossings in the Do Minimum and C11 Do Something across all three growth scenarios, in the 2035 AM peak and PM peak.

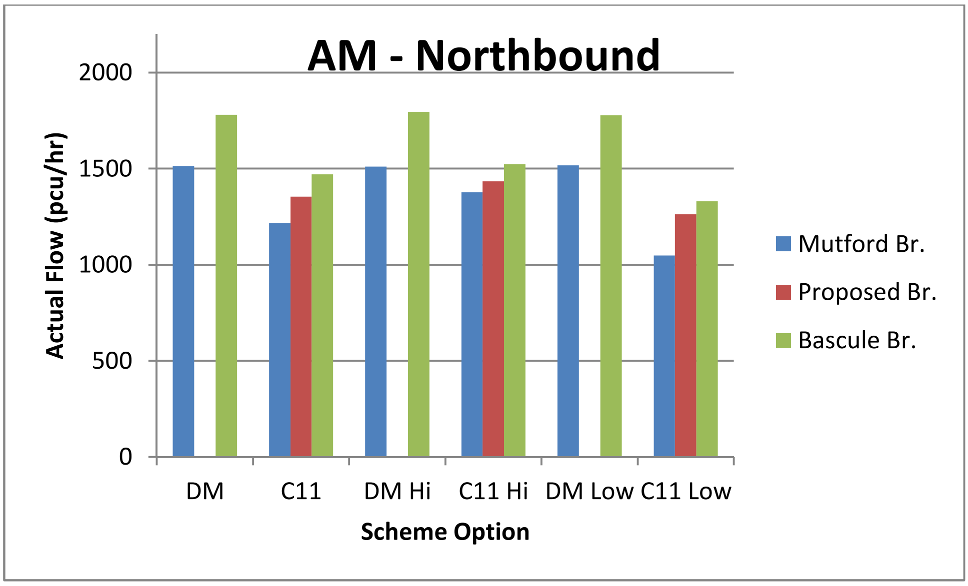


Figure 7.8 – AM 2035 all growth scenarios bridge crossing flows - Northbound

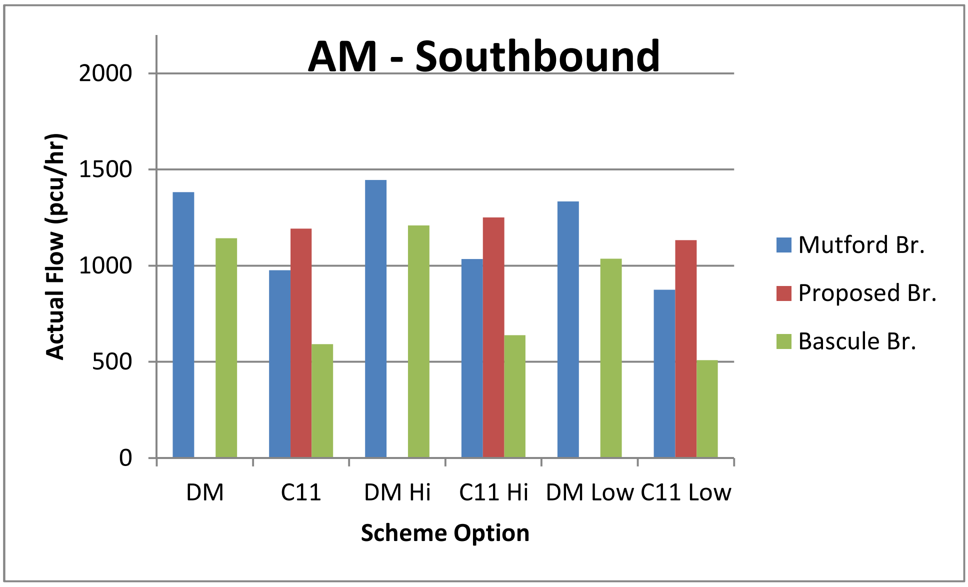


Figure 7.9 – AM 2035 all growth scenarios bridge crossing flows - Southbound

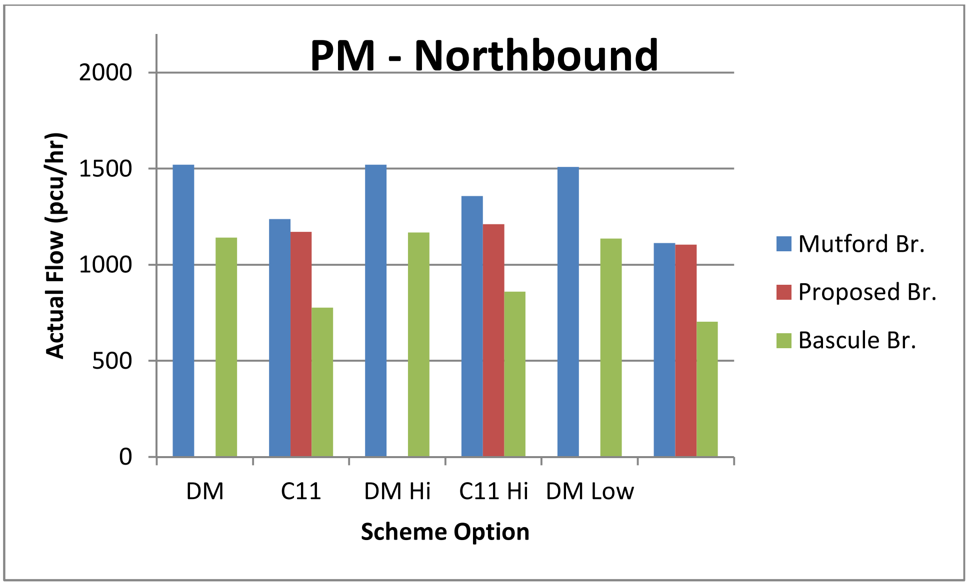


Figure 7.10 – PM 2035 all growth scenarios bridge crossing flows - Northbound

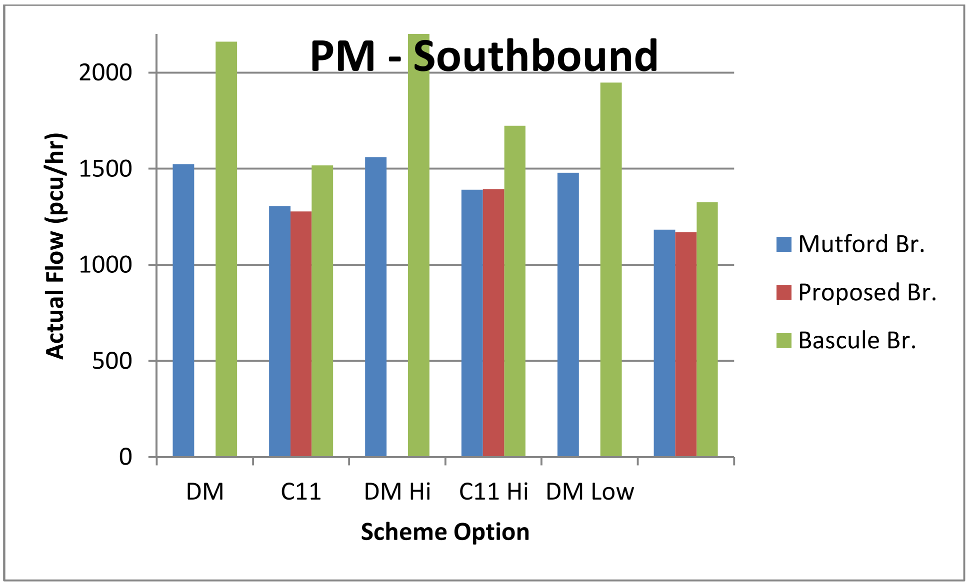


Figure 7.11 – PM 2035 all growth scenarios bridge crossing flows - Southbound

8 SUMMARY

8.1.1 The forecast model runs detailed in this report have been carried out to assess various scheme options for a third river crossing of Lake Lothing in Lowestoft. The forecasts were built on the 2015 base year model detailed in the Local Model Validation Report (December 2015). The following options have been tested:

- Swing bridge in the centre of the existing bridges (C6)
- Swing bridge in the centre of the existing bridges (C11)
- Tunnel in the centre of the existing bridges (T3)
- Swing bridge near the existing western bridge (W4)

8.1.2 The model forecast years run were 2020, representing the scheme opening year, and 2035, which represents the design year (opening year plus 15 years). The models were built following the latest guidance as contained in TAG Unit M4 (January 2014). An uncertainty log was used for the development and transport infrastructure inputs. The core scenario forms the basis of this report, though high and low growth model runs have already been carried out and are also presented.

8.1.3 Analysis of the planning data within NTEM version 6.2 compared to the level of development advised by Waveney District Council shows a disparity between the two sources whereby the proposed development showed significantly higher levels of growth compared to NTEM. Overall growth has been constrained to NTEM by adjusting the planning data at the Suffolk county level.

8.1.4 The model is shown to consistently achieve a satisfactory level of convergence, so the benefits which the models will show in terms of the central crossings can be relied upon to be based on realistic reassignment of traffic flows rather than variations in model convergence.

8.1.5 In terms of network summary statistics C11 is shown to produce the best overall benefits in terms of reducing queuing, distance travelled and increasing average speeds within the network. The C11 option attracts the highest amount of traffic of the options tested, in 2035 reaching a maximum of around 1,350 pcu northbound and 1,300 pcu southbound.

8.1.6 In terms of junction delay, all four options are shown to reduce congestion at both the existing western Mutford Bridge and eastern Bascule Bridge crossings. However, the two central options (C6 and C11) alleviate the congestion at junctions more than the T3 and W4 options.

8.1.7 Comparing the travel time across three strategic routes within the model shows the central crossing options offer the most benefit to northbound travel times, though small improvements are also apparent in the southbound direction. The two central options (C6 and C11) offer the quickest routes. The two western options (T3 and W4) are shown to be slower than a north-south route via the Mutford Bridge / A1117 / A146 / Lowestoft Relief Road, but faster than a north-south route via the Bascule Bridge / A12 Yarmouth Road / A12 Tom Crisp Way.

8.1.8 Overall the forecast models detailed within this report are deemed a suitable basis from which to determine the economic benefits of the various Lake Lothing crossing schemes.

Appendix A

SCHEME DRAWINGS

APPENDIX A-1

OPTION C6 SCHEME DRAWING

New Roundabout
RailTrack Crossing
Denmark Rd Alignment
New Bridge
Mouchel C6 Option
Notes
Speed Limit = 30 mph
Design Speed = 60 kph
Min Horizontal Radius = 180 m.
Railtrack Headroom = 8.3 m.
Max Vertical Gradient = 5%
Riverside Rd Headroom = 6.5 m.
Channel Air Draft = 12 m
(MSL to underside of bridge)
New Bascule Bridge
TURNING AREA
Access Road to commercial properties
New junction at Waveney Drive
Link between roundabouts to be widened
New Roundabout
RailTrack
PETO WAY
DENMARK ROAD
COMMERCIAL ROAD
WAVENEY DRIVE
A12 HORN HILL
A12 BELVEDERE RD
A12 TOM CRISP WAY
Lake Lothing
C6 Option
(Working Option 26/10/15)
Scale 1:2000

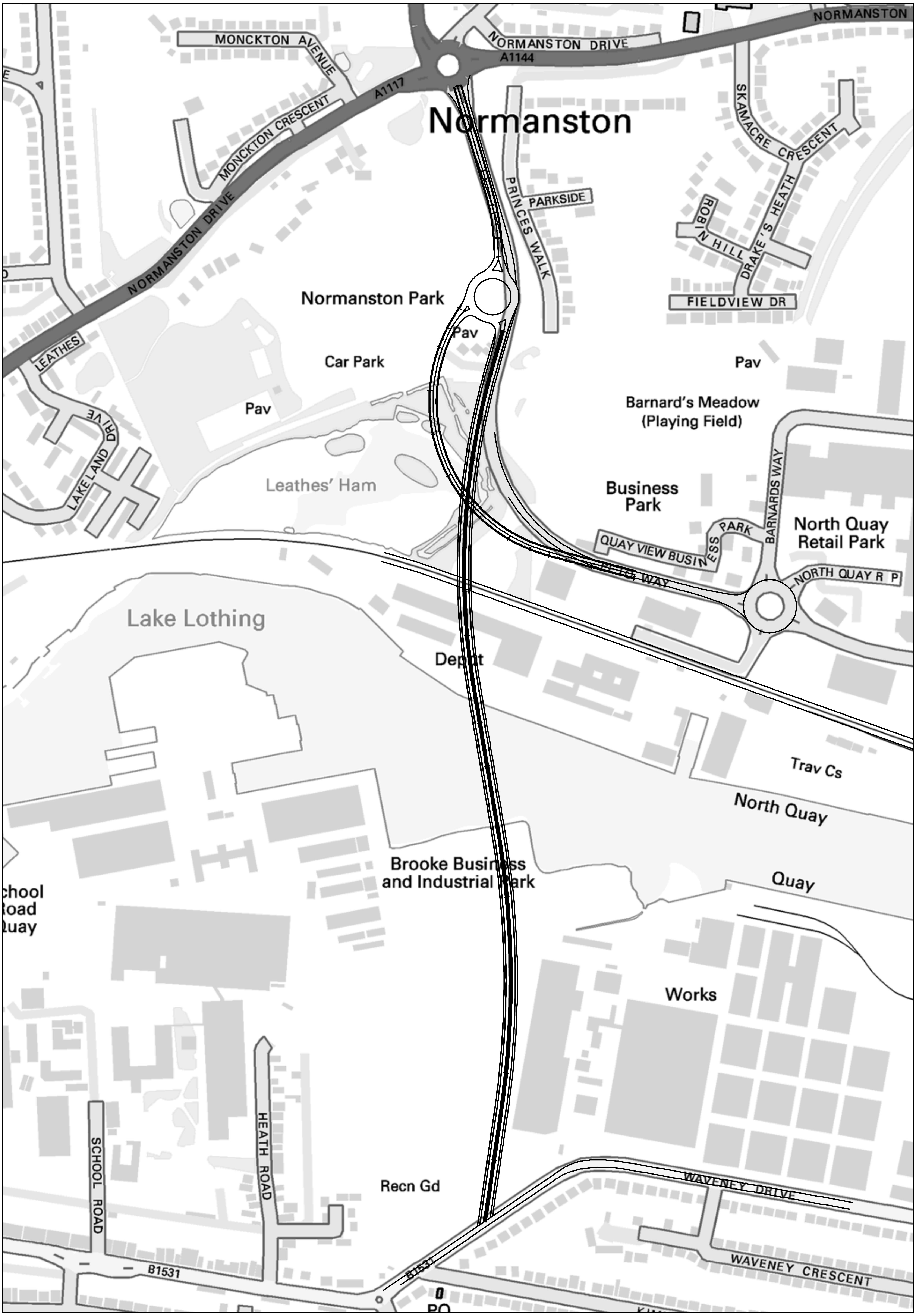
APPENDIX A-2

OPTION C11 SCHEME DRAWING

Lake Lothing
C11 Option
(Working Option 19/11/15)
Scale 1:1000

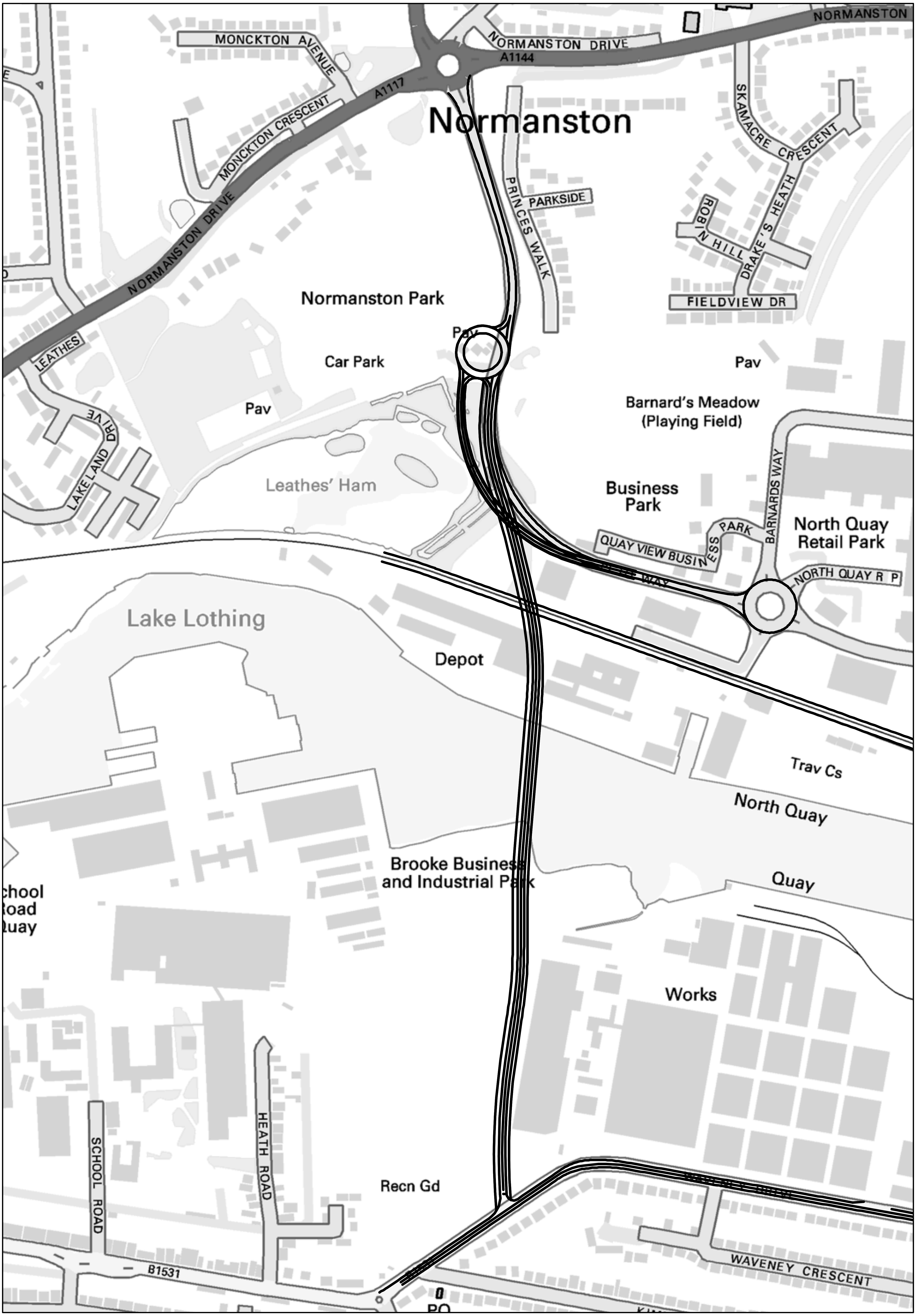
APPENDIX A-3

OPTION T3 SCHEME DRAWING


Normanston
NORMANSTON
NORMANSTON DRIVE
A1144
A1117
MONCKTON AVENUE
MONCKTON CRESCENT
NORMANSTON DRIVE
PRINCES WALK
PARKSIDE
SKAMACRE CRESCENT
DRAKE'S HEATH
ROBIN HILL
FIELDVIEW DR
Normanston Park
Pav
Car Park
Pav
Pav
LEATHES
LAKELAND DRIVE
Barnard's Meadow
(Playing Field)
Business
Park
Leathes' Ham
BARNARDS WAY
North Quay
Retail Park
QUAY VIEW BUSINESS PARK
PETO WAY
NORTH QUAY R P
Lake Lothing
Depot
Trav Cs
North Quay
Brooke Business
and Industrial Park
Quay
School
Road
Quay
Works
SCHOOL ROAD
HEATH ROAD
Recn Gd
WAVENEY DRIVE
WAVENEY CRESCENT
B1531
B1531
PO

APPENDIX A-4

OPTION W4 SCHEME DRAWING


Normanston
NORMANSTON
MONCKTON AVENUE
NORMANSTON DRIVE
A1144
A1117
MONCKTON CRESCENT
NORMANSTON DRIVE
SKAMACRE CRESCENT
PRINCES WALK
PARKSIDE
ROBIN HILL
DRAKE'S HEATH
FIELDVIEW DR
Normanston Park
LEATHES
Pav
Car Park
Pav
Pav
Barnard's Meadow
(Playing Field)
LAKELAND DRIVE
Leathes' Ham
Business
Park
BARNARDS WAY
North Quay
Retail Park
QUAY VIEW BUSINESS PARK
NORTH QUAY R P
Lake Lothing
Depot
Trav Cs
North Quay
Quay
Brooke Business
and Industrial Park
School
Road
Quay
Works
HEATH ROAD
SCHOOL ROAD
Recn Gd
B1531
WAVENEY CRESCENT
PO

Appendix B

DEVELOPMENT INPUTS

Appendix B - developments included within LTM core scenario

2020 Residential developments (included in all scenarios)

				TRICS - EAST ANGLIA*					
				ARRIVALS			DEPARTURES		
Ref	Development	Households	Uncertainty	AM	IP	PM	AM	IP	PM
100	SSP3 - Kirkley Waterfront and Sustainable Urban Neighbourhood - Mixed-use development within Kirkley Waterfront and the new Sustainable Urban Neighbourhood (SUN) within the south west of the AAP area - housing, waterfront industry and employment uses, social and community facilities, open space, marina and a retirement village.	1440	Near certain	266	301	550	624	288	292
101	Woods Meadow, Oulton	800	Near certain	148	167	306	346	160	162
103	Outline application for residential development with associated facilities and open space	124		23	26	47	54	25	25
104	SSP7 - Oswalds Boatyard	80	Near certain	15	17	31	35	16	16
105	Re-development of former Pegasus Boatyard to provide 76 dwellings, new boatyard buildings, office, moorings and new access road.	76		14	16	29	33	15	15
107	SSP6 - Western end of Lake Lothing	57	Near certain	11	12	22	25	11	12
108	Oulton Broad Caravan site, Saltwater Way, Lowestoft	56	Near certain	10	12	21	24	11	11
109	Construction of 8 terraced houses, 16 flats, upto 5 shop units, 31 sheltered housing units and a wardens flat and provision of car parking	56		4	5	24	27	4	6
110	LOW6 - Neeves Pit, Lowestoft	50	Near certain	9	10	19	22	10	10
112	Land off Foxborough Road, Lowestoft	50	Near certain	9	10	19	22	10	10
113	O A Residential development	50		9	10	19	22	10	10
114	LOW9 - Monckton Avenue Nursery, Lowestoft	45	Near certain	8	9	17	19	9	9
115	Construction of extension to residential care home comprising of 31 beds and associated works and construction of 33 no. detached bungalows to provide very sheltered housing, associated works including a private drive, car parking, communal gardens, inf	33	Has planning application	4	4	9	11	4	5
116	LOW5 - Site of Normanshurst Fire Station, Normanston Drive, Lowestoft	32	Completed	6	7	12	14	6	6
117	SSP8 - The Scores	30	Near certain	6	6	11	13	6	6
118	Longs Dairy St Margarets Road, Lowestoft, NR32 4HU	17	Near certain	3	4	6	7	3	3
119	Construction of 16no sheltered bungalow units and 1no warden's house with plant and ancillary accommodation, alterations to access road and parking provision	17	Has planning application	2	2	5	5	2	2
120	Phase 3 Park Meadows Oulton	13	Near certain	2	3	5	6	3	3
122	Conversion [from B8 storage and 1 flat]to form 12no. apartments and 4no. studios at ground floor (A1/A2/B1)	12	Has planning application	1	1	3	3	1	1
123	St Mary's Convent, Rectory Road, Lowestoft	11	Has planning application	0	0	1	1	0	0
124	Plots 1-11 Rodber Way Lowestoft	11	Has planning application	2	2	4	5	2	2
125	Phase 4 land at Foxborough Road Lowestoft	10	Has planning application	2	2	4	4	2	2
			TOTAL	**555**	**628**	**1164**	**1320**	**600**	**611**

2035 Residential developments

Ref	Development	Households	Uncertainty	AM	IP	PM	AM	IP	PM
102	Carlton Hall, Carlton Colville	124	Near certain	23	26	47	54	25	25
106	LOW7 - Gunton Park, off Old Lane, Lowestoft	60	More than likely	11	13	23	26	12	12
111	Dunston, Oulton	50	Near certain	9	10	19	22	10	10
			TOTAL	**43**	**49**	**89**	**101**	**47**	**48**

2020 developments with employment (included in all scenarios)

					TRICS - EAST ANGLIA					
					ARRIVALS			DEPARTURES		
Ref	Development	Jobs	Size	Uncertainty	AM	IP	PM	AM	IP	PM
126	LOW2 - Land south of South Lowestoft Industrial Estate, Gisleham - Mix B1, B2, B8	1961	16.06 ha	More than likely	747	207	89	102	233	726
131	SSP1 - Power Park - around the outer harbour and existing industrial area north of Hamilton Dock around the existing OrbisEnergy building.	241	24.5 ha	More than likely	92	25	11	13	29	89
130	Former Wessex Foods site, 1 Hadenham Road - B1, B2, B8	285	9560 sqm	Has planning application	109	30	13	15	34	106
129	Outline Application - Proposed office development comprising 6no. commercial buildings, creation of lagoon and associated pump room, Land off Mobbs Way, Oulton - B1, B8	103	3440 sqm	Has planning application	157	36	23	27	41	136
135	Construction of a single industrial unit for Starfrost Ltd., Land off Mobbs Way, Oulton - B2	42	1422 sqm	Has planning application	21	10	3	5	11	30
137	Former Lavender Laundry, Whapload Road - B1, B2, B8	42	1400 sqm	Has planning application	16	4	2	2	5	15
132	Construction of a two-storey office building with associated car parking and servicing, Land off Mobbs Way, Oulton - B1	33	1105 sqm	Has planning application	86	20	13	15	23	74
136	Construction of a new build research and development workshop with ancillary offices, 1 Pinbush Road - B1	24	805 sqm	Has planning application	33	8	5	6	9	28
133	Outline Application - Renovation of existing building to offices / commercial / trade counter, and new build of 4 No. A1(retail shop) / A2(offices and professional services) / B1(light industrial) / B2(general industrial) units with all matters reserved, Former Lowestoft Cold Store - A1, A2, B1, B2	12	411 sqm	Has planning application	49	14	7	8	16	43
134	Construction of 2no. business units (plots 4 and 5), Land off Mobbs Way, Oulton - B1	10	350 sqm	Has planning application	47	11	7	8	13	41
127	Outline Application - Construction of 16no. commercial units (B1 and B8), Land off Mobbs Way, Oulton	223	7480 sqm	Has planning application	341	78	50	58	90	295
121	SSP3 - Kirkley Waterfront and Sustainable Urban Neighbourhood - Mixed-use development within Kirkley Waterfront and the new Sustainable Urban Neighbourhood (SUN) within the south west of the AAP area - housing, waterfront industry and employment uses, social and community facilities, open space, marina and a retirement village.	181	12 ha	More than likely	69	19	8	9	22	67
				TOTAL	**1767**	**462**	**231**	**268**	**524**	**1650**

2035 developments with employment

128	SSP3 - Kirkley Waterfront and the new Sustainable Urban Neighbourhood - Primary School	181	1	More than likely	97	18	11	65	19	16
				TOTAL	**97**	**18**	**11**	**65**	**19**	**16**

*East Anglia TRICS were not available for cells in blue - All Regions TRICS were used in these cases

Overall 2020 trips	**2322**	**1090**	**1395**	**1587**	**1124**	**2262**
Overall 2035 trips	**2462**	**1157**	**1495**	**1754**	**1190**	**2325**

Appendix B - developments included within LTM high growth scenario

2035 Residential developments (included in high growth scenario only)

Ref	Development	Households	Uncertainty	TRICS - EAST ANGLIA* ARRIVALS AM	IP	PM	DEPARTURES AM	IP	PM
138	LOW8 - CEFAS Laboratory, Pakefield Road, Lowestoft	50	Reasonably foreseeable	3	4	11	12	4	5
141	SSP5 - Kirkley Rise	41	Reasonably foreseeable	8	9	16	18	8	8
			TOTAL	**11**	**13**	**27**	**29**	**12**	**13**

2035 developments with employment (included in high growth scenario only)

Ref	Development	Jobs	Size	Uncertainty	TRICS - EAST ANGLIA ARRIVALS AM	IP	PM	DEPARTURES AM	IP	PM
139	SSP9 - Peto Way/Denmark Road - B1, B2, B8	190	6360 sqm	Hypothetical	72	20	9	10	23	70
140	SSP9 - Land at the far west of Peto Way/Denmark Road - A1		3856 sqm	Hypothetical	14	114	44	4	108	71
143	LOW1 - Land south of Parkhill/west of Millennium Way, Oulton - Primary school		1	Hypothetical	97	18	11	65	19	16
				TOTAL	**183**	**152**	**63**	**79**	**150**	**157**

*East Anglia TRICS were not available for cells in blue - All Regions TRICS were used in these cases

	Arrivals AM	Arrivals IP	Arrivals PM	Departures AM	Departures IP	Departures PM
Overall 2035 trips	**194**	**165**	**90**	**108**	**162**	**171**
Overall 2035 trips (with Core Scenario)	**2656**	**1322**	**1585**	**1862**	**1353**	**2496**

Appendix C

HIGH & LOW GROWTH SCENARIO MATRIX TOTALS

HIGH GROWTH SCENARIO MATRICES

Table C.1 – 2020 high growth matrix development – AM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	5447	5460	2507	7967	8413
UC2	622	623	312	935	987
UC3	3474	3619	1091	4710	4973
UC4	2855	3288	0	3288	3472
UC5	868	909	0	909	959
Total	**13267**	**13900**	**3909**	**17809**	**18805**

Table C.2 – 2035 high growth matrix development – AM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	5447	5597	2898	8304	9233
UC2	622	636	360	972	1081
UC3	3474	4185	1260	5363	5962
UC4	2855	4492	0	4492	4994
UC5	868	1071	0	1071	1191
Total	**13267**	**15980**	**4518**	**20202**	**22461**

Table C.3 – 2020 high growth matrix development – Inter peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	1696	1703	509	2212	2335
UC2	658	665	200	864	913
UC3	5954	6210	1505	7715	8147
UC4	2919	3362	0	3362	3550
UC5	825	864	0	864	912
Total	**12052**	**12803**	**2213.8**	**15017**	**15856**

Table C.4 – 2035 high growth matrix development – Inter peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	1696	1763	615	2304	2561
UC2	658	689	241	901	1002
UC3	5954	7235	1818	8835	9823
UC4	2919	4592	0	4592	5106
UC5	825	1018	0	1018	1131
Total	**12052.35**	**15296.72**	**2674**	**17650**	**19623**

Table C.5 – 2020 high growth matrix development – PM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	3964	3978	1590	5567	5879
UC2	904	907	252	1159	1224
UC3	6141	6331	1814	8145	8600
UC4	3215	3703	0	3703	3910
UC5	456	477	0	477	504
Total	**14680**	**15395**	**3656**	**19052**	**20117**

Table C.6– 2035 high growth matrix development – PM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	3964	4084	1774	5747	6390
UC2	904	928	282	1193	1326
UC3	6141	7131	2025	9031	10041
UC4	3215	5058	0	5058	5623
UC5	456	563	0	563	626
Total	**14680**	**17764**	**4081**	**21592**	**24006**

LOW GROWTH SCENARIO MATRICES

Table C.7 – 2020 low growth matrix development – AM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	5447	5460	2507	7967	7522
UC2	622	623	312	935	883
UC3	3474	3619	1091	4710	4447
UC4	2855	3288	0	3288	3104
UC5	868	9089	0	909	858
Total	**13267**	**13900**	**3909**	**17809**	**16813**

Table C.8 – 2035 low growth matrix development – AM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	5447	5601	2704	8304	7376
UC2	622	636	336	972	863
UC3	3474	4187	1176	5363	4763
UC4	2855	4492	0	4492	3990
UC5	868	1071	0	1071	951
Total	**13267**	**15986**	**4216**	**20202**	**17943**

Table C.9 – 2020 low growth matrix development – Inter peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	1696	1703	509	2212	2088
UC2	658	665	200	864	816
UC3	5954	6210	1505	7715	7284
UC4	2919	3362	0	3362	3174
UC5	825	864	0	863	815
Total	**12052**	**12803**	**2214**	**15017**	**14177**

Table C.10 – 2035 low growth matrix development – Inter peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	1696	1764	539	2304	2046
UC2	658	689	212	901	800
UC3	5954	7239	1596	8835	7847
UC4	2919	4592	0	4592	4079
UC5	8245	1018	0	1018	904
Total	**12052**	**15303**	**2347**	**17650**	**15676**

Table C.11 – 2020 low growth matrix development – PM peak

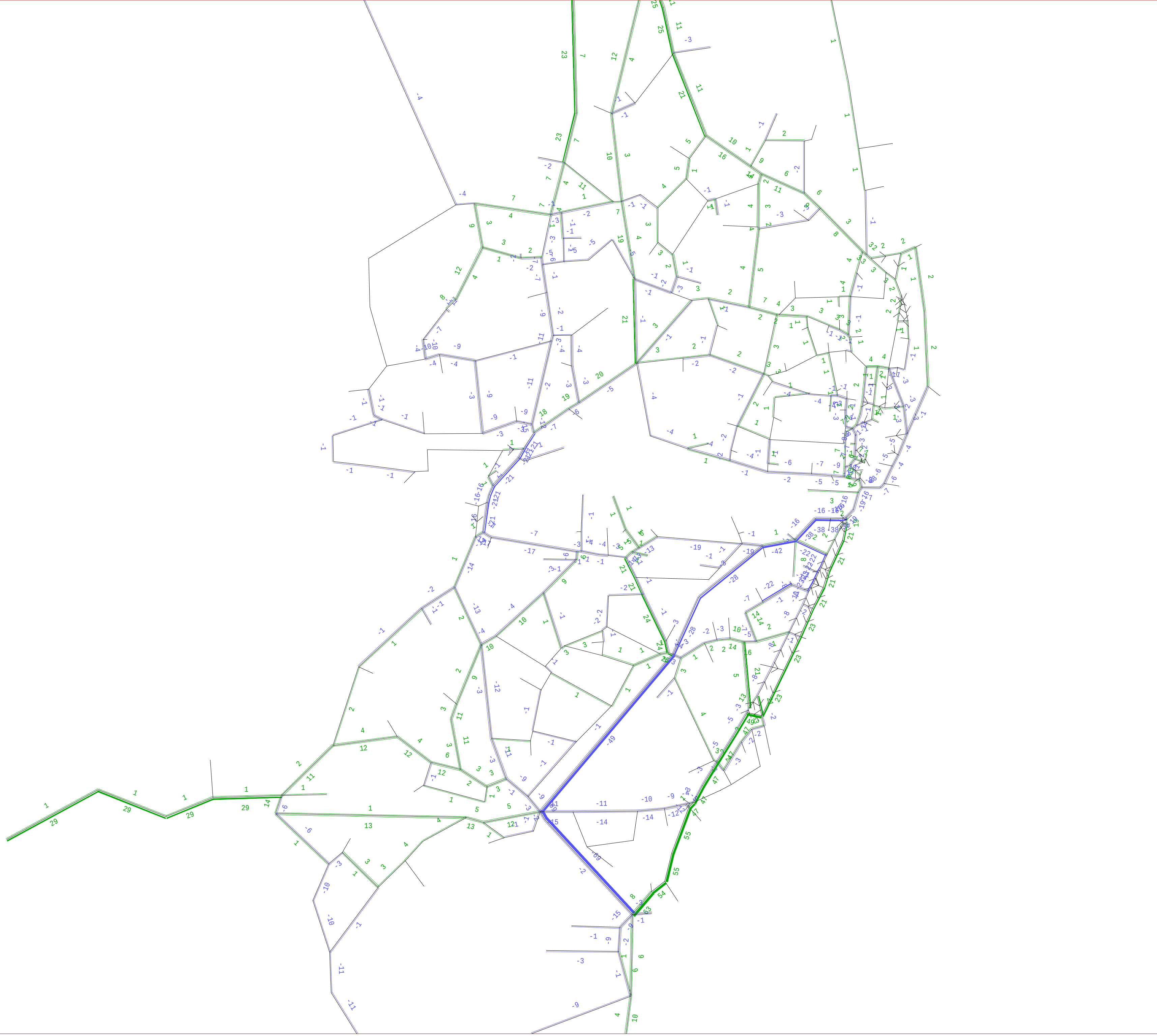
User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	3964	4035	1590	5567	5256
UC2	904	918	252	1159	1094
UC3	6141	6432	1814	8145	7690
UC4	3215	3703	0	3703	3496
UC5	456	477	0	477	451
Total	**14680**	**15565**	**3656**	**19052**	**1798**

Table C.12 – 2035 low growth matrix development – PM peak

User Class	Base Year Matrix	Background Growth	Development Trips	Core Scenario Matrix	Final Matrix
UC1	3964	4086	1661	5747	5105
UC2	904	929	264	1193	1059
UC3	6141	7135	1895	9031	8021
UC4	3215	5058	0	5058	4492
UC5	456	563	0	563	500
Total	**14680**	**17772**	**3820**	**21592**	**19178**

Appendix D

PRE & POST-DIADEM FLOW DIFFERENCE



SATURN

Atkins Ltd /
DVV / ITS

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Scale 25919

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Differ: 1-2

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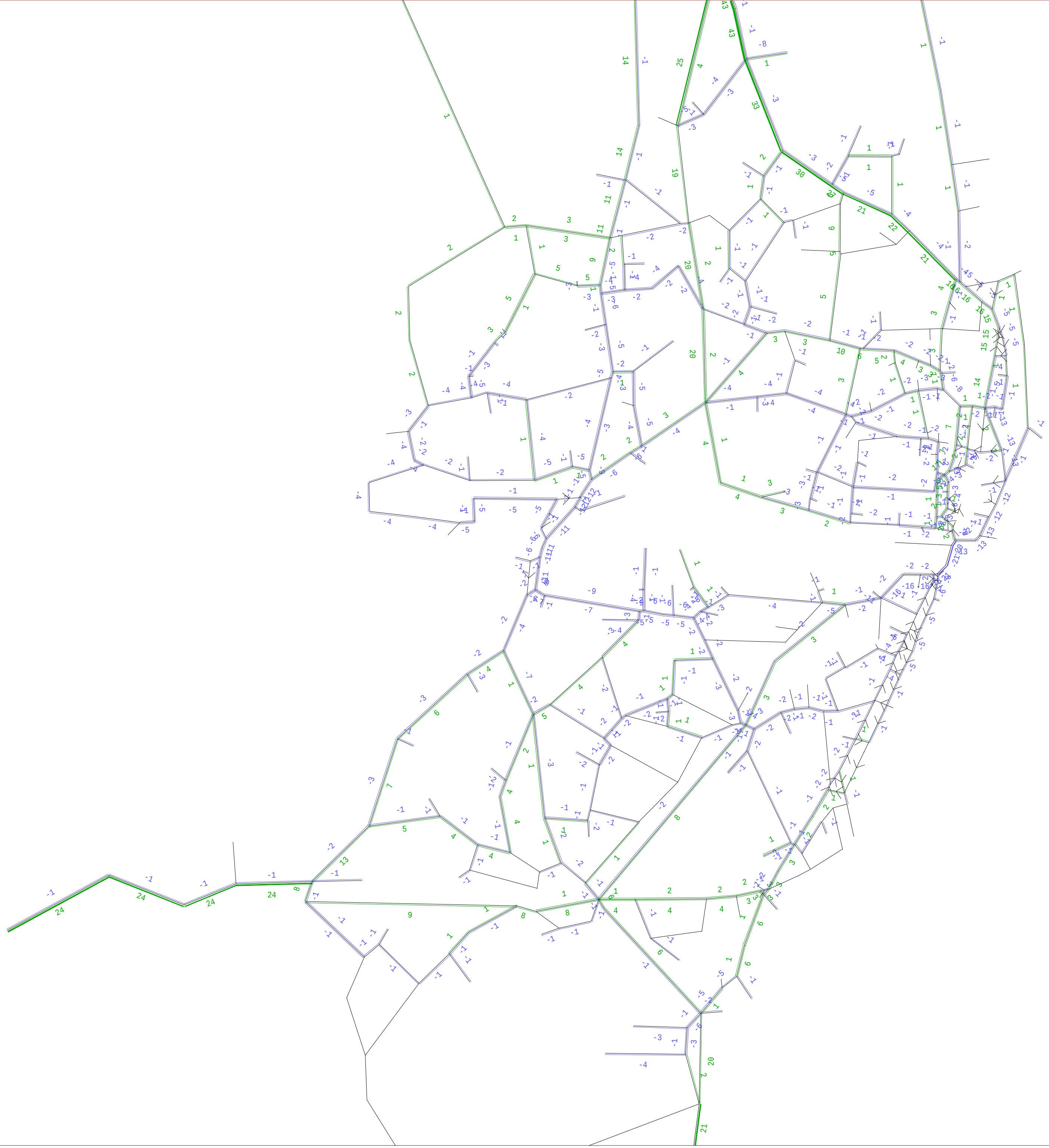

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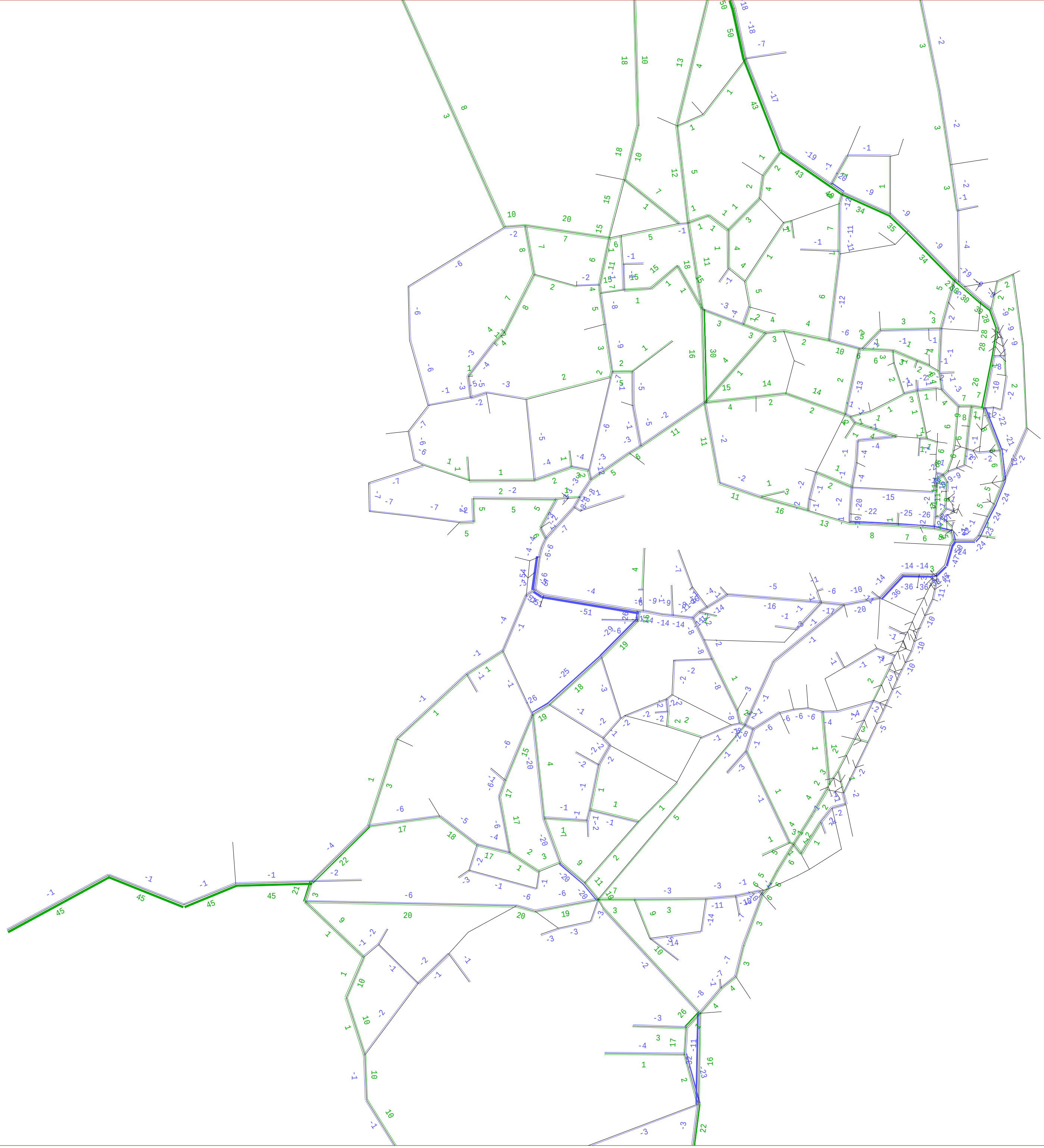

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DVV / ITS

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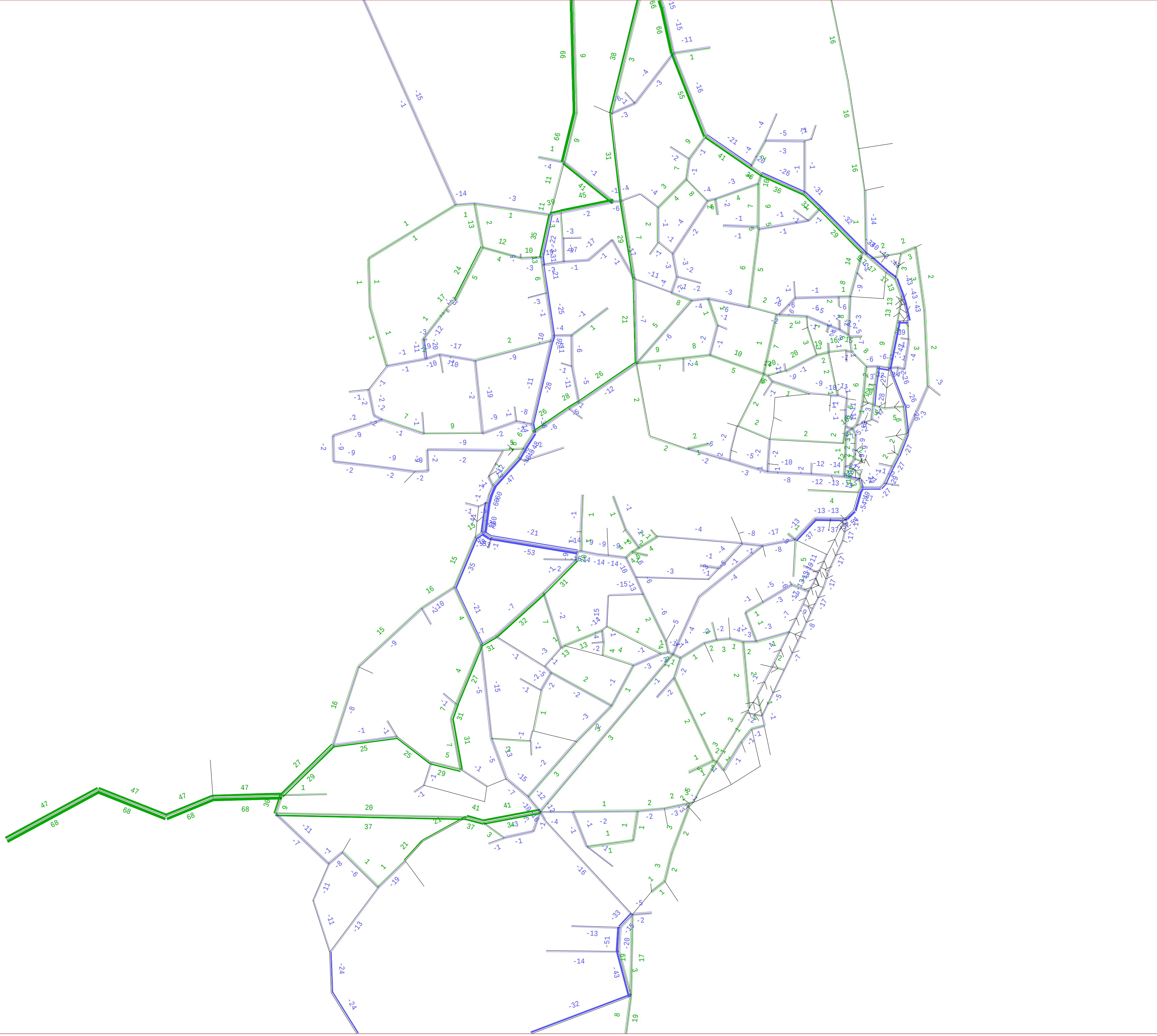

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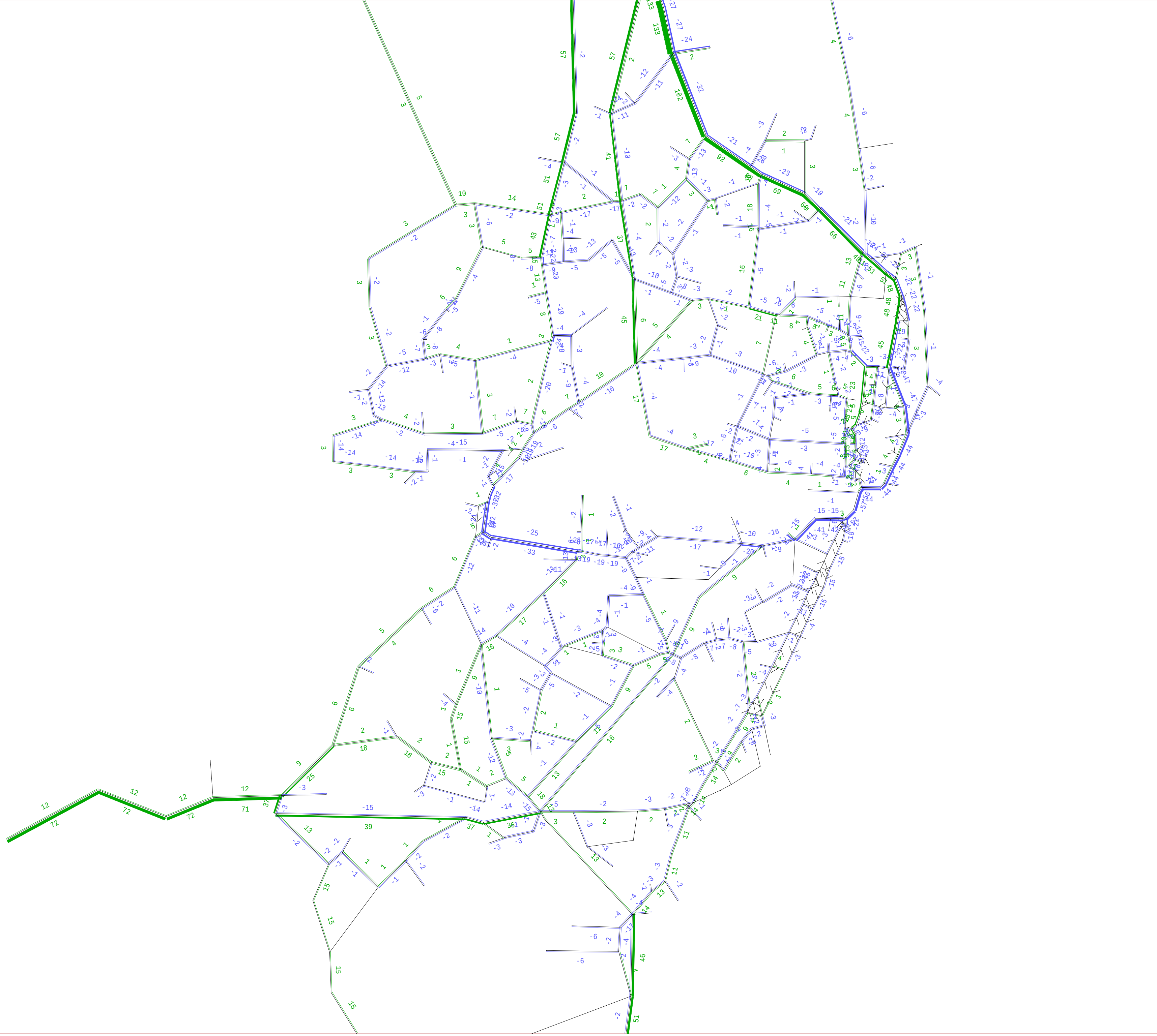

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Atkins Ltd /
DVV / ITS

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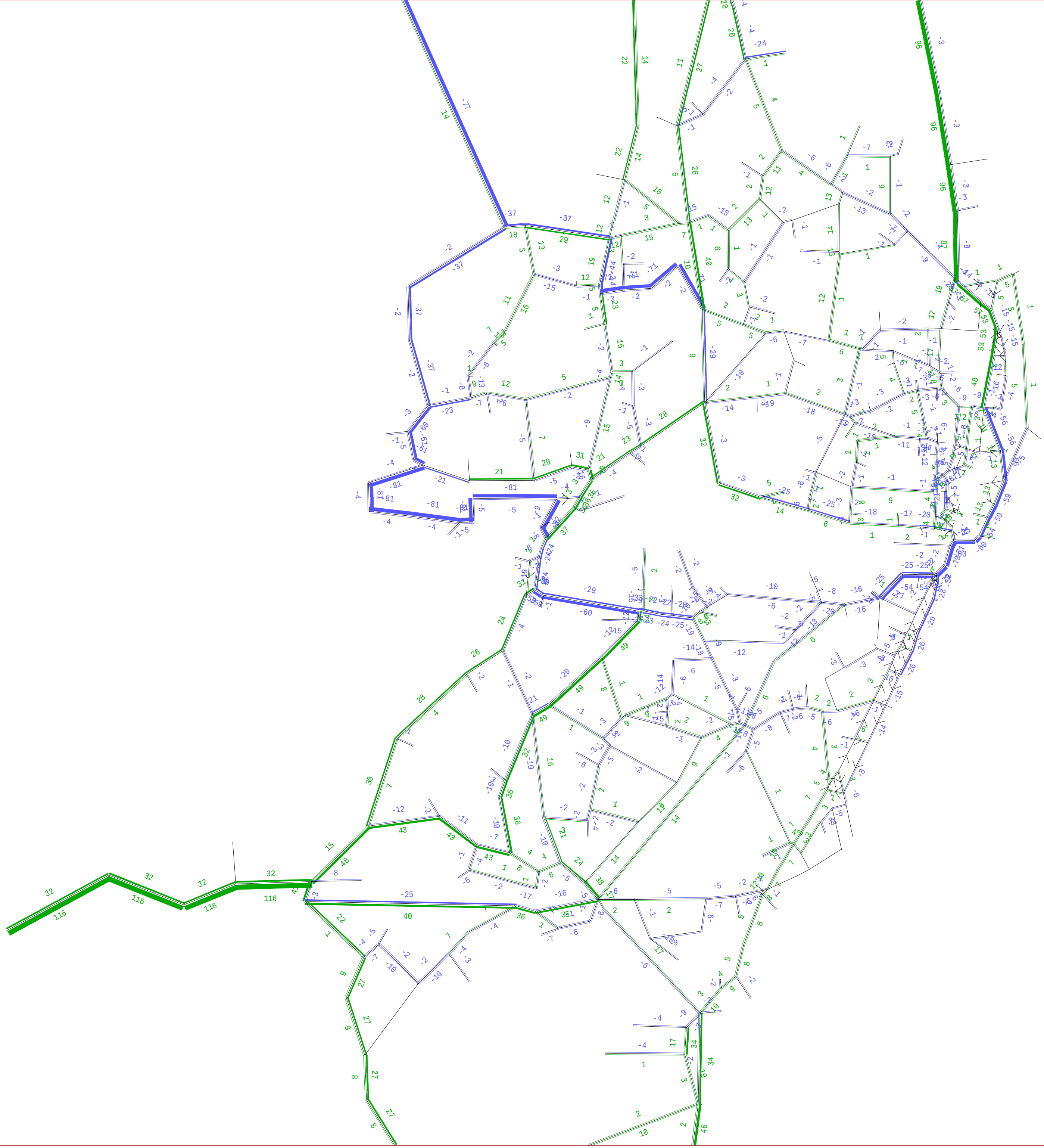

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DVV / ITS

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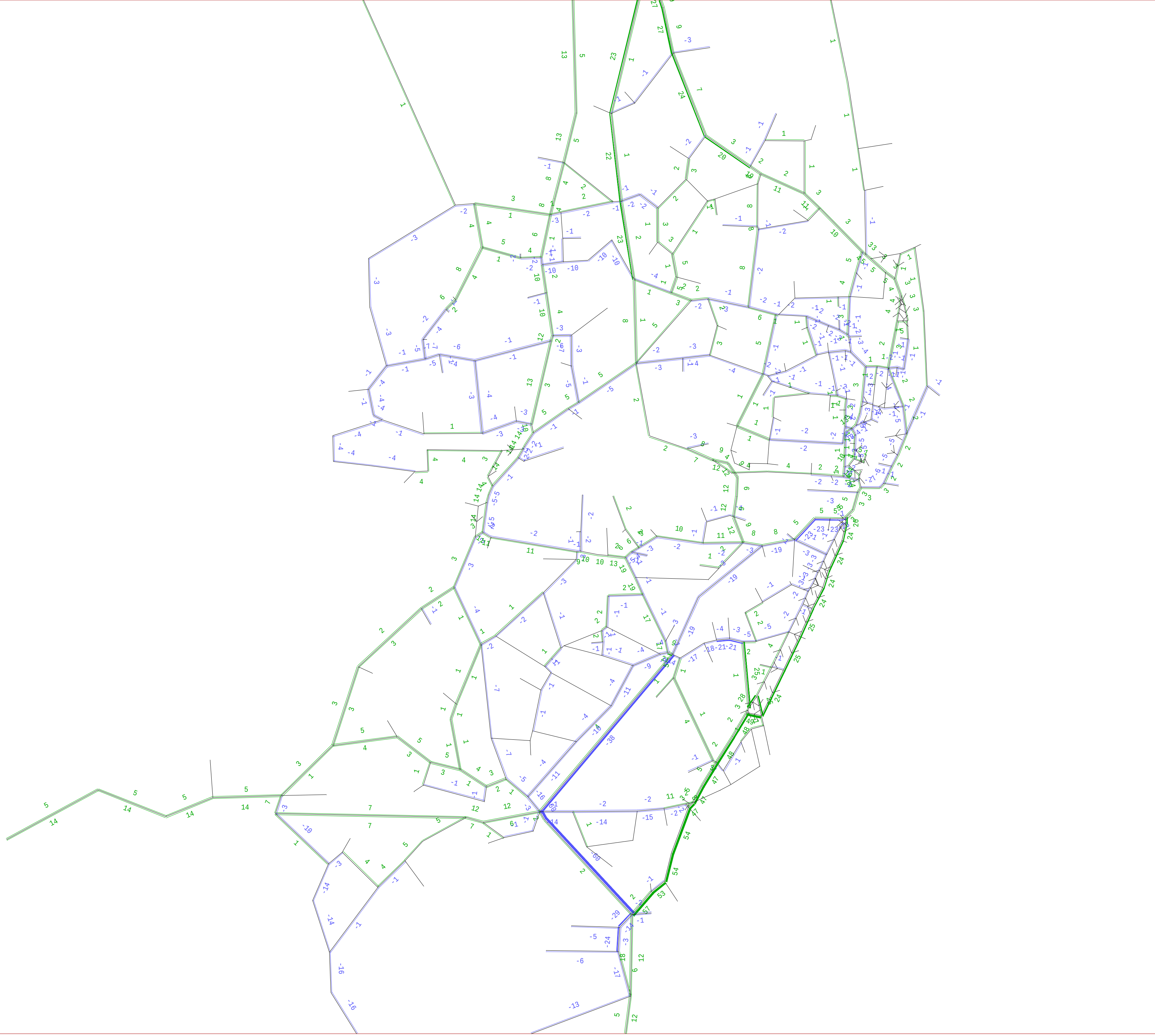

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DVV / ITS

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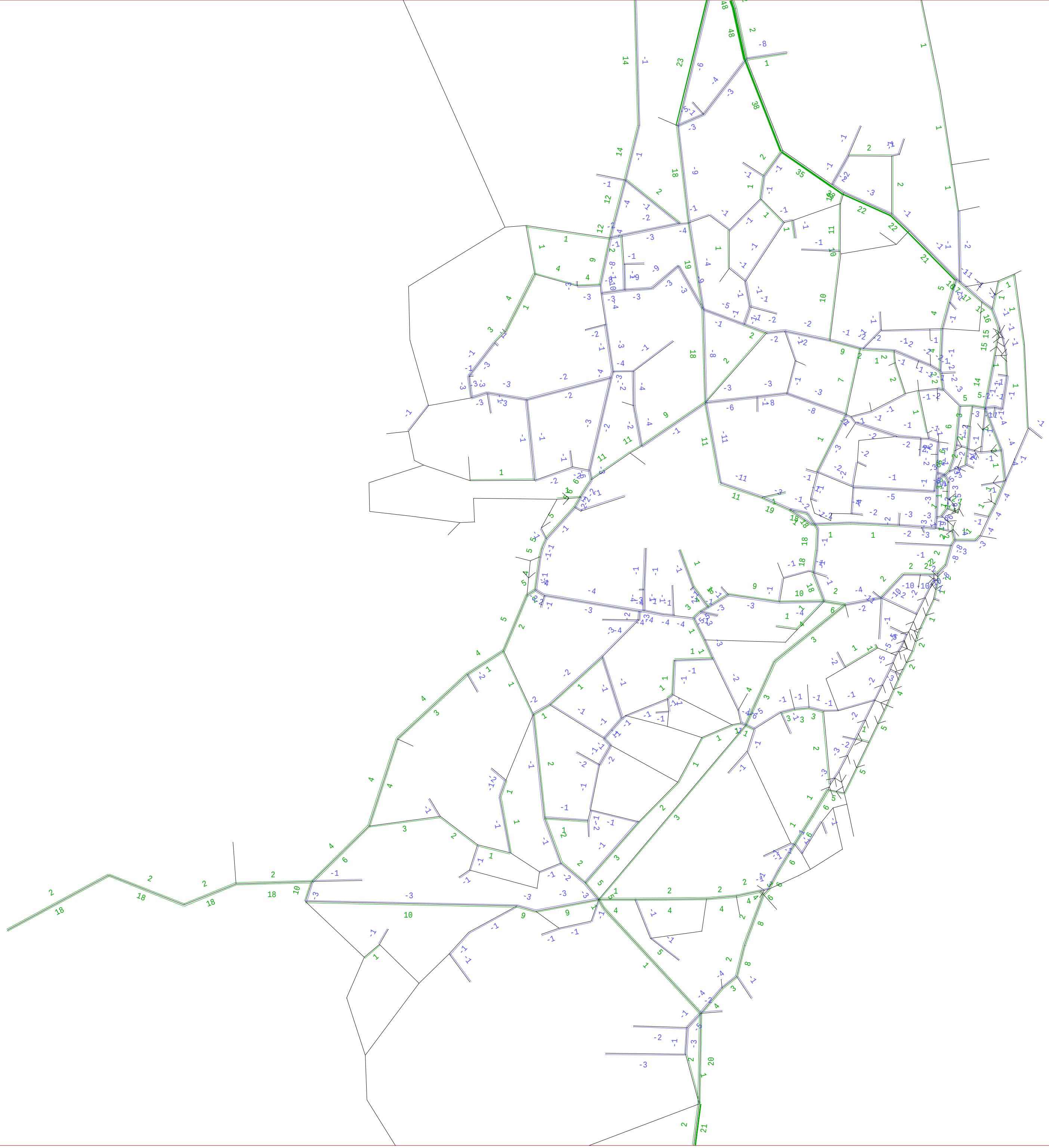

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DVV / ITS

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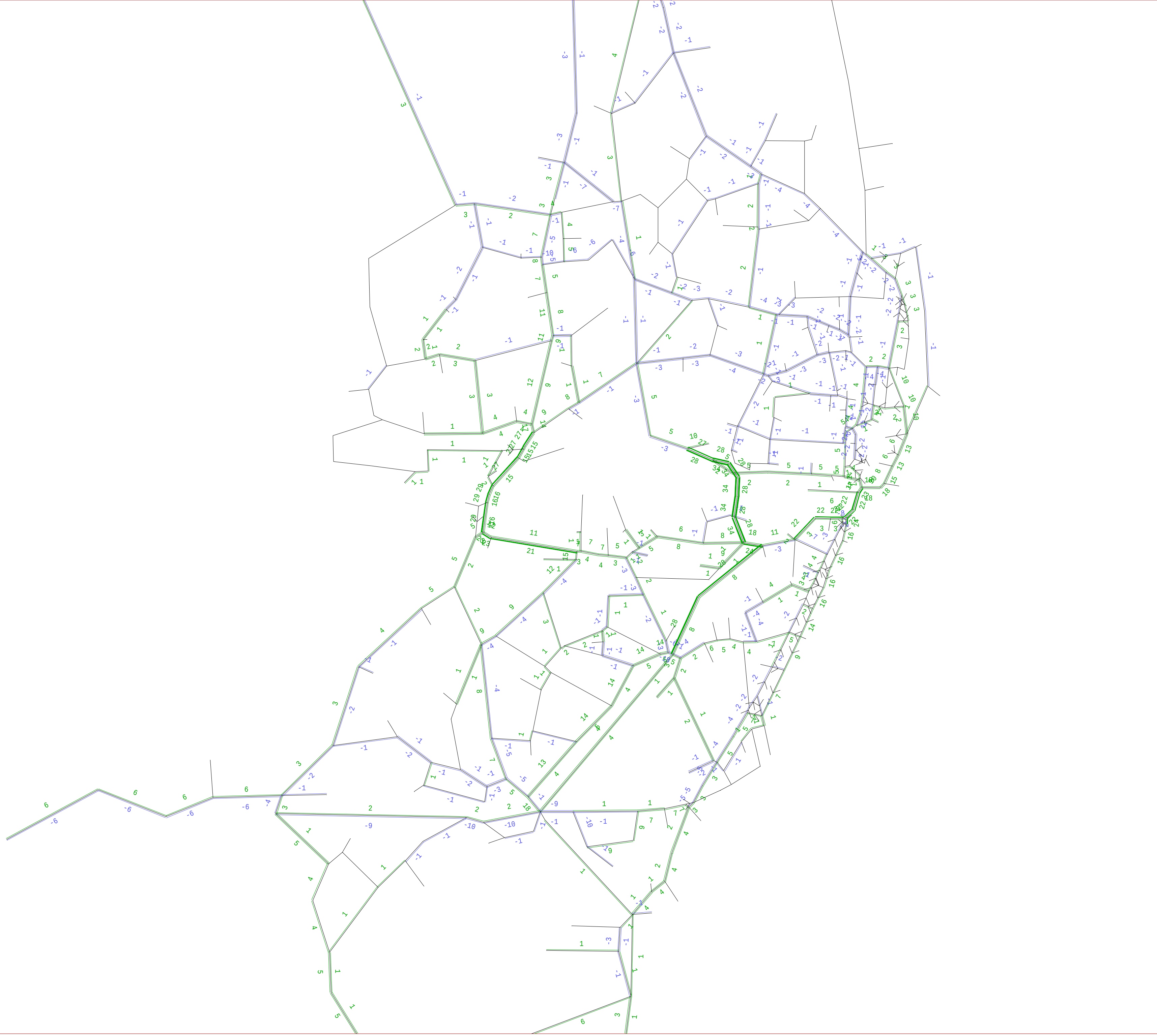

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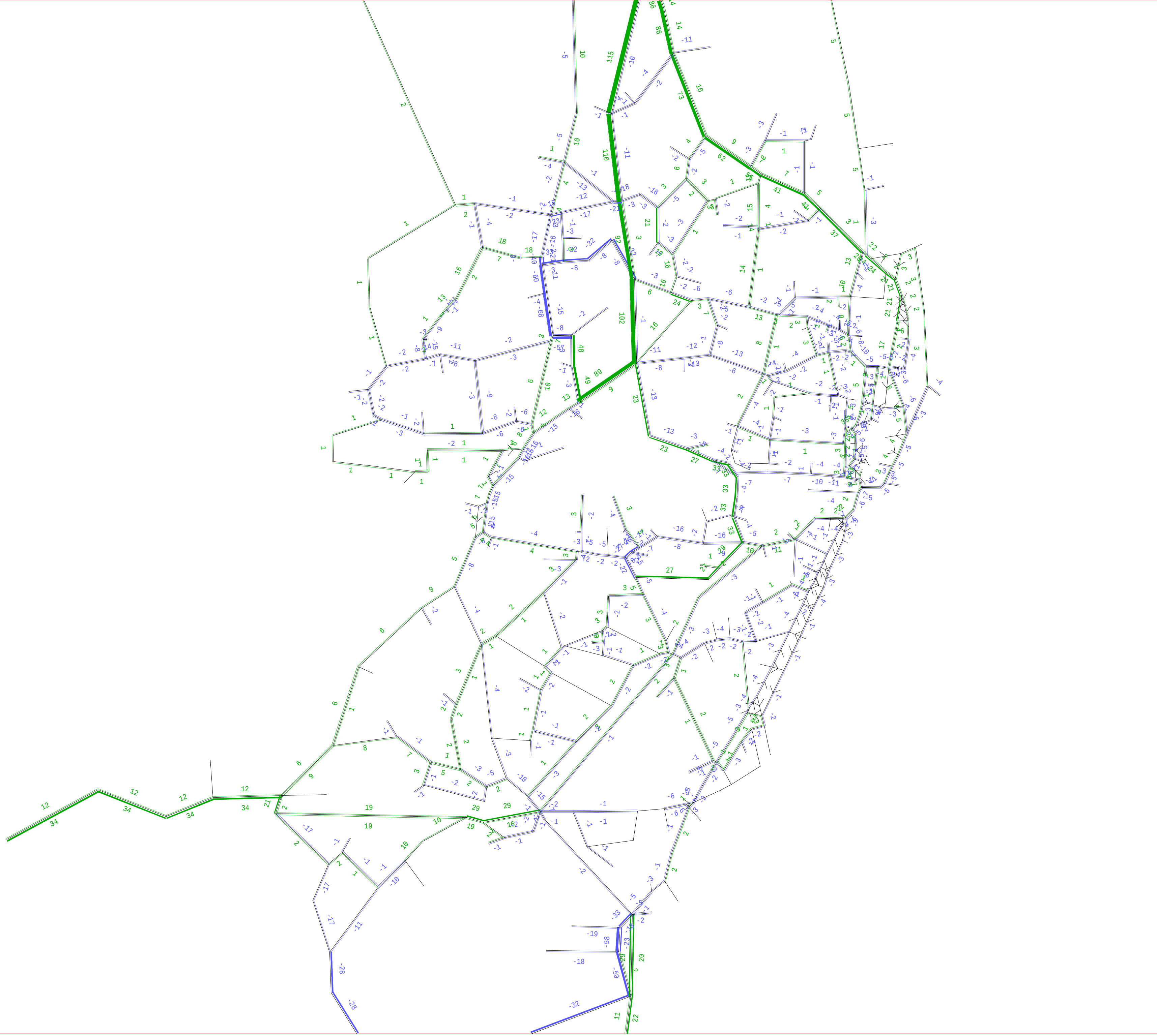

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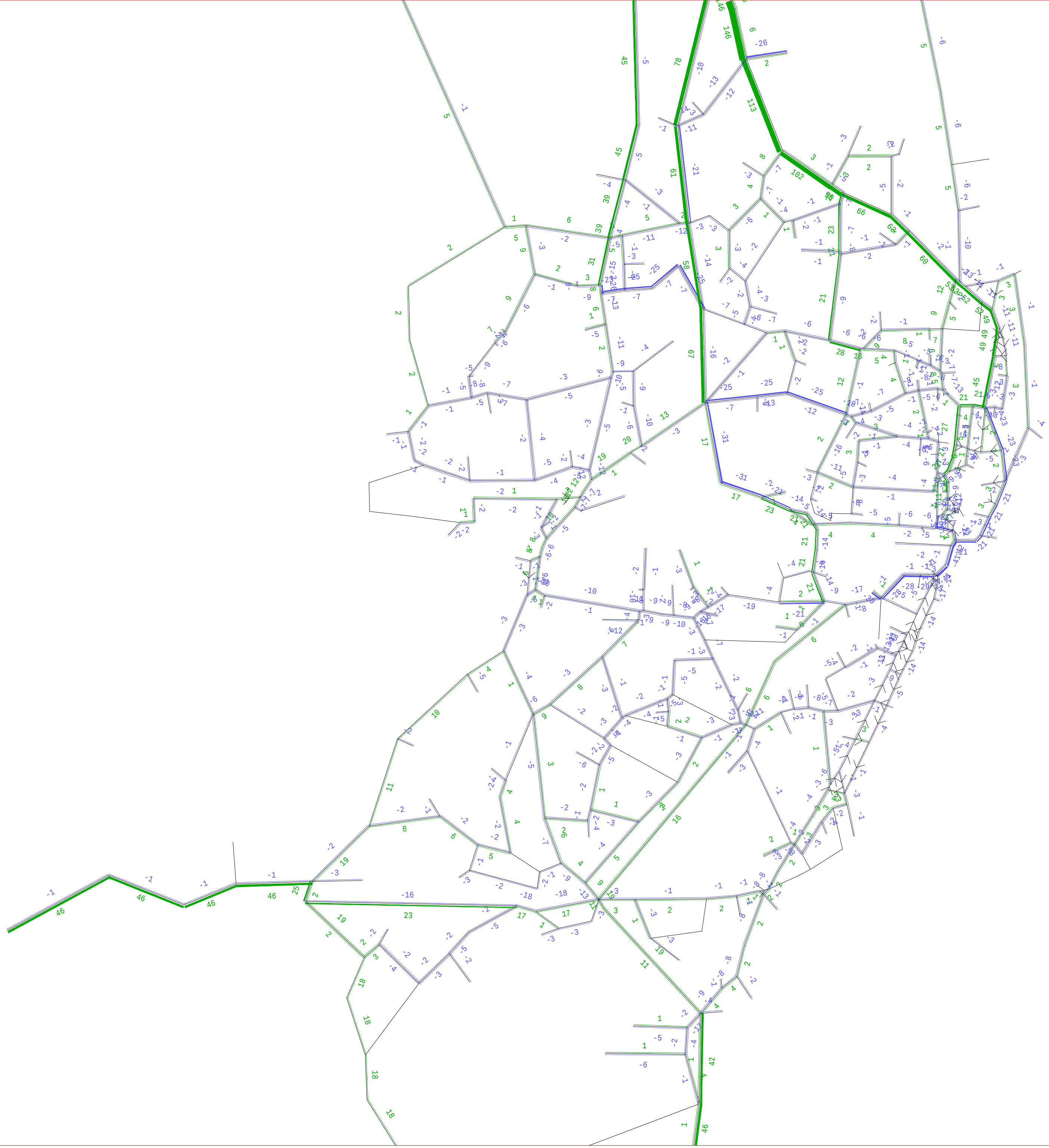

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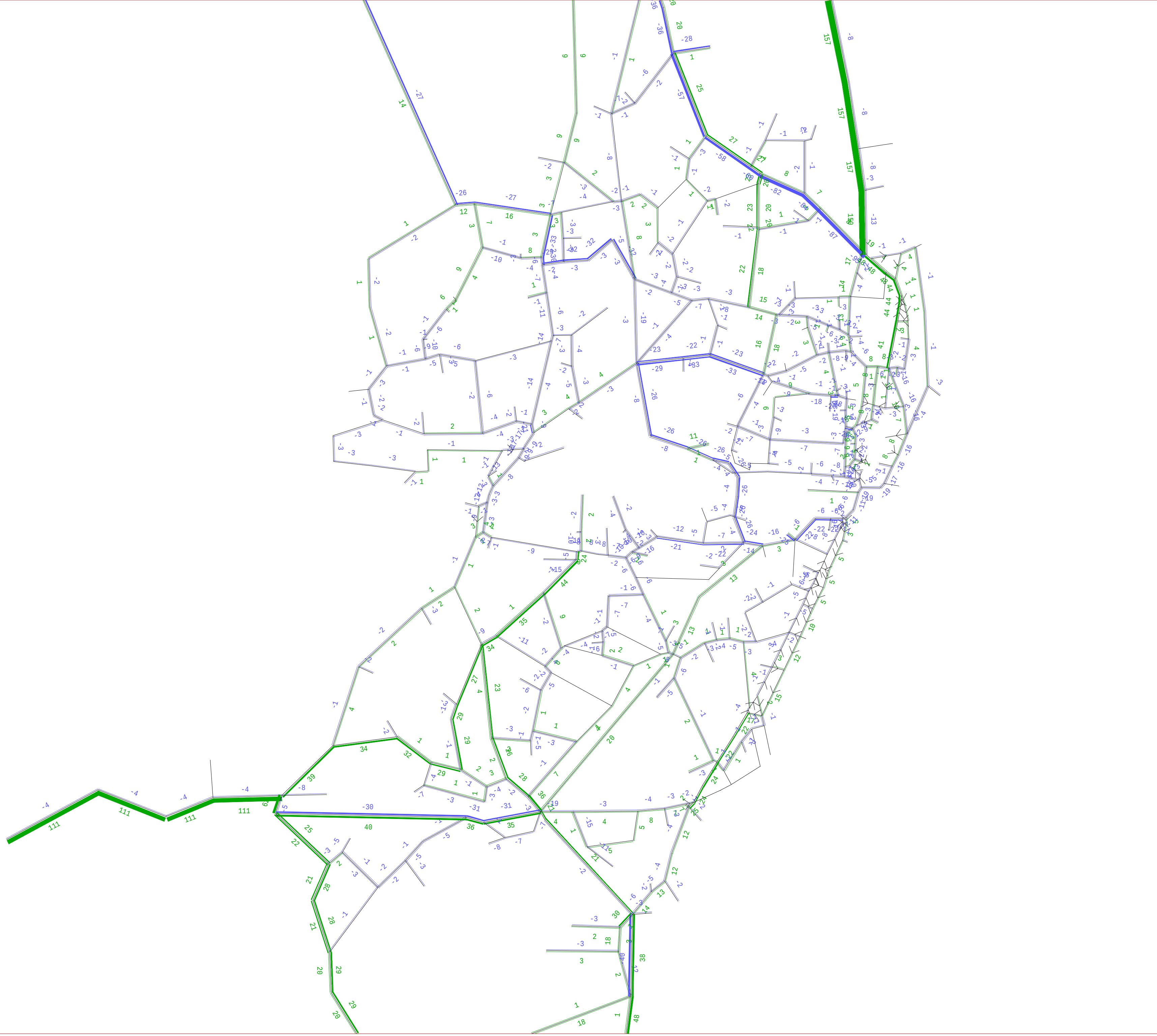

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DVV / ITS

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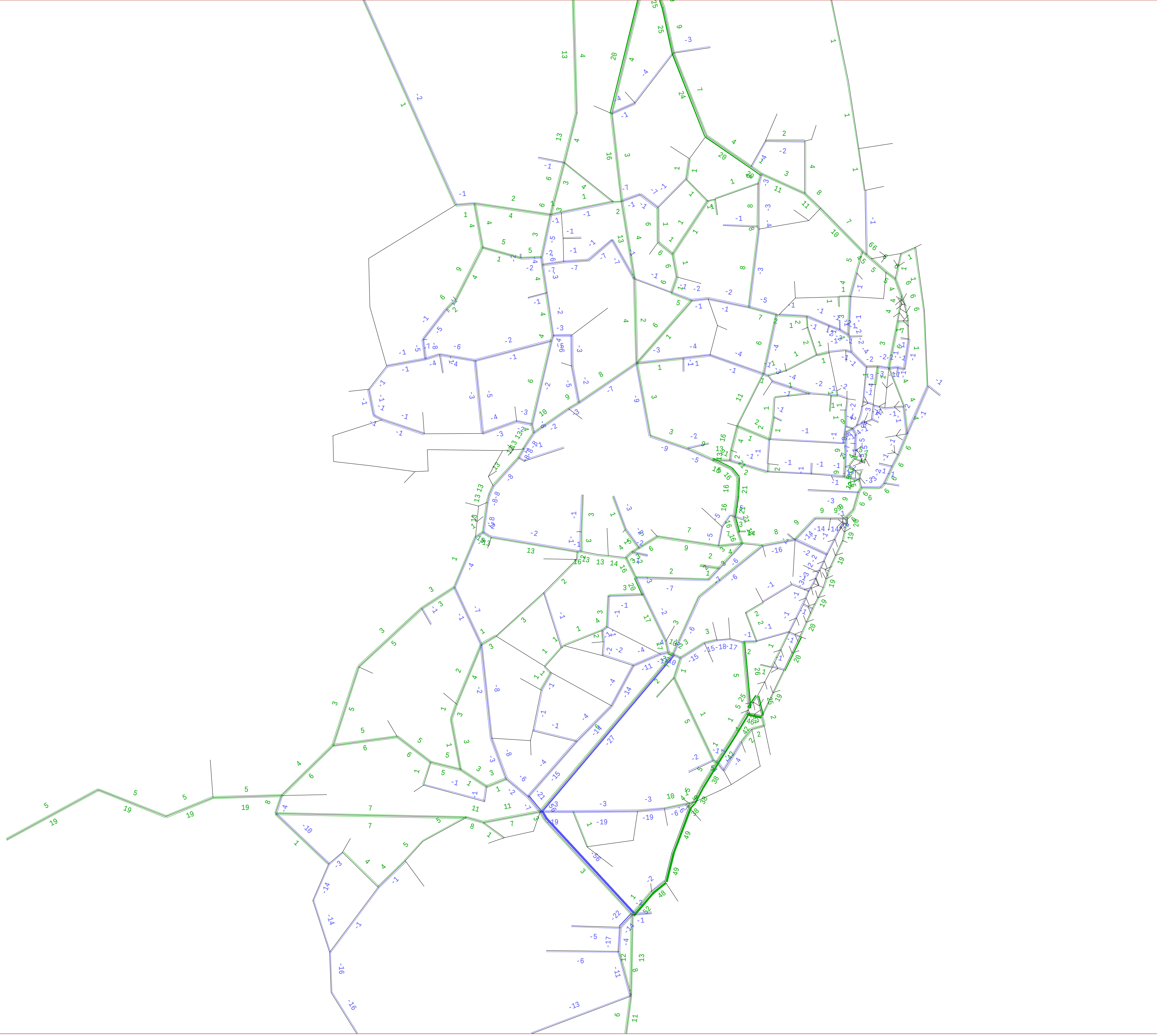

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Atkins Ltd /
DVV / ITS

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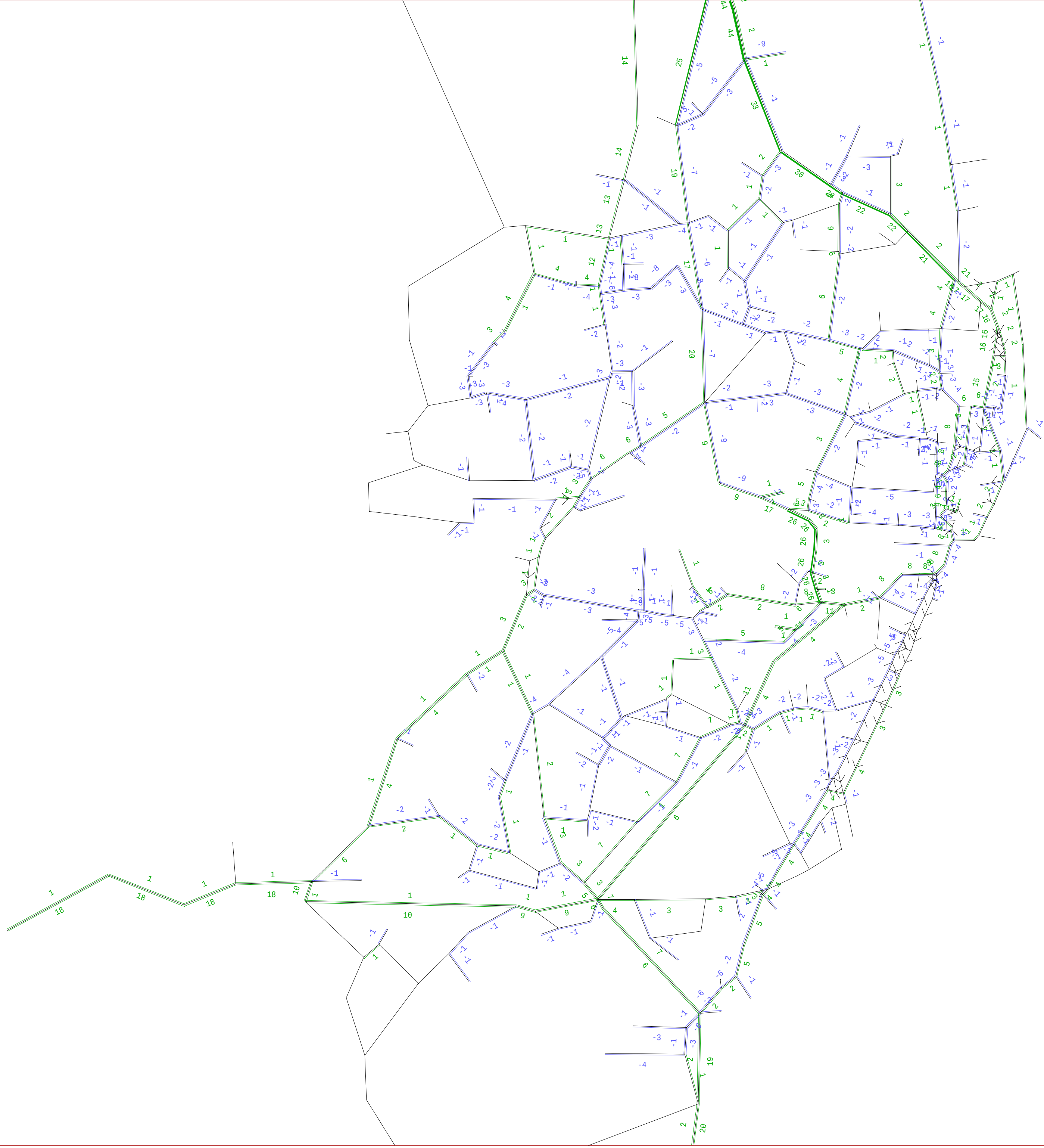

SATURN

Atkins Ltd /
DVV / ITS

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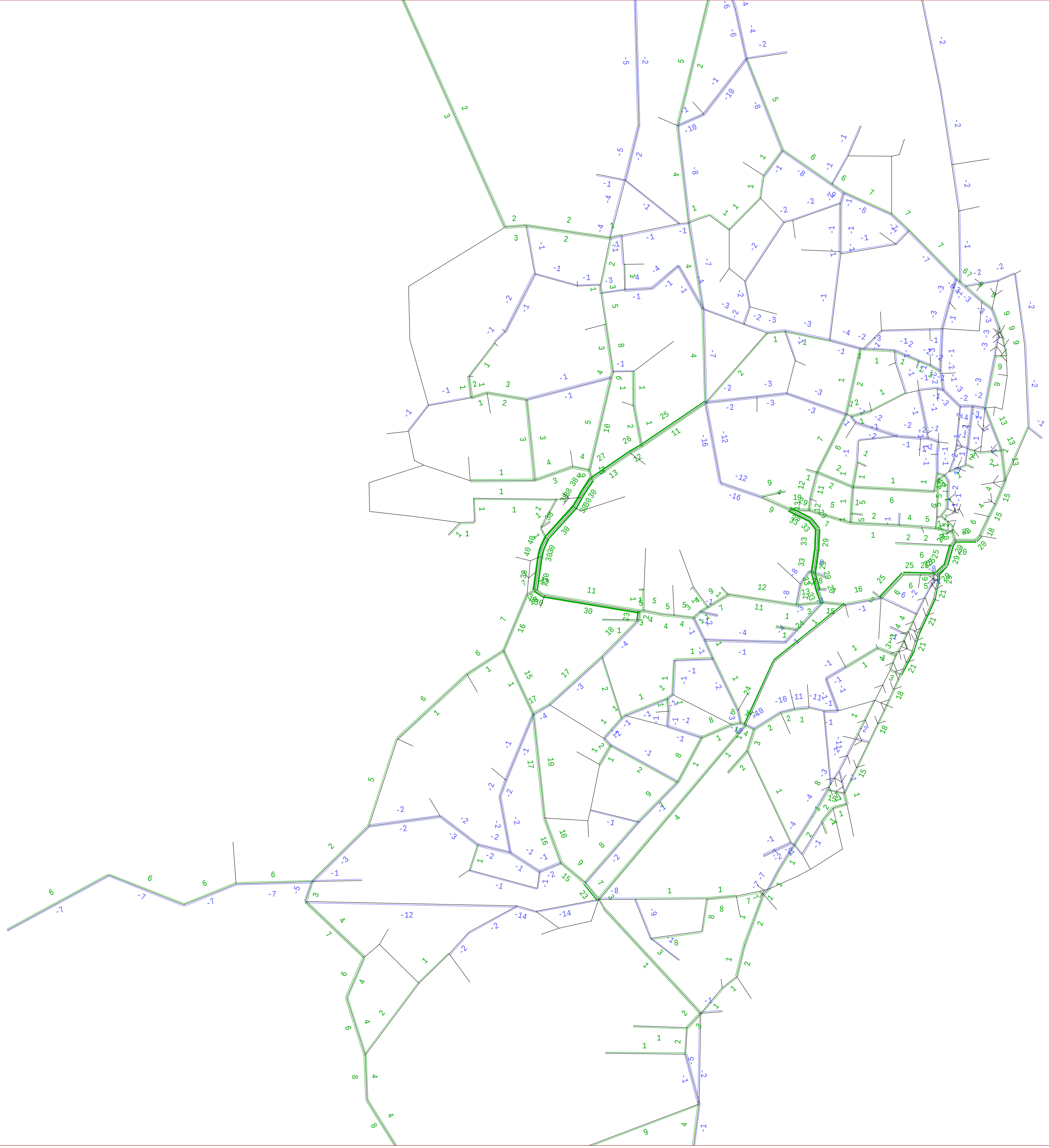

SATURN

Atkins Ltd /
DVV / ITS

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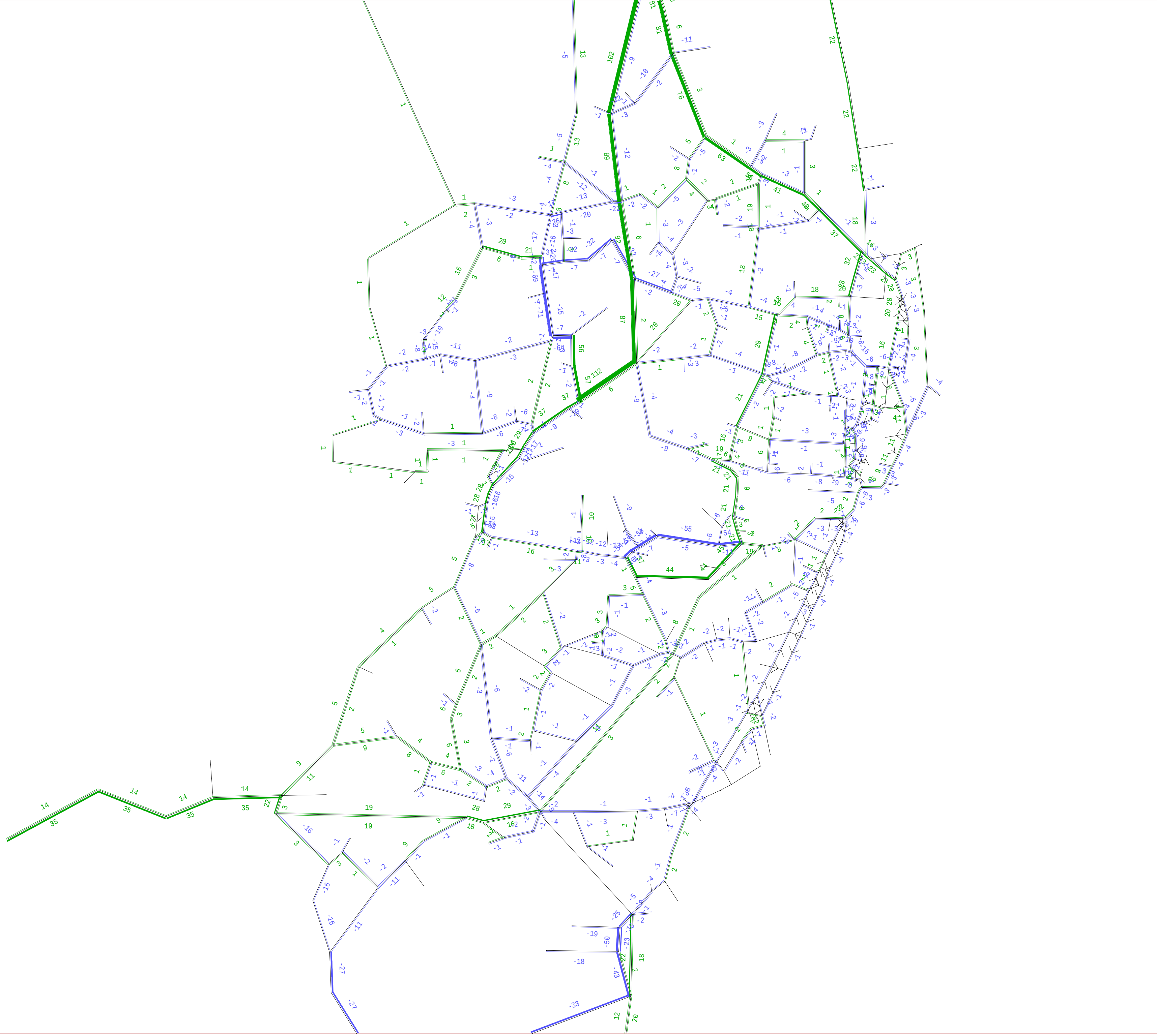

SATURN

Atkins Ltd /
DVV / ITS

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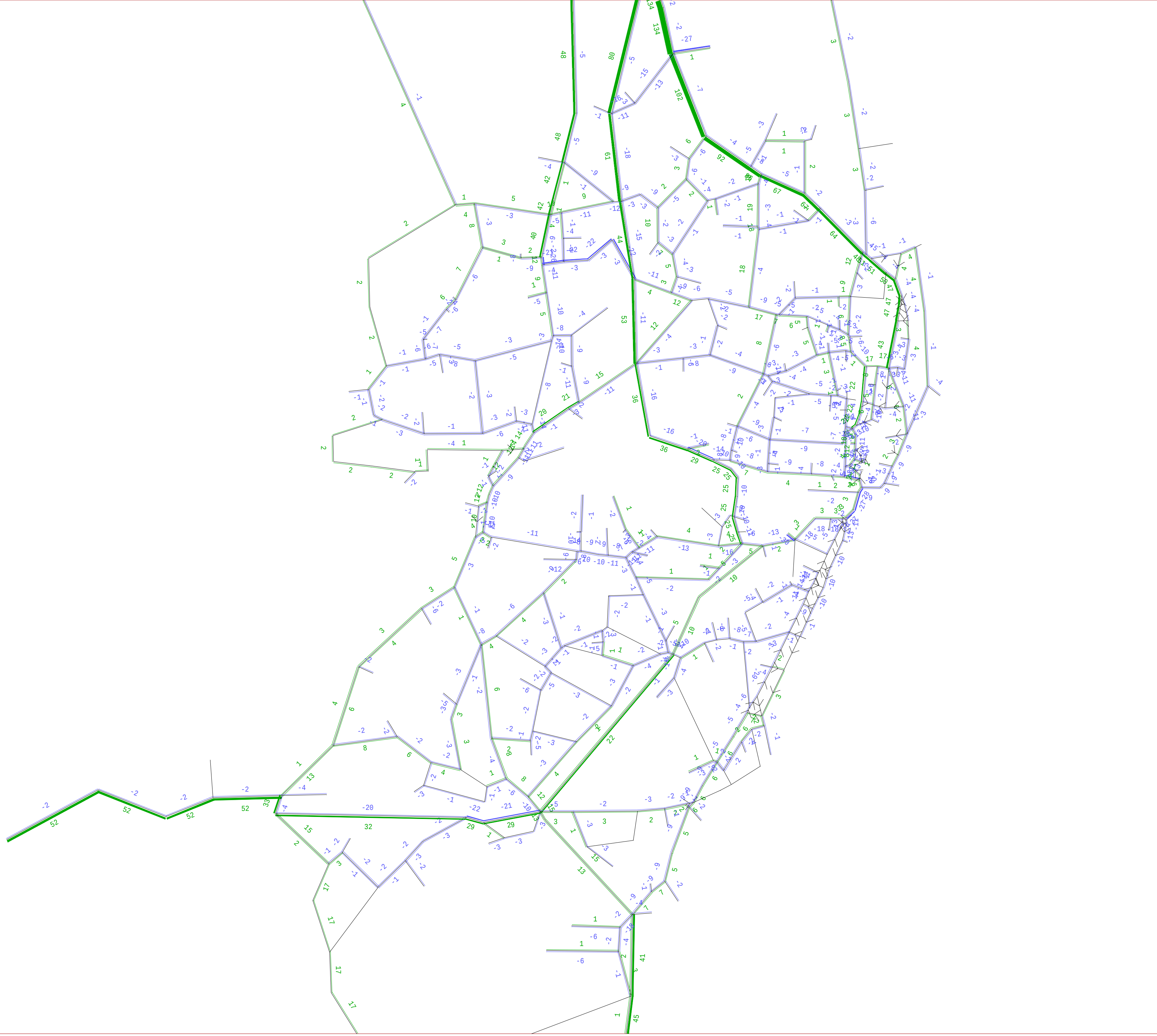

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Atkins Ltd /
DVV / ITS

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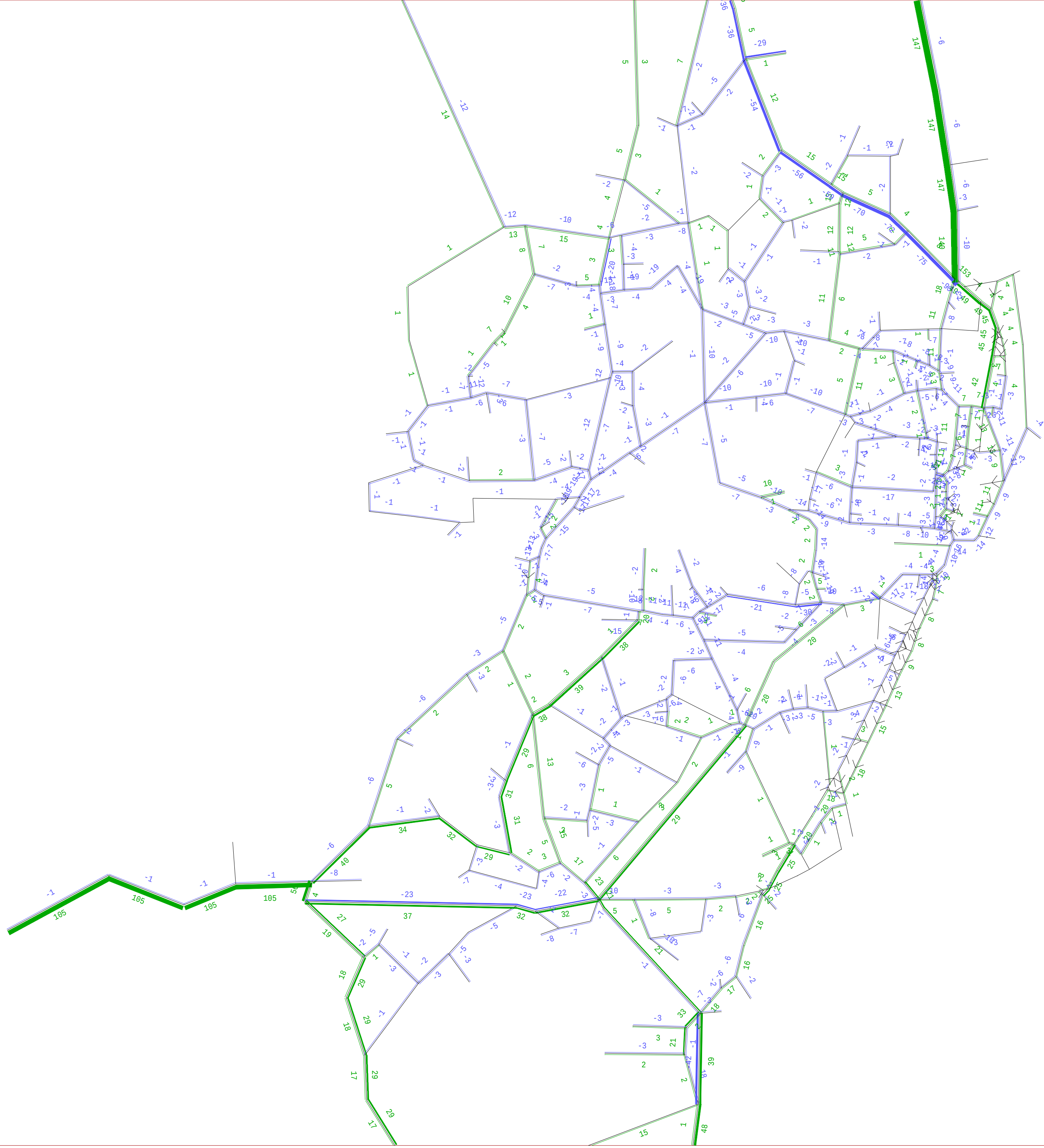

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Atkins Ltd /
DVV / ITS

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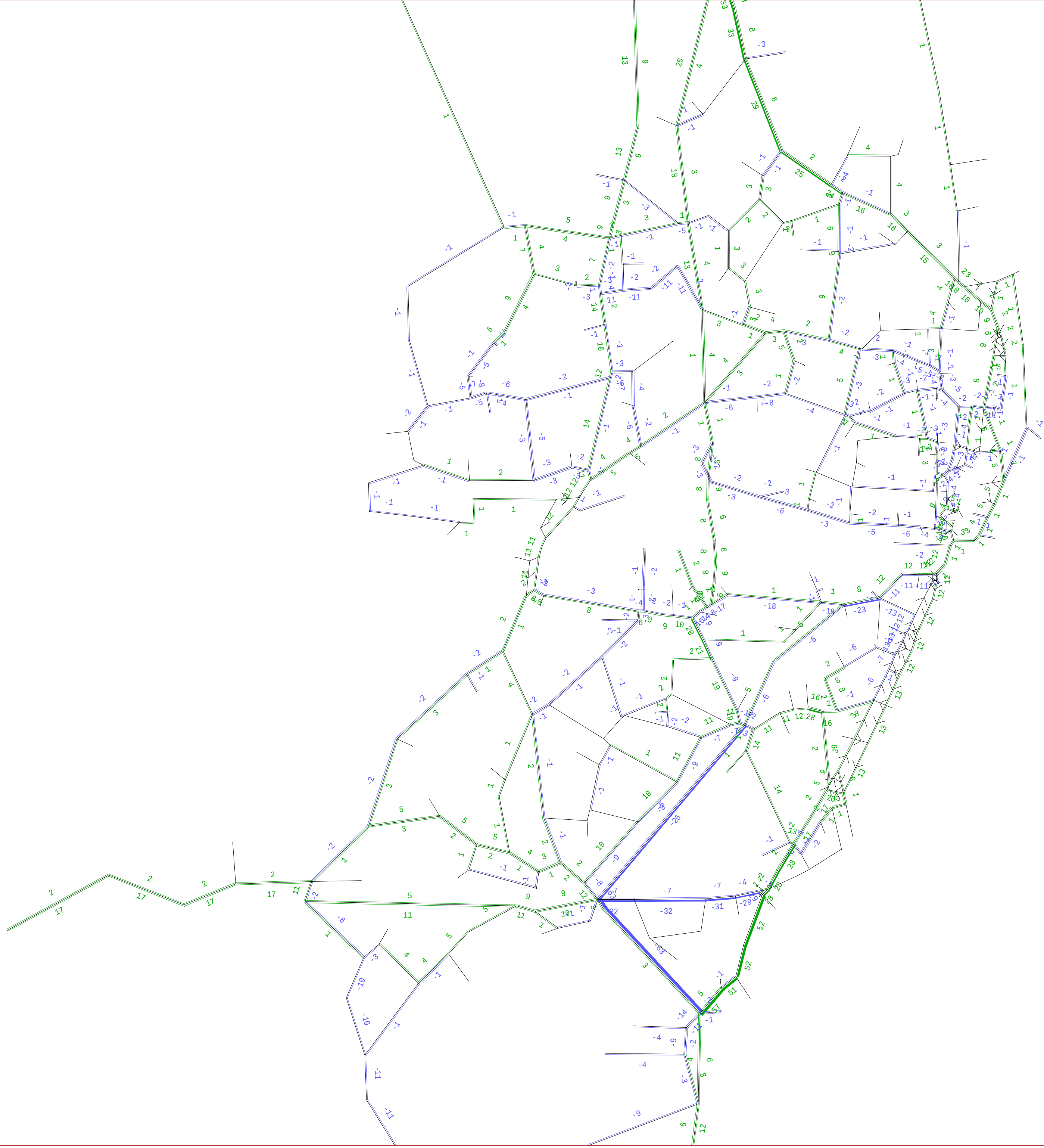

SATURN

Atkins Ltd /
DVV / ITS

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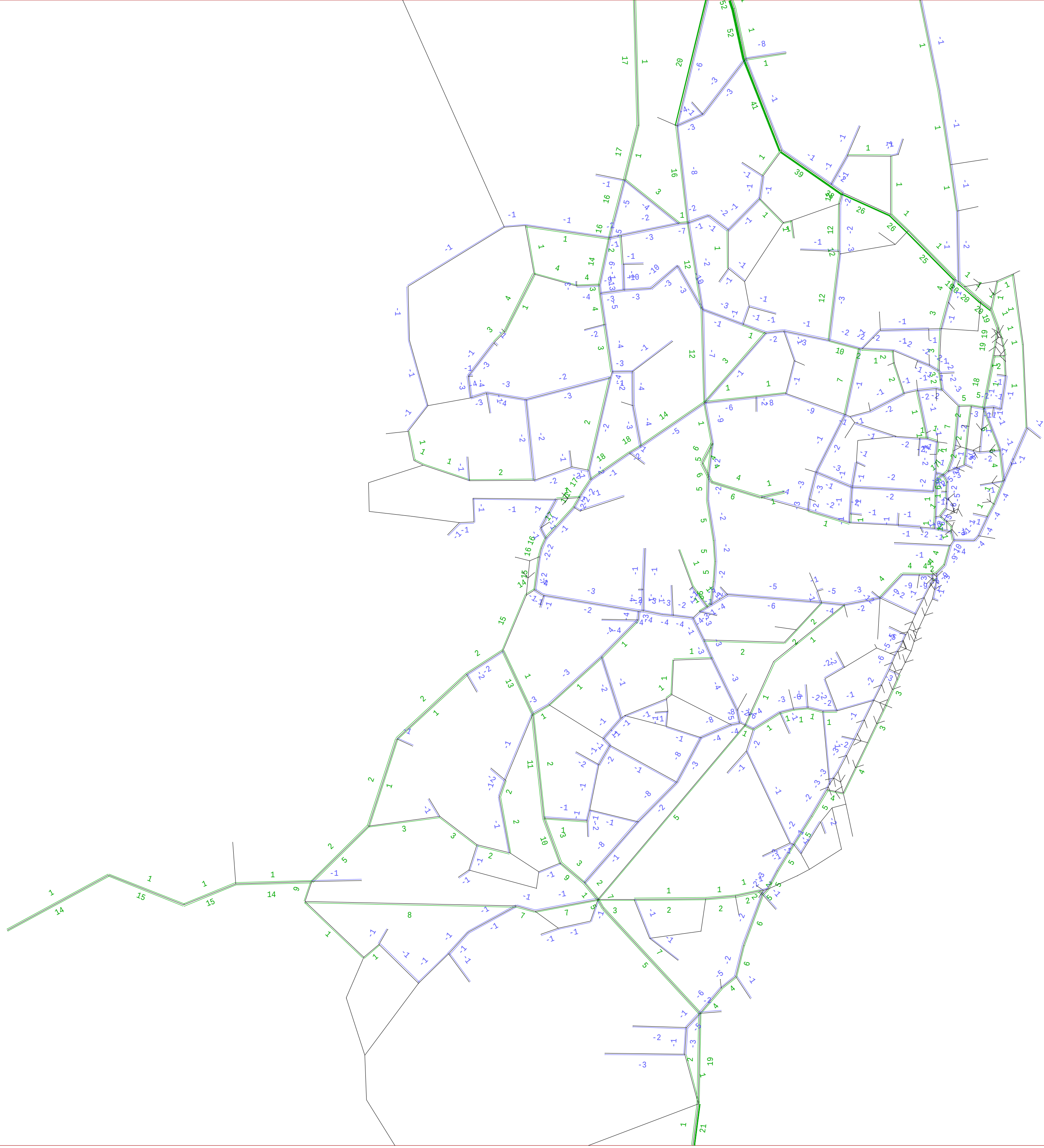
WSP GROUP (S

LTM AM 2020 DS T3 9-12-15



SATURN

Atkins Ltd /
DVV / ITS

17_unconstra
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Differ: 1-2

Bandwidths =
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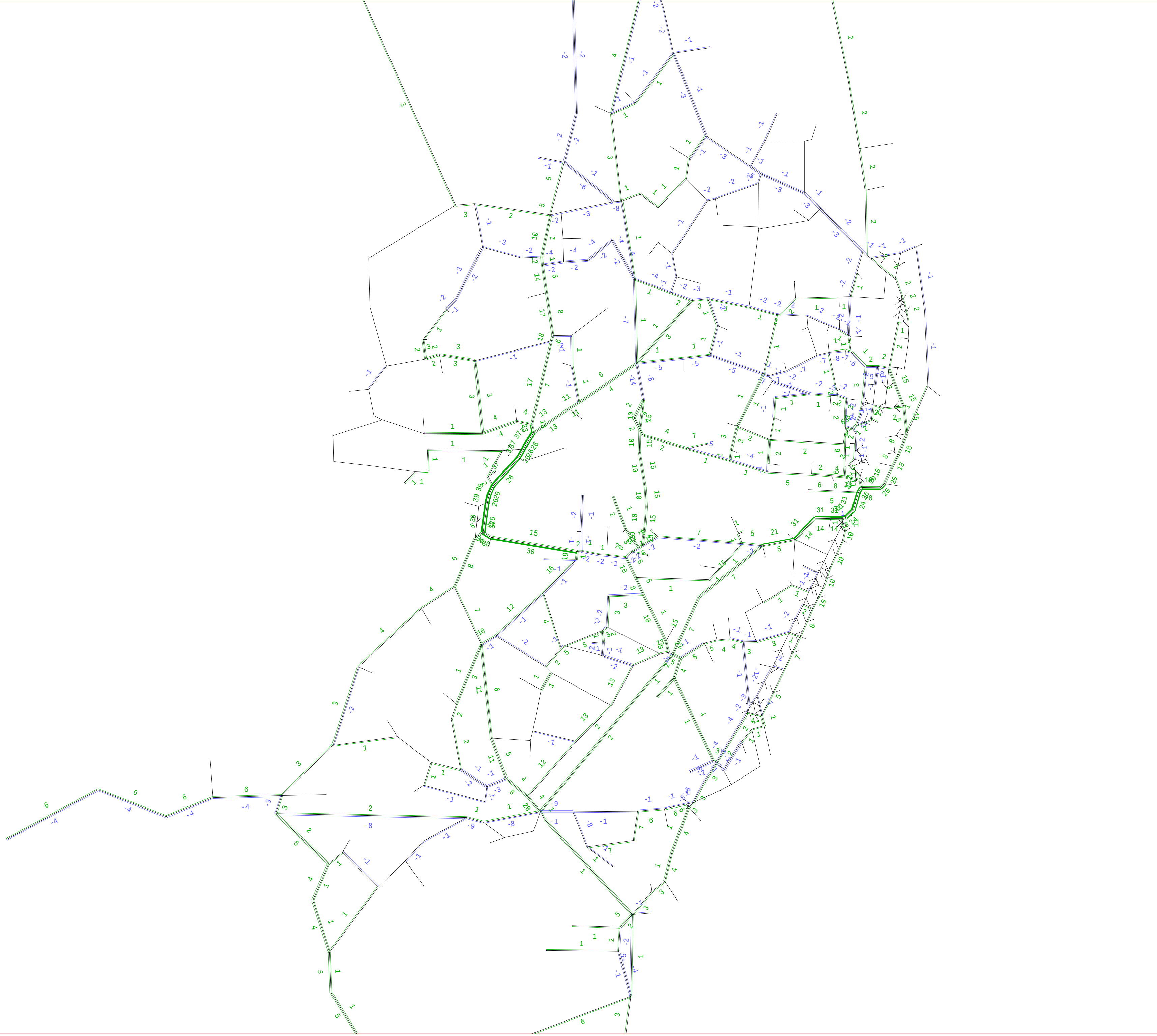
9-12-15
WSP GROUP (S



SATURN

Atkins Ltd /
DVV / ITS

17_unconstra
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Differ: 1-2

Bandwidths =
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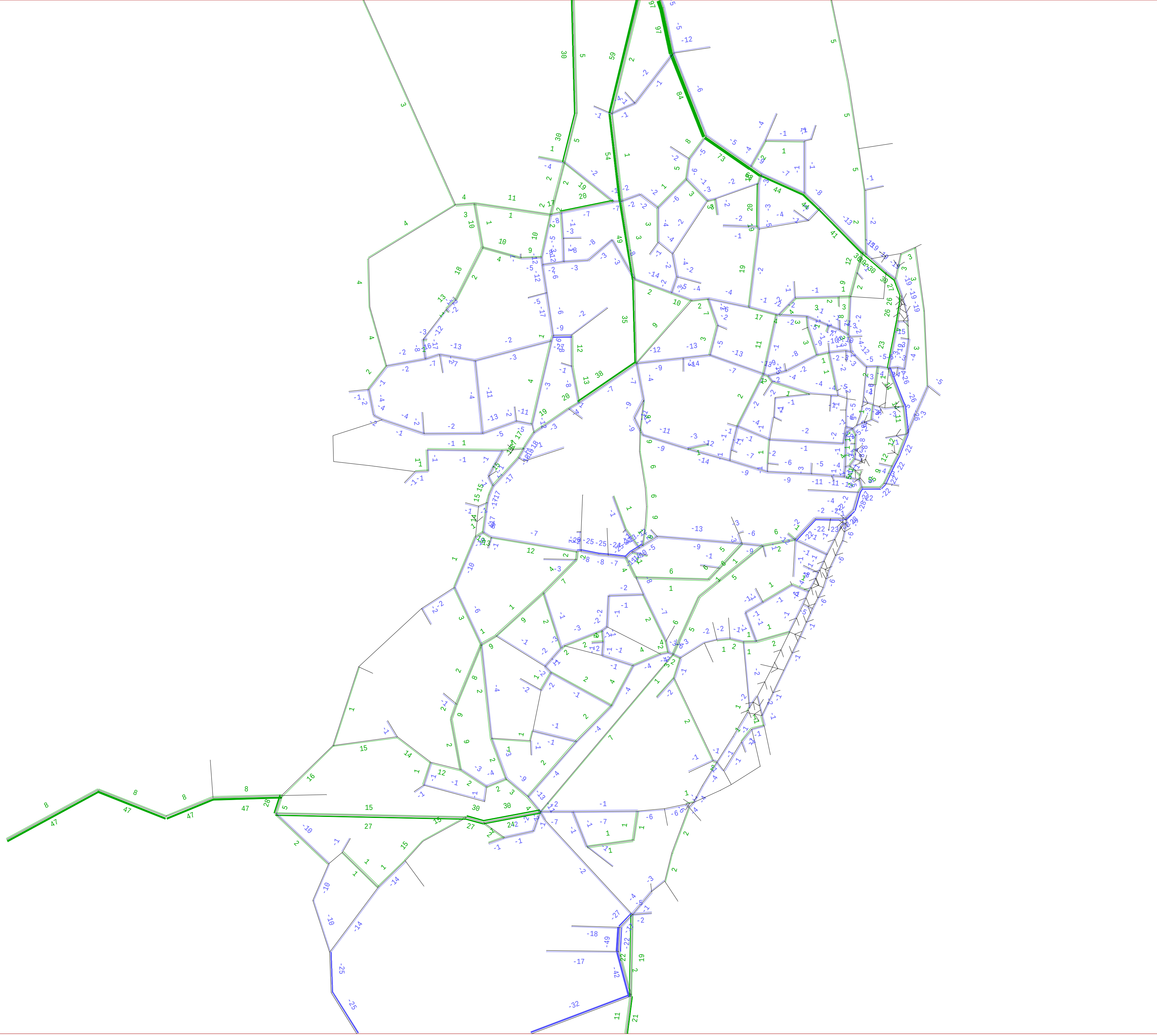
WSP GROUP (S



SATURN

Atkins Ltd /
DVV / ITS

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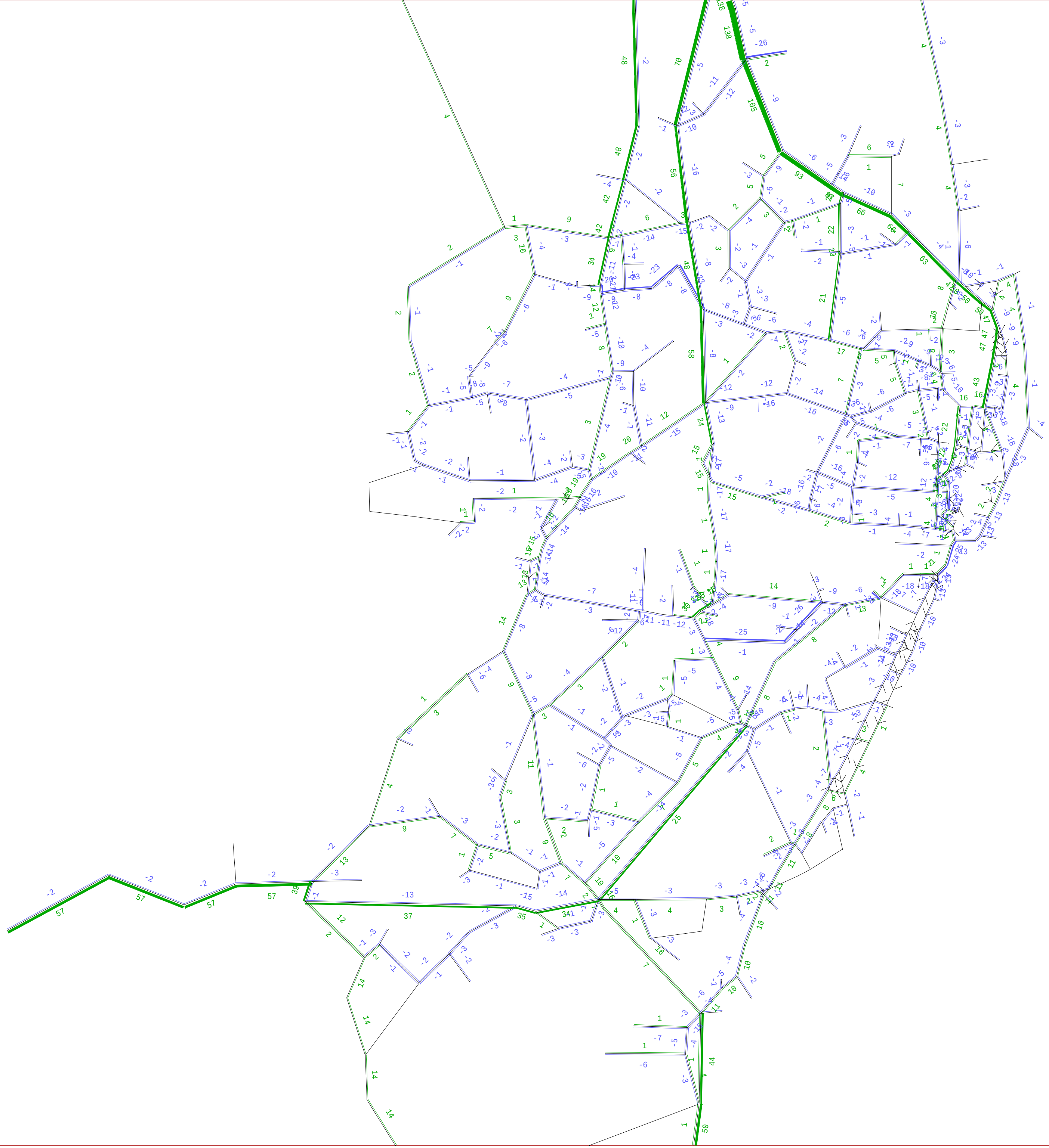

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DVV / ITS

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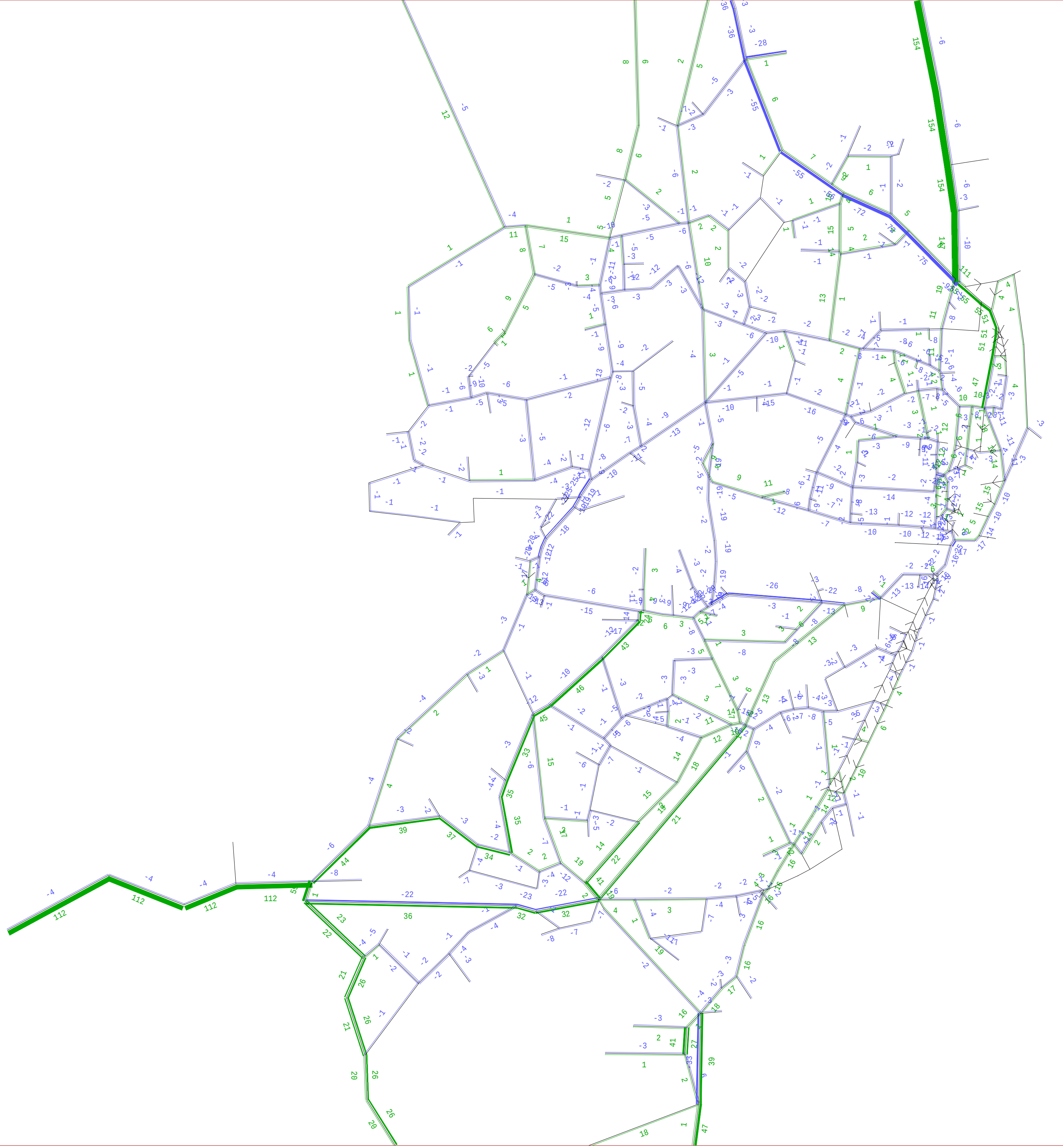

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DVV / ITS

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Scale 25919

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Bandwidths =
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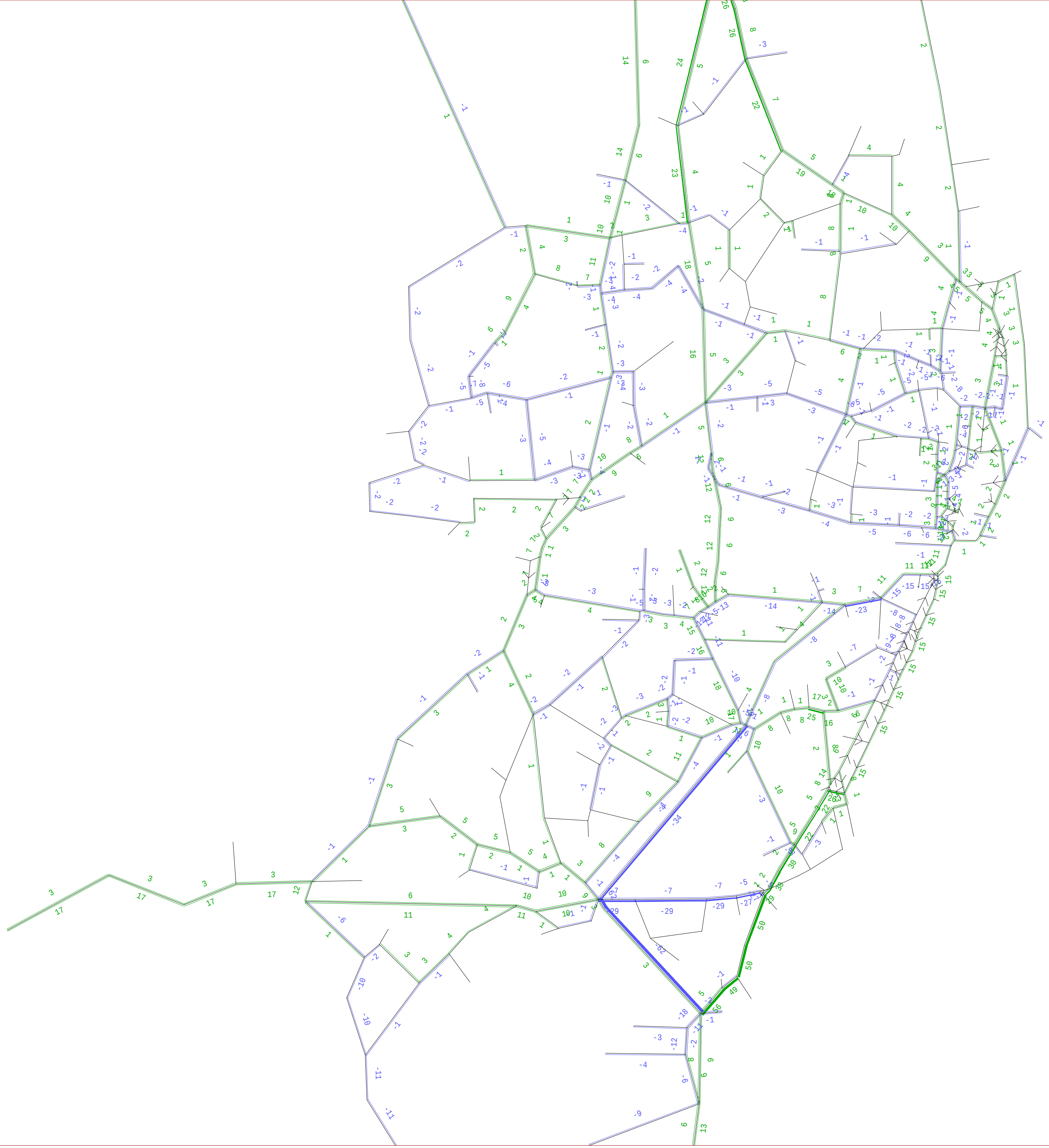

SATURN

Atkins Ltd /
DVV / ITS

17_unconstrained_VDM.UFS
S_W4_AM_Peak

Scale 25919

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Differ: 1-2

Bandwidths =
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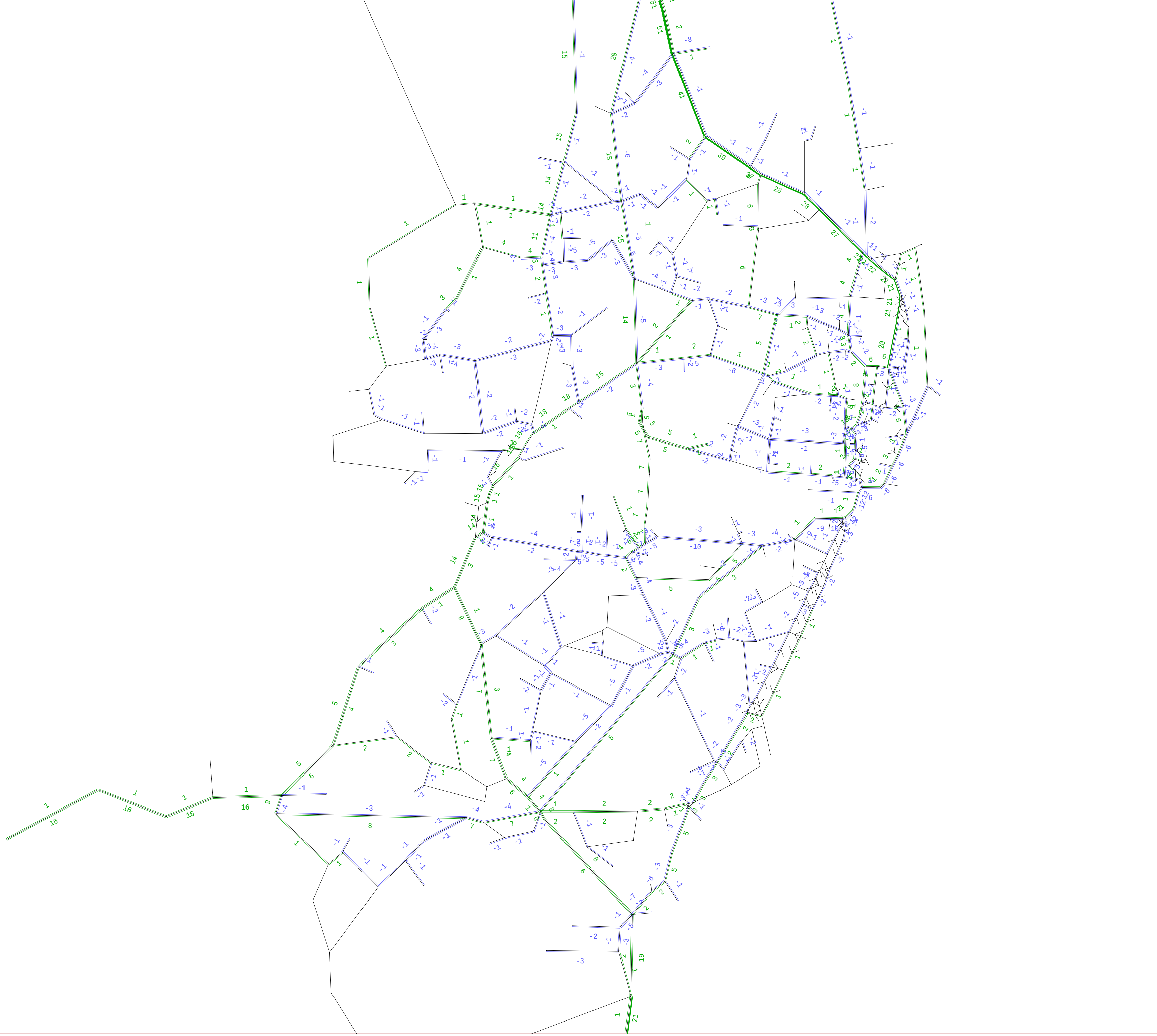
WSP GROUP (S



SATURN

Atkins Ltd /
DVV / ITS

17_unconstra
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Scale 25919

Link Annot:

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Differ: 1-2

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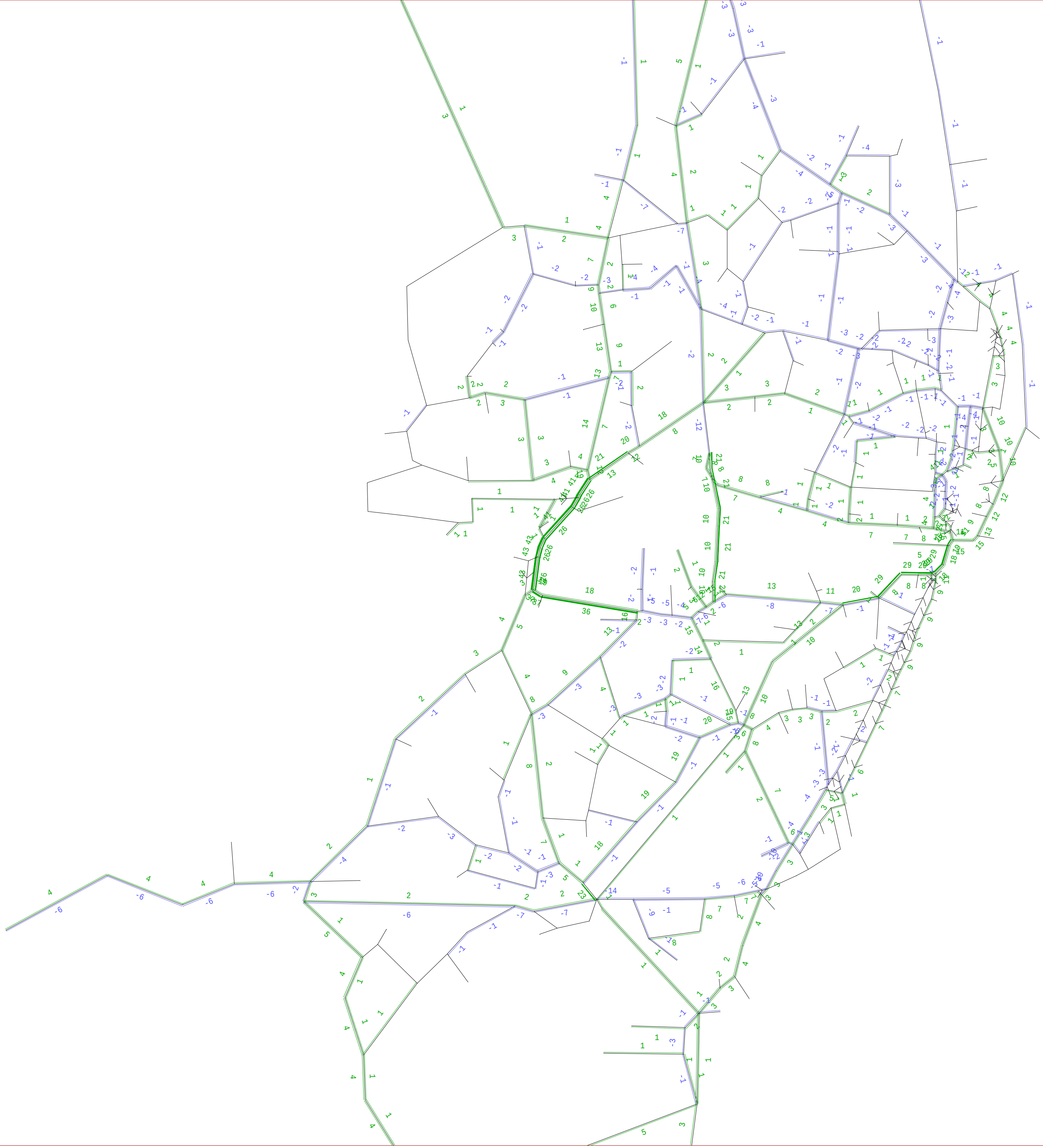

SATURN

Atkins Ltd /
DVV / ITS

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Differ: 1-2

Bandwidths =
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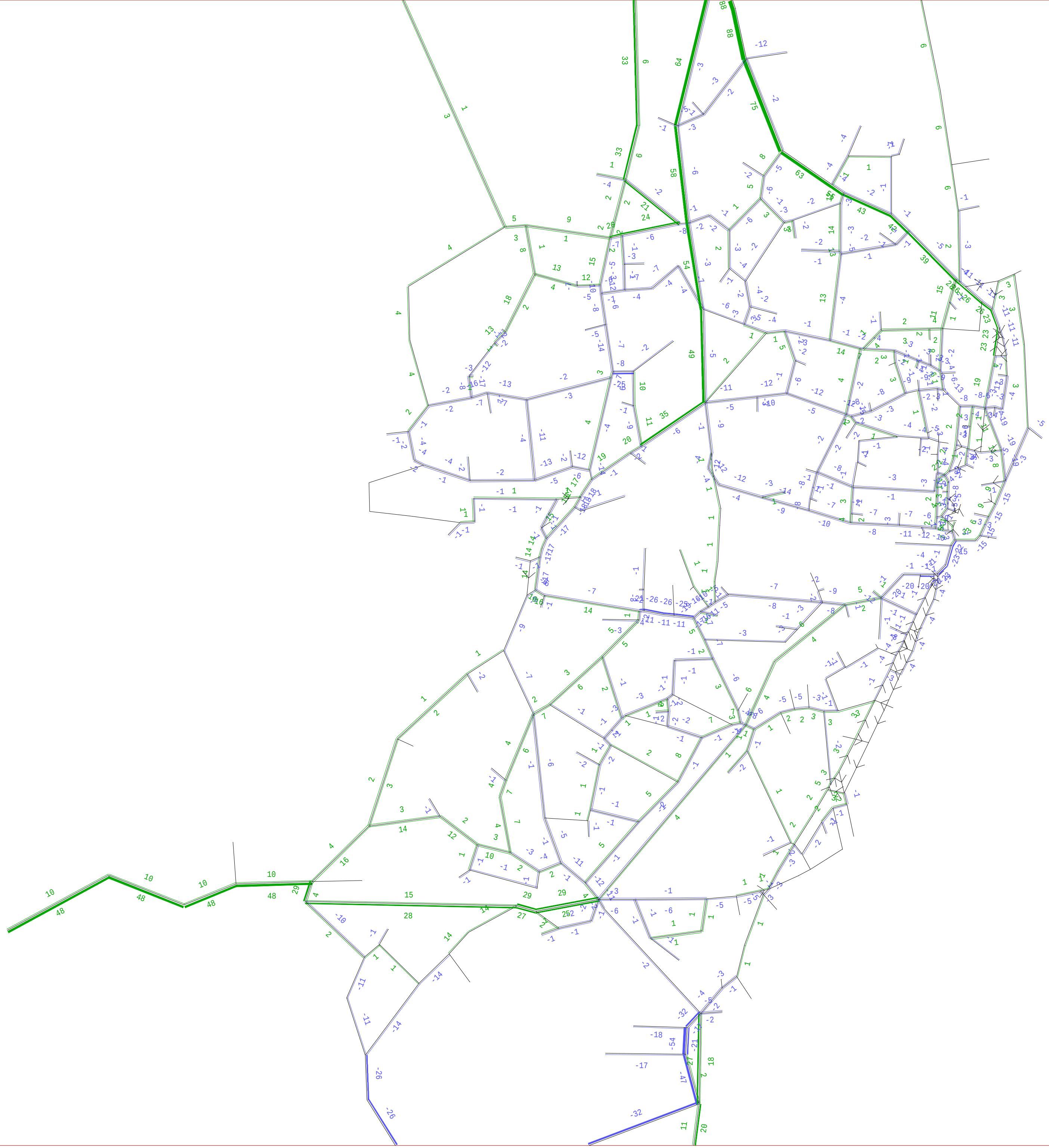

SATURN

Atkins Ltd /
DVV / ITS

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S_W4_AM_Peak

Scale 25919

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Differ: 1-2

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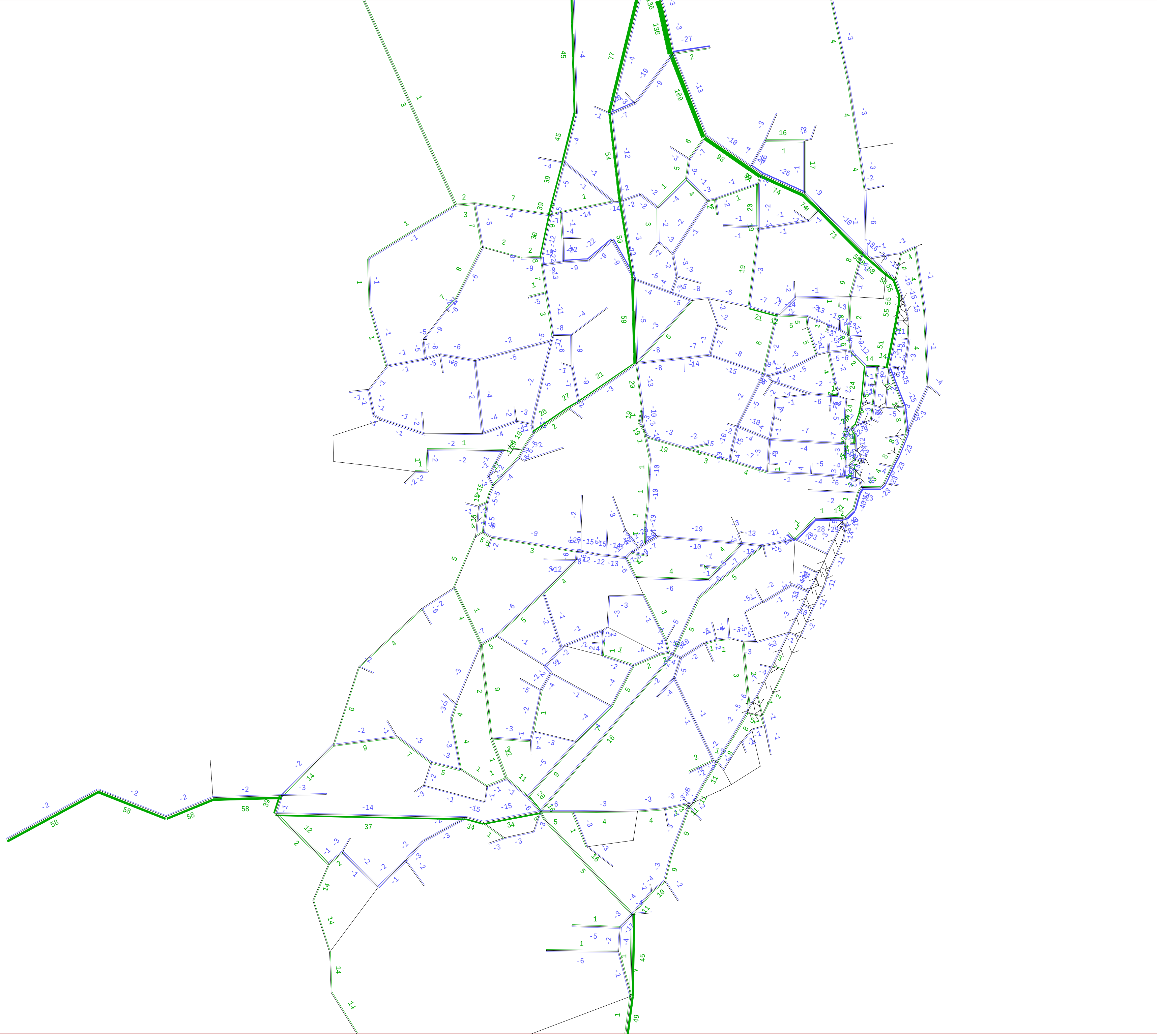

SATURN

Atkins Ltd /
DVV / ITS

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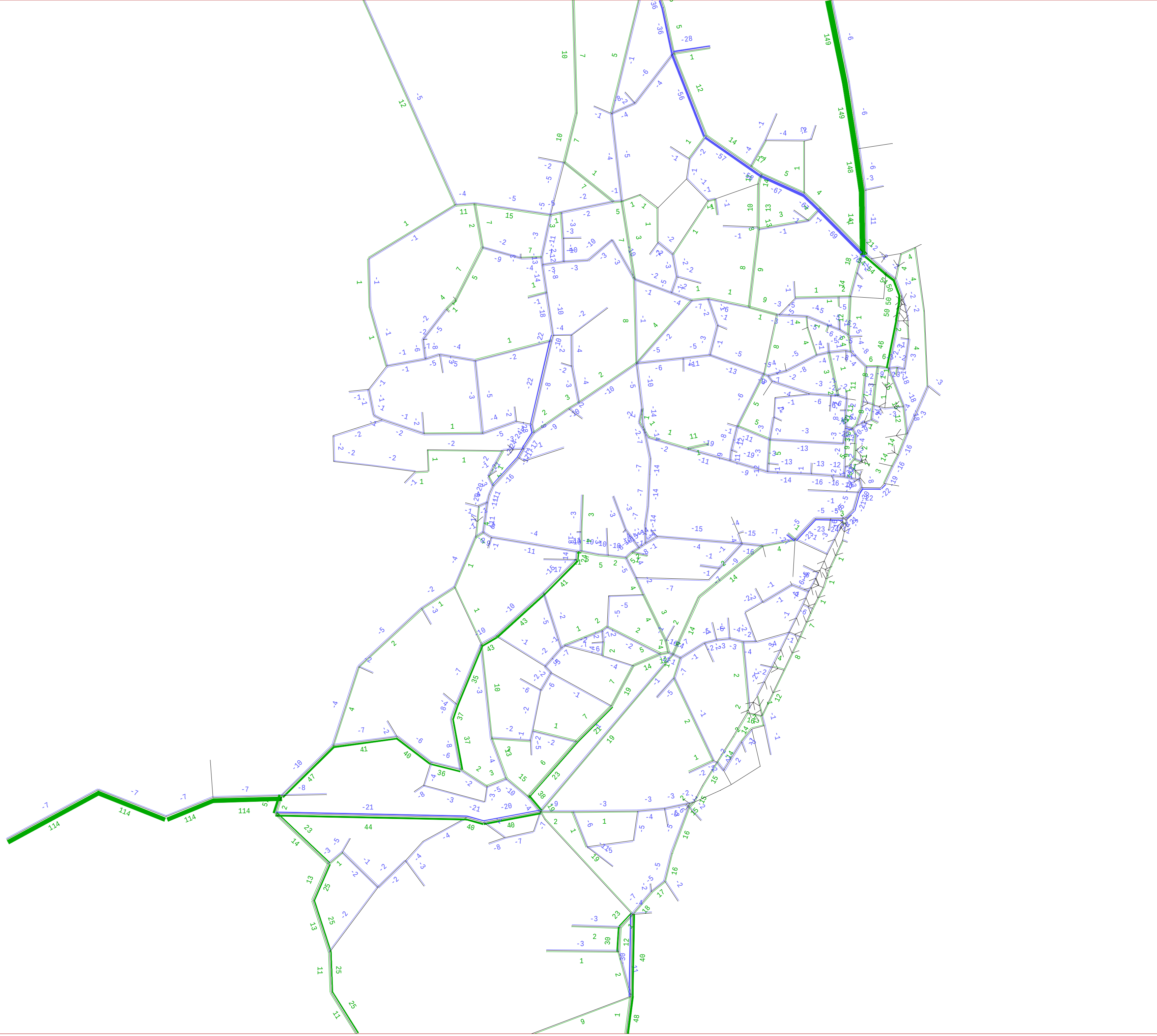

SATURN

Atkins Ltd /
DVV / ITS

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Appendix E

MODEL CONVERGENCE

Table E.1 – AM 2020 DM convergence

Iteration	Delta	%Flow	%Gap
16	0.0012	97.7	0.00075
17	0.0006	97.9	0.00098
18	0.0007	99.2	0.00047
19	0.0004	98.6	0.0011
20	0.0005	98.7	0.00037
21	0.0008	99.1	0.00032

Table E.2 – IP 2020 DM convergence

Iteration	Delta	%Flow	%Gap
14	0.00321	96.2	0.0044
15	0.00360	97.7	0.0029
16	0.00181	98.1	0.003
17	0.00181	98.3	0.0039
18	0.00212	98.7	0.0018
19	0.00127	99.2	0.002

Table E.3 – PM 2020 DM convergence

Iteration	Delta	%Flow	%Gap
19	0.00770	98.4	0.014
20	0.00653	97.8	0.019
21	0.00954	98.9	0.012
22	0.010	99.1	0.018
23	0.00555	98.2	0.01
24	0.00479	99.4	0.017

Table E.4 – AM 2035 DM convergence

Iteration	Delta	%Flow	%Gap
19	0.00126	97.2	0.0069
20	0.00175	98	0.002
21	0.00111	98.4	0.0013
22	0.00090	98.8	0.002
23	0.00084	98.5	0.001
24	0.00055	99	0.0037

Table E.5 – IP 2035 DM convergence

Iteration	Delta	%Flow	%Gap
13	0.00547	96	0.0026
14	0.00168	96.9	0.0041
15	0.00232	98.9	0.0016
16	0.00119	99.2	0.0011
17	0.00073	99.7	0.0008
18	0.00068	99.7	0.0006

Table E.6 – PM 2035 DM convergence

Iteration	Delta	%Flow	%Gap
27	0.013	97.3	0.016
28	0.011	97.4	0.015
29	0.013	98.2	0.012
30	0.012	98.4	0.012
31	0.00900	99	0.011
32	0.00721	98.6	0.011

Table E.7 – AM 2020 C6 convergence

ITERATION	DELTA	%FLOW	%GAP
13	0.00125	97.4	0.0071
14	0.00096	96.6	0.0047
15	0.00077	98.5	0.0028
16	0.00067	98.7	0.003
17	0.00070	98.4	0.0032
18	0.00053	98.8	0.0019

Table E.8 – IP 2020 C6 convergence

ITERATION	DELTA	%FLOW	%GAP
11	0.010	96.1	0.0095
12	0.00625	97.9	0.008
13	0.00588	98.8	0.0049
14	0.00378	99.5	0.0051
15	0.00386	99.2	0.0032
16	0.00332	99.7	0.0029

Table E.9 – PM 2020 C6 convergence

ITERATION	DELTA	%FLOW	%GAP
15	0.012	96.8	0.012
16	0.00997	97.7	0.0099
17	0.00789	98.5	0.0086
18	0.00723	99	0.0076
19	0.00604	99.3	0.0076
20	0.00345	99.6	0.0072

Table E.10 – AM 2035 C6 convergence

ITERATION	DELTA	%FLOW	%GAP
25	0.00161	97.8	0.0064
26	0.00130	97.7	0.0027
27	0.00259	98.6	0.0015
28	0.00107	98.9	0.002
29	0.00178	99.1	0.001
30	0.00089	98.9	0.002

Table E.11 – IP 2035 C6 convergence

ITERATION	DELTA	%FLOW	%GAP
10	0.00723	96.9	0.011
11	0.00524	96.6	0.0094
12	0.00457	98	0.0067
13	0.00360	98.7	0.0055
14	0.00277	98.2	0.0041
15	0.00248	98.5	0.0035

Table E.12 – PM 2035 C6 convergence

ITERATION	DELTA	%FLOW	%GAP
16	0.063	98.2	0.06
17	0.030	97.3	0.059
18	0.056	99	0.055
19	0.026	98.6	0.057
20	0.025	99	0.053
21	0.024	99	0.049

Table E.13 – AM 2020 C11 convergence

Iteration	Delta	%Flow	%Gap
14	0.00044	97.2	0.002
15	0.00039	97.3	0.0021
16	0.00041	98.2	0.0008
17	0.00036	98.6	0.0012
18	0.00033	99.1	0.0007
19	0.00028	99.3	0.0003

Table E.14 – IP 2020 C11 convergence

Iteration	Delta	%Flow	%Gap
9	0.00916	95	0.0079
10	0.00604	97.7	0.0069
11	0.00525	99.2	0.0047
12	0.00430	99.6	0.0038
13	0.00323	99.7	0.0037
14	0.00308	99.7	0.0029

Table E.15 – PM 2020 C11 convergence

Iteration	Delta	%Flow	%Gap
16	0.012	97.5	0.012
17	0.00927	97.6	0.0097
18	0.00873	98.8	0.0084
19	0.00723	98.9	0.0077
20	0.00694	99.5	0.0076
21	0.00644	99.3	0.0088

Table E.16 – AM 2035 C11 convergence

Iteration	Delta	%Flow	%Gap
18	0.00986	97.1	0.0031
19	0.00335	97.8	0.0051
20	0.00210	98.7	0.0032
21	0.00193	98.1	0.0021
22	0.00162	98.9	0.0021
23	0.00140	99.1	0.0014

Table E.17 – IP 2035 C11 convergence

Iteration	Delta	%Flow	%Gap
11	0.00648	96.4	0.0093
12	0.00455	97.4	0.0066
13	0.00440	98	0.0052
14	0.00308	98.2	0.0038
15	0.00312	98.6	0.0033
16	0.00249	99.1	0.002

Table E.18 – PM 2035 C11 convergence

Iteration	Delta	%Flow	%Gap
16	0.053	97.6	0.059
17	0.028	97.7	0.057
18	0.050	98.2	0.058
19	0.043	98.5	0.054
20	0.025	98.2	0.054
21	0.023	98.9	0.051

Table E.19 – AM 2020 T3 convergence

ITERATION	DELTA	%FLOW	%GAP
12	0.00347	97.6	0.0016
13	0.00227	96.8	0.0009
14	0.00066	98.1	0.0008
15	0.00117	98.5	0.0005
16	0.00061	99.5	0.0004
17	0.00032	99.8	0.0004

Table E.20 – IP 2020 T3 convergence

ITERATION	DELTA	%FLOW	%GAP
17	0.011	98.5	0.0051
18	0.00503	97.8	0.0099
19	0.00867	98.5	0.0044
20	0.00364	98.2	0.0068
21	0.00516	98.3	0.0032
22	0.00262	98.1	0.0061

Table E.21 – PM 2020 T3 convergence

ITERATION	DELTA	%FLOW	%GAP
15	0.00891	98.1	0.015
16	0.012	97.5	0.011
17	0.00685	98.3	0.0098
18	0.00824	99.1	0.0089
19	0.011	99.5	0.0083
20	0.00709	99.5	0.0078

Table E.22 – AM 2035 T3 convergence

ITERATION	DELTA	%FLOW	%GAP
30	0.00292	98.4	0.0049
31	0.00399	98	0.0026
32	0.00253	98.4	0.0033
33	0.00178	99.1	0.002
34	0.00145	99.3	0.0021
35	0.00134	99.6	0.0013

Table E.23 – IP 2035 T3 convergence

ITERATION	DELTA	%FLOW	%GAP
94	0.020	92.3	0.058
95	0.033	91.9	0.058
96	0.033	91.9	0.055
97	0.020	92.3	0.054
98	0.020	92.3	0.054
99	0.020	92.3	0.058

Table E.24 – PM 2035 T3 convergence

ITERATION	DELTA	%FLOW	%GAP
19	0.021	97.8	0.026
20	0.017	97.7	0.026
21	0.020	98.1	0.021
22	0.014	98.6	0.021
23	0.014	98.8	0.019
24	0.013	98.8	0.017

Table E.25 – AM 2020 W4 convergence

ITERATION	DELTA	%FLOW	%GAP
13	0.00224	95.8	0.0026
14	0.00170	97.5	0.0019
15	0.00144	98.1	0.0014
16	0.00118	99.3	0.0015
17	0.00104	98.7	0.0013
18	0.00087	99.3	0.001

Table E.26 – IP 2020 W4 convergence

ITERATION	DELTA	%FLOW	%GAP
21	0.00716	97.7	0.0045
22	0.00393	98	0.0063
23	0.00664	98.4	0.0036
24	0.00608	98.2	0.0033
25	0.00267	98.4	0.0047
26	0.00451	99.2	0.0023

Table E.27 – PM 2020 W4 convergence

ITERATION	DELTA	%FLOW	%GAP
18	0.025	98.6	0.017
19	0.00699	97.5	0.011
20	0.014	98.2	0.009
21	0.012	99.3	0.0083
22	0.00917	99.4	0.0077
23	0.00662	99.7	0.0071

Table E.28 – AM 2035 W4 convergence

ITERATION	DELTA	%FLOW	%GAP
23	0.00670	97.9	0.004
24	0.00349	97.3	0.0063
25	0.00377	98.1	0.0043
26	0.00381	98.4	0.0029
27	0.00290	98.6	0.0022
28	0.00431	98.9	0.0018

Table E.29 – IP 2035 W4 convergence

ITERATION	DELTA	%FLOW	%GAP
93	0.00645	89.2	0.057
94	0.00490	89.2	0.0056
95	0.00226	98.8	0.0056
96	0.00207	99.3	0.0056
97	0.00206	99.3	0.005
98	0.00220	98.9	0.0083

Table E.30 – PM 2035 W4 convergence

ITERATION	DELTA	%FLOW	%GAP
14	0.060	94.7	0.066
15	0.052	96	0.062
16	0.028	98	0.06
17	0.028	99	0.066
18	0.027	98.6	0.061
19	0.026	98.6	0.06

Appendix F

NETWORK SUMMARY STATISTICS

Table F.1 – 2020 network summary statistics comparison – AM peak

VARIABLE	2020 DM AM	2020 C6 AM	2020 C6 AM vs DM	2020 C11 AM	2020 C11 AM vs DM	2020 T3 AM	2020 T3 AM vs DM	2020 W4 AM	2020 W4 AM vs DM
Over-Capacity Queues (PCU.HRS/HR)	81.3	21.7	-73.3%	21.9	-73.1%	21.5	-73.6%	21.3	-73.8%
Total Travel Time (PCU.HRS/HR)	2681.1	2548.5	-4.9%	2530.2	-5.6%	2569.3	-4.2%	2570.5	-4.1%
Travel Distance (PCU.KMS/HR)	111930.9	113116.6	1.1%	112397.9	0.4%	112616.1	0.6%	112441.4	0.5%
Average Speed (KMPH)	41.7	44.4	6.5%	44.4	6.5%	43.8	5.0%	43.7	4.8%

Table F.2 – 2035 network summary statistics comparison – AM peak

VARIABLE	2020 DM AM	2020 C6 AM	2020 C6 AM vs DM	2020 C11 AM	2020 C11 AM vs DM	2020 T3 AM	2020 T3 AM vs DM	2020 W4 AM	2020 W4 AM vs DM
Over-Capacity Queues (PCU.HRS/HR)	267.5	69	-74.2%	61.8	-76.9%	94.2	-64.8%	95.5	-64.3%
Total Travel Time (PCU.HRS/HR)	3427.6	3198	-6.7%	3182.7	-7.1%	3264.1	-4.8%	3256	-5.0%
Travel Distance (PCU.KMS/HR)	129437	133050.3	2.8%	132207.7	2.1%	131969.9	2.0%	131737	1.8%
Average Speed (KMPH)	37.8	41.6	10.1%	41.5	9.8%	40.4	6.9%	40.5	7.1%

Table F.3 – 2020 network summary statistics comparison – Inter peak

Variable	2020 DM AM	2020 C6 AM	2020 C6 AM vs DM	2020 C11 AM	2020 C11 AM vs DM	2020 T3 AM	2020 T3 AM vs DM	2020 W4 AM	2020 W4 AM vs DM
Over-Capacity Queues (PCU.HRS/HR)	39.2	3.7	-90.6%	4	-89.8%	8.8	-77.6%	8.6	-78.1%
Total Travel Time (PCU.HRS/HR)	2242.8	2110.5	-5.9%	2083	-7.1%	2138.2	-4.7%	2137.9	-4.7%
Travel Distance (PCU.KMS/HR)	94254.1	94581.6	0.3%	93761.2	-0.5%	94042.8	-0.2%	93804.5	-0.5%
Average Speed (KMPH)	42	44.8	6.7%	45	7.1%	44	4.8%	43.9	4.5%

Table F.4 – 2035 network summary statistics comparison – Inter peak

Variable	2020 DM AM	2020 C6 AM	2020 C6 AM vs DM	2020 C11 AM	2020 C11 AM vs DM	2020 T3 AM	2020 T3 AM vs DM	2020 W4 AM	2020 W4 AM vs DM
Over-Capacity Queues (PCU.HRS/HR)	190.4	29.2	-84.7%	29.3	-84.6%	57.4	-69.9%	61.9	-67.5%
Total Travel Time (PCU.HRS/HR)	2906.2	2661.9	-8.4%	2629.7	-9.5%	2712.4	-6.7%	2715.7	-6.6%
Travel Distance (PCU.KMS/HR)	113090.5	114953.6	1.6%	113864.5	0.7%	114187.7	1.0%	113803.4	0.6%
Average Speed (KMPH)	38.9	43.2	11.1%	43.3	11.3%	42.1	8.2%	41.9	7.7%

Table F.5 – 2020 network summary statistics comparison – PM peak

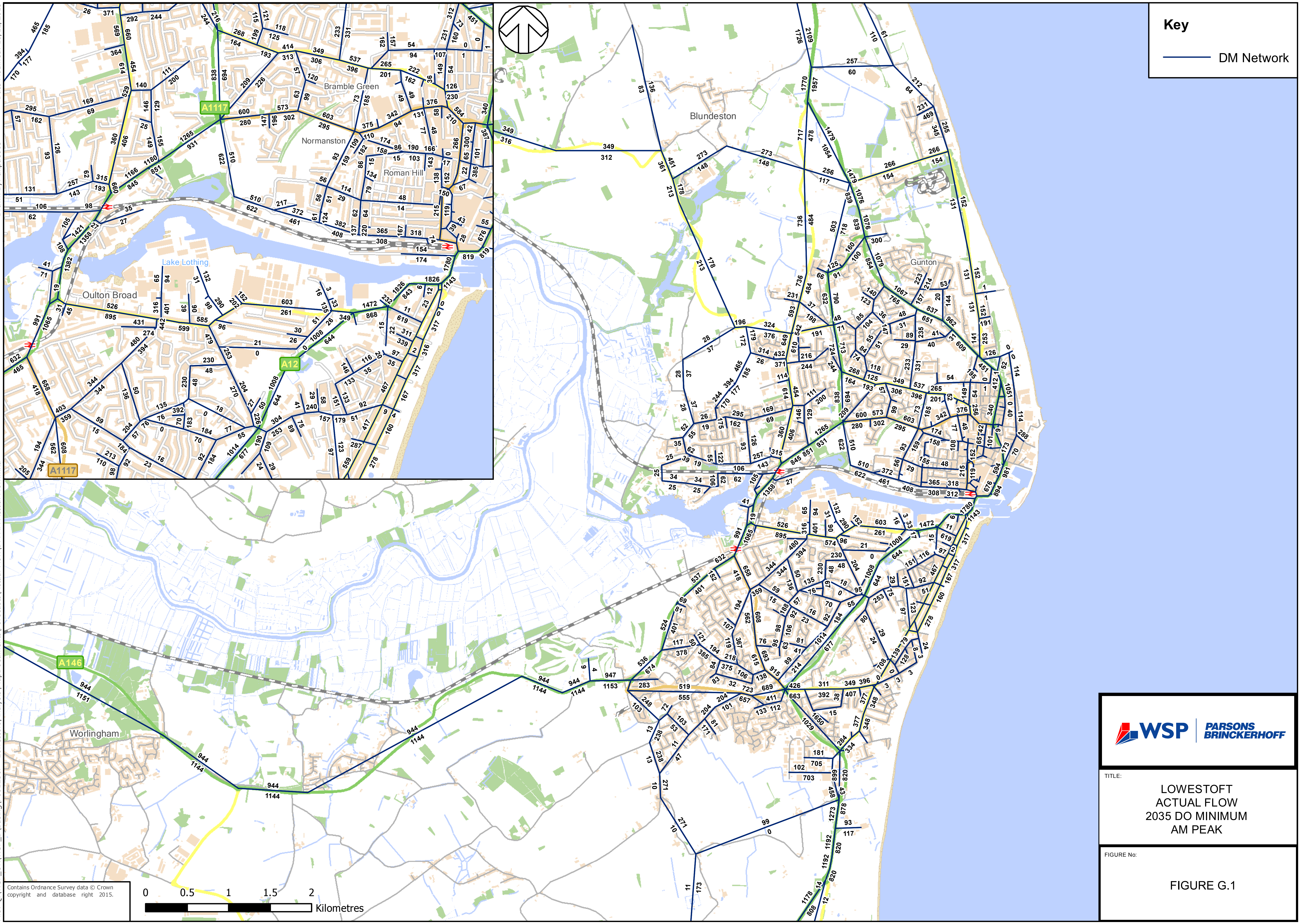
Variable	2020 DM AM	2020 C6 AM	2020 C6 AM vs DM	2020 C11 AM	2020 C11 AM vs DM	2020 T3 AM	2020 T3 AM vs DM	2020 W4 AM	2020 W4 AM vs DM
Over-Capacity Queues (PCU.HRS/HR)	279.7	193.7	-30.7%	188.5	-32.6%	190.8	-31.8%	190.5	-31.9%
Total Travel Time (PCU.HRS/HR)	3281.8	3094	-5.7%	3057.6	-6.8%	3114.7	-5.1%	3121	-4.9%
Travel Distance (PCU.KMS/HR)	122735.7	123215.7	0.4%	122361.5	-0.3%	122855.7	0.1%	122561	-0.1%
Average Speed (KMPH)	37.4	39.8	6.4%	40	7.0%	39.4	5.3%	39.3	5.1%

Table F.6 – 2035 network summary statistics comparison – PM peak

Variable	2020 DM AM	2020 C6 AM	2020 C6 AM vs DM	2020 C11 AM	2020 C11 AM vs DM	2020 T3 AM	2020 T3 AM vs DM	2020 W4 AM	2020 W4 AM vs DM
Over-Capacity Queues (PCU.HRS/HR)	636.3	430.3	-32.4%	413.5	-35.0%	429.7	-32.5%	437.3	-31.3%
Total Travel Time (PCU.HRS/HR)	4167.5	3935.9	-5.6%	3889.8	-6.7%	3964.7	-4.9%	3975.9	-4.6%
Travel Distance (PCU.KMS/HR)	139429.8	142379.2	2.1%	141451.7	1.5%	141982.7	1.8%	141541.5	1.5%
Average Speed (KMPH)	33.5	36.2	8.1%	36.4	8.7%	35.8	6.9%	35.6	6.3%

Appendix G

ACTUAL FLOW AND FLOW DIFFERENCE PLOTS



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 DO MINIMUM
AM PEAK

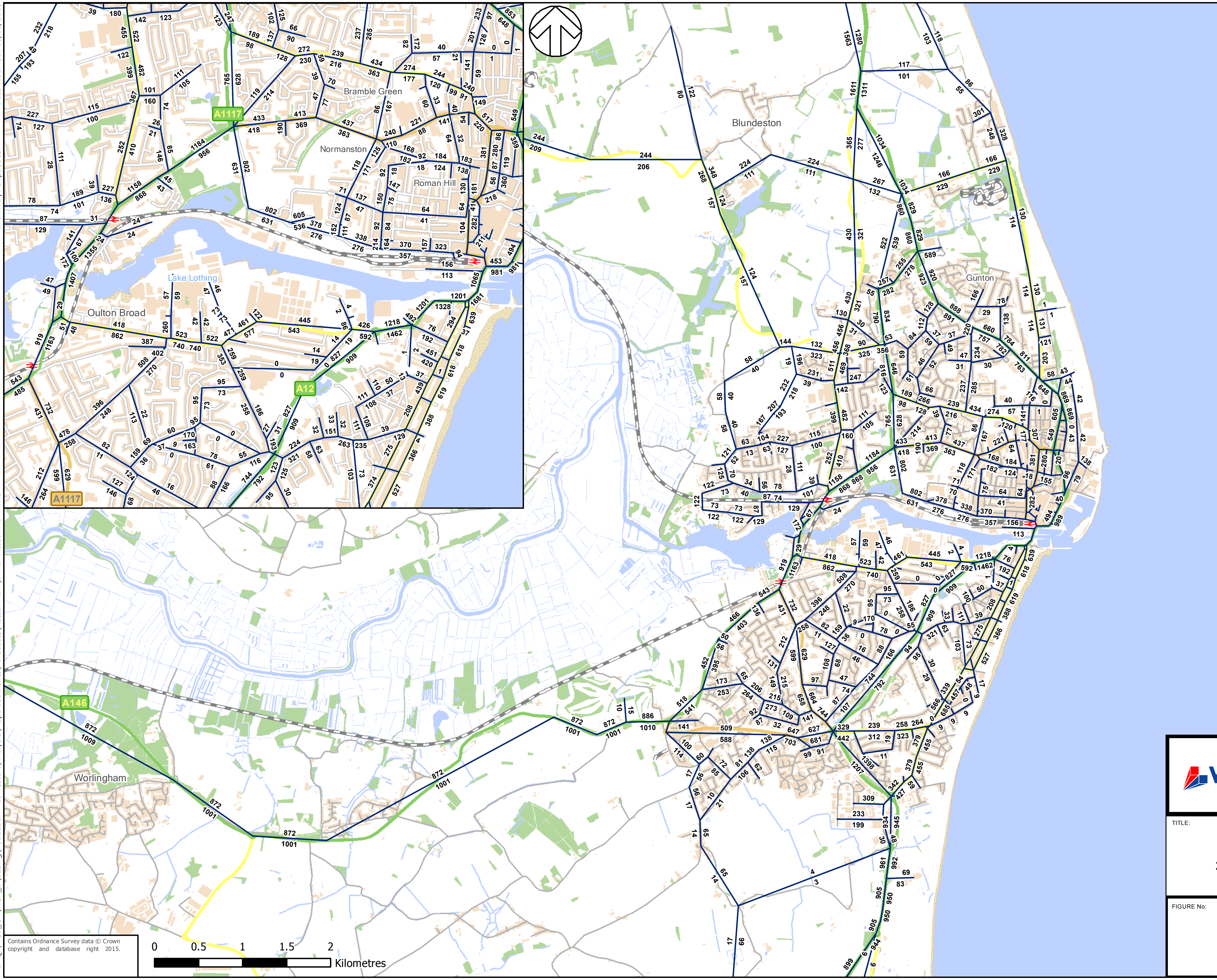
FIGURE No:

FIGURE G.1

Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\DM AM Actual Flow.mxd



Key

DM Network

WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 DO MINIMUM
INTER PEAK

FIGURE No:

FIGURE G.2

Date Modified: 10/12/2015

Drawn By: ukpde003

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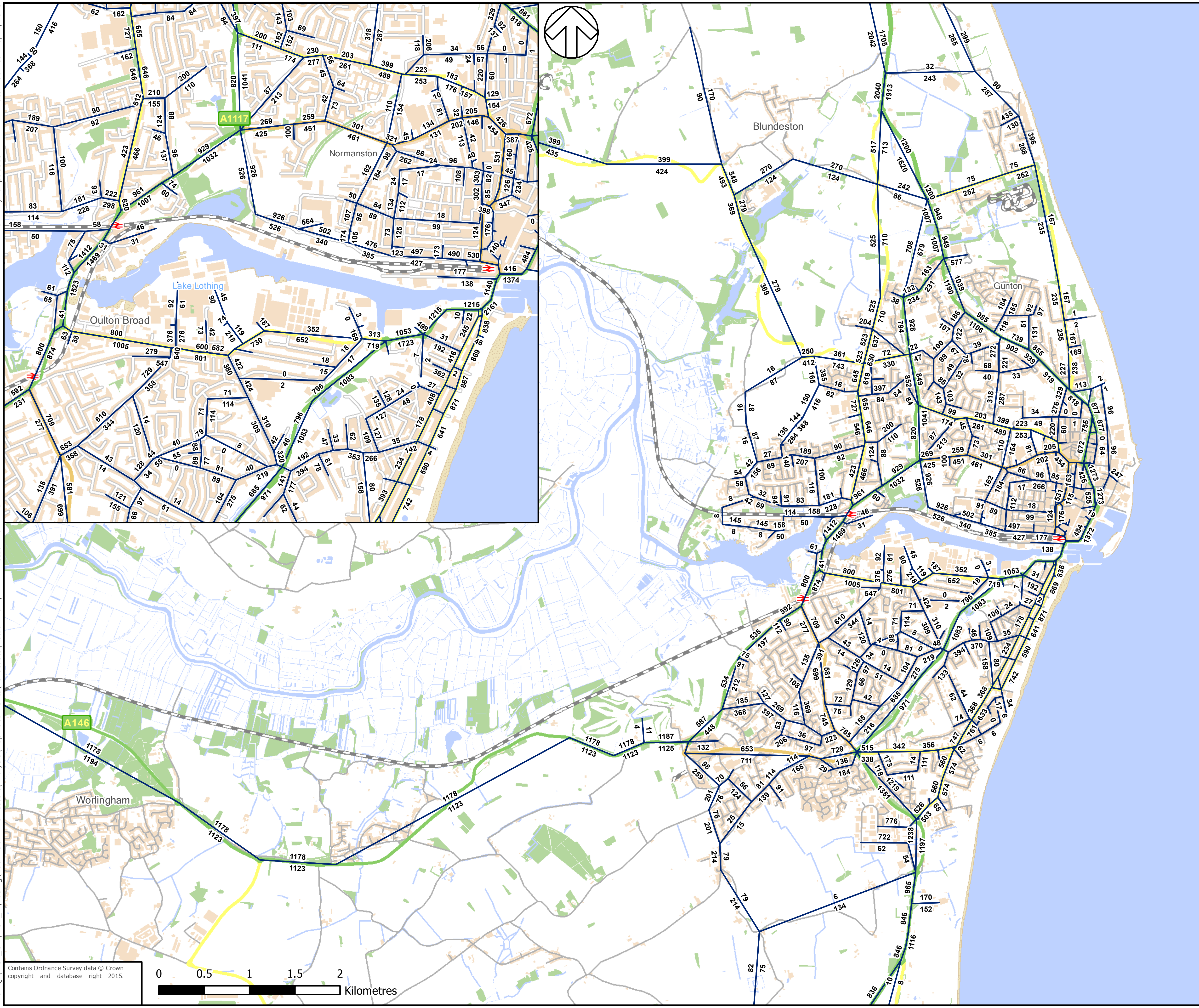


Key

DM Network

WSP | PARSONS BRINCKERHOFF

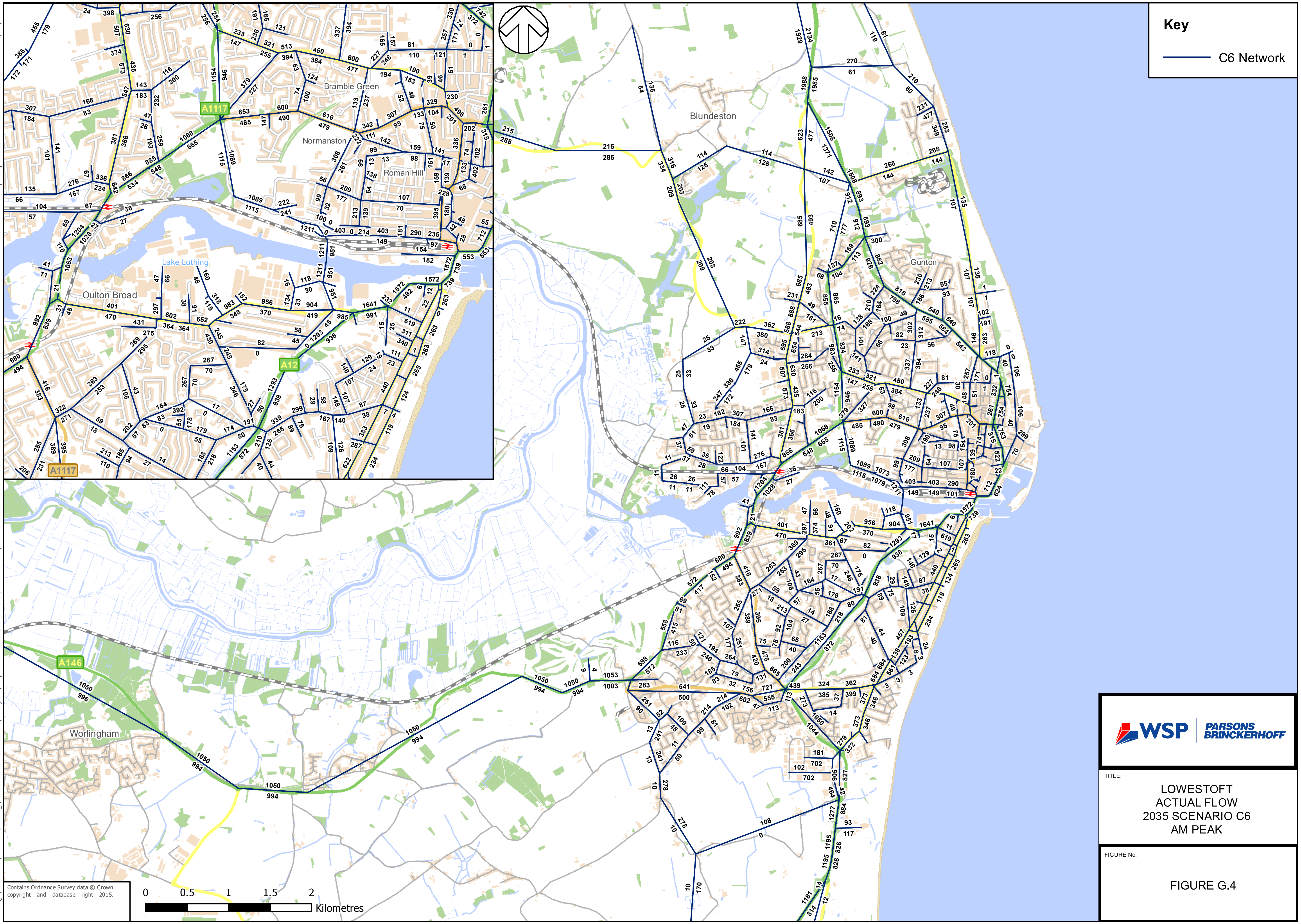
TITLE:

LOWESTOFT
ACTUAL FLOW
2035 DO MINIMUM
PM PEAK

FIGURE No:

FIGURE G.3

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\DM PM Actual Flow.mxd Drawn By: ukpde003 Date Modified: 10/12/2015



TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO C6
AM PEAK

FIGURE No:

FIGURE G.4

Date Modified: 10/12/2015
Drawn By: ukpde003
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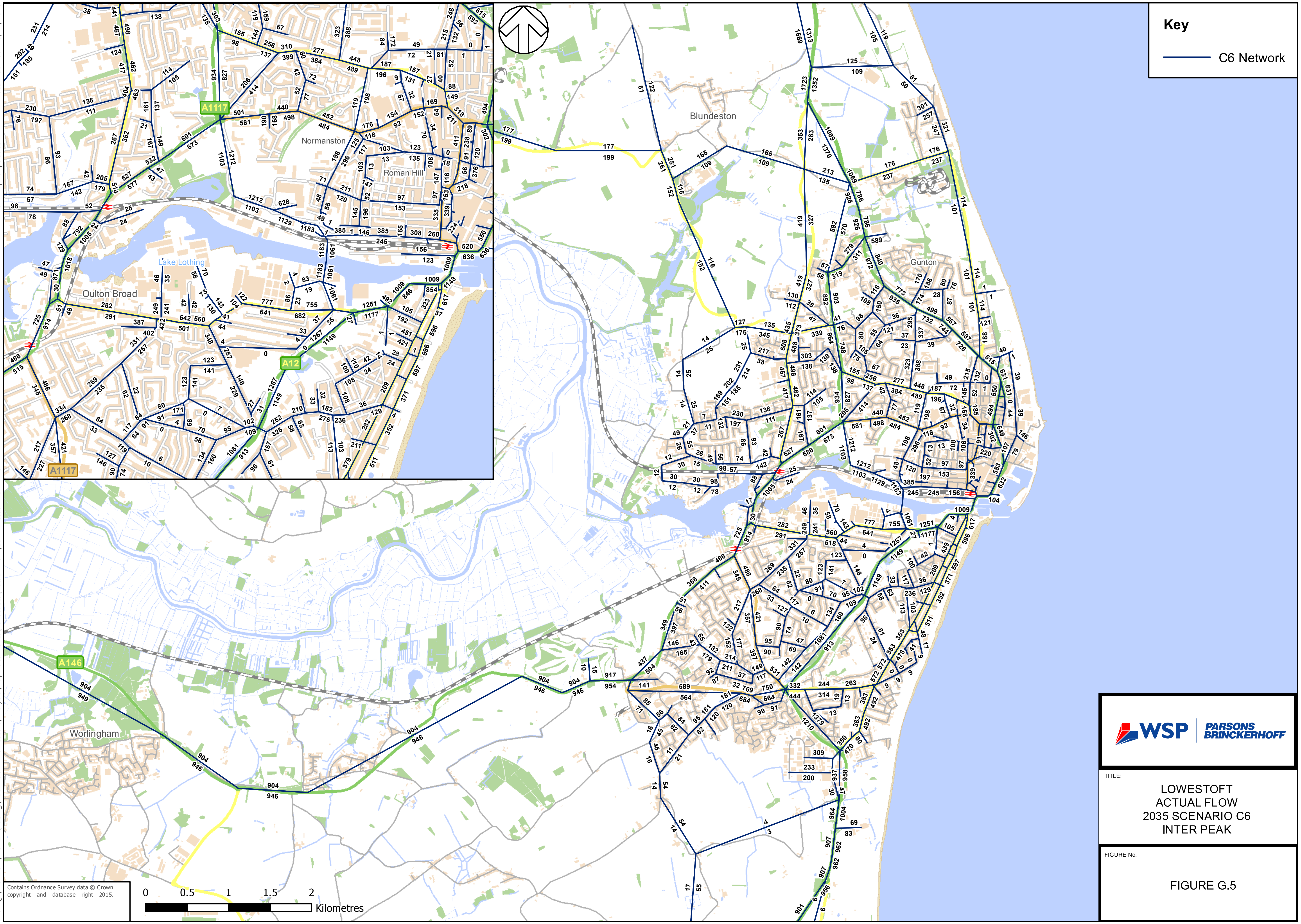


WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO C6
INTER PEAK

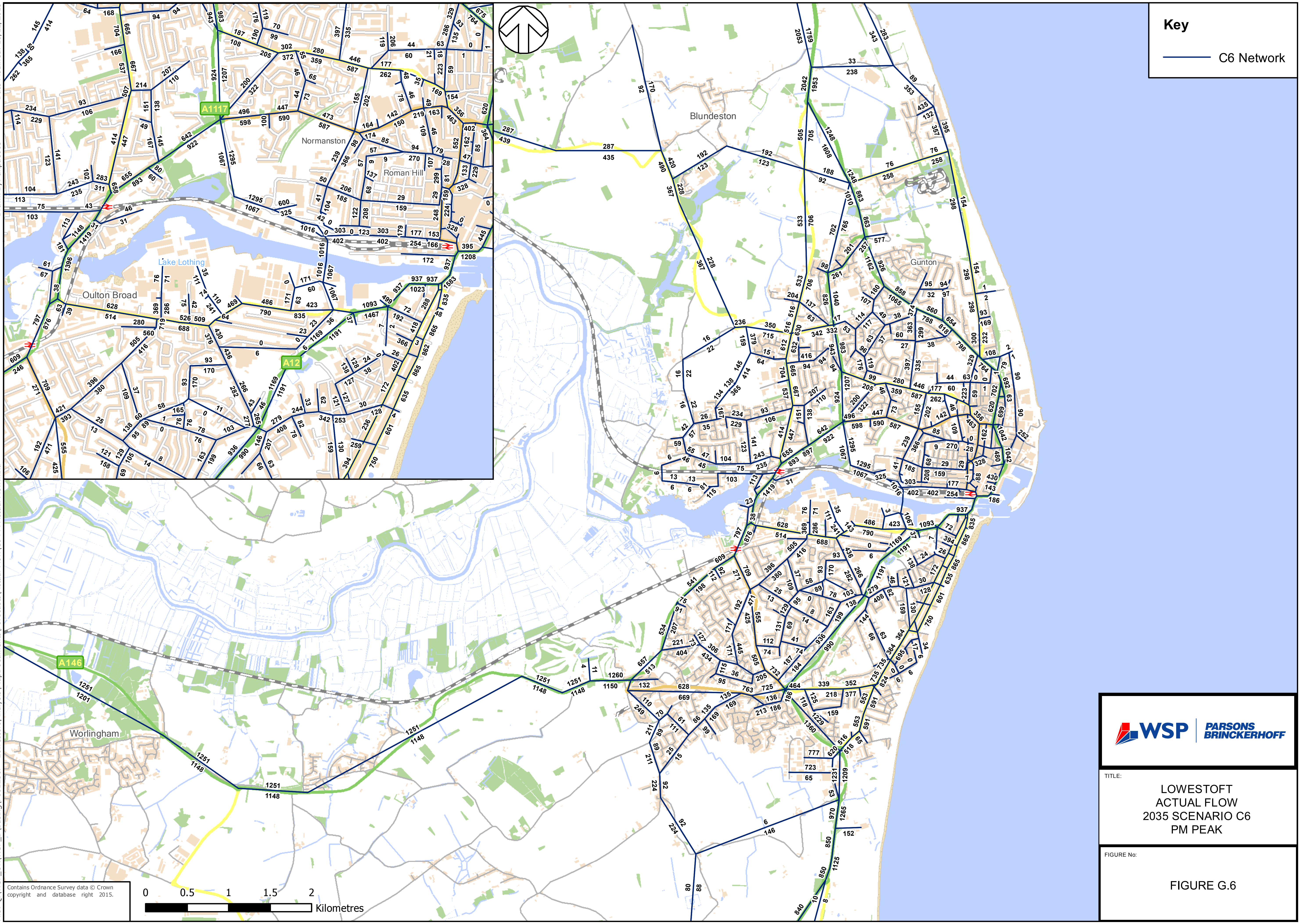
FIGURE No:

FIGURE G.5

Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\C6 IP Actual Flow.mxd



Key

C6 Network

WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO C6
PM PEAK

FIGURE No:

FIGURE G.6

Date Modified: 10/12/2015

Drawn By: ukrdt001

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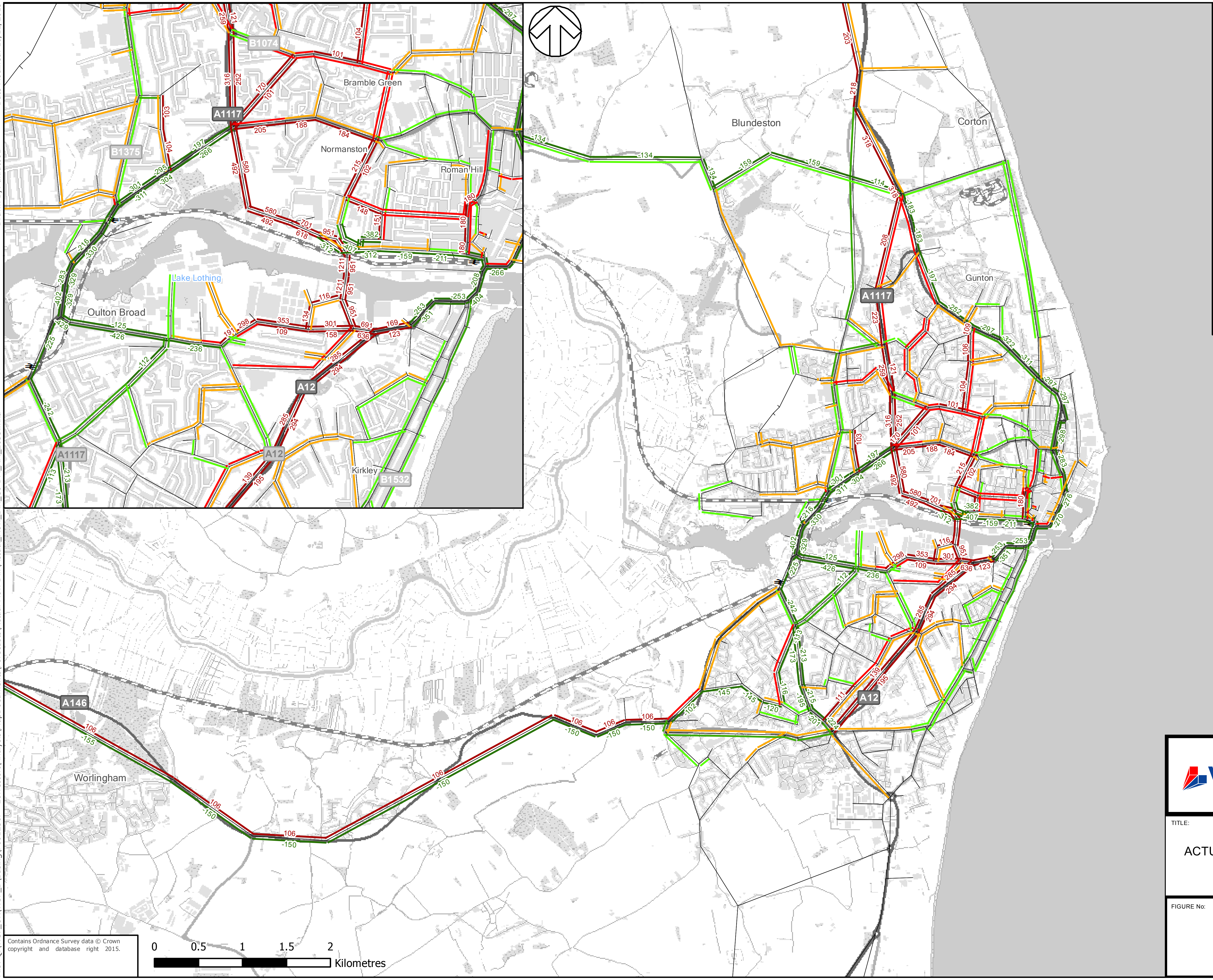


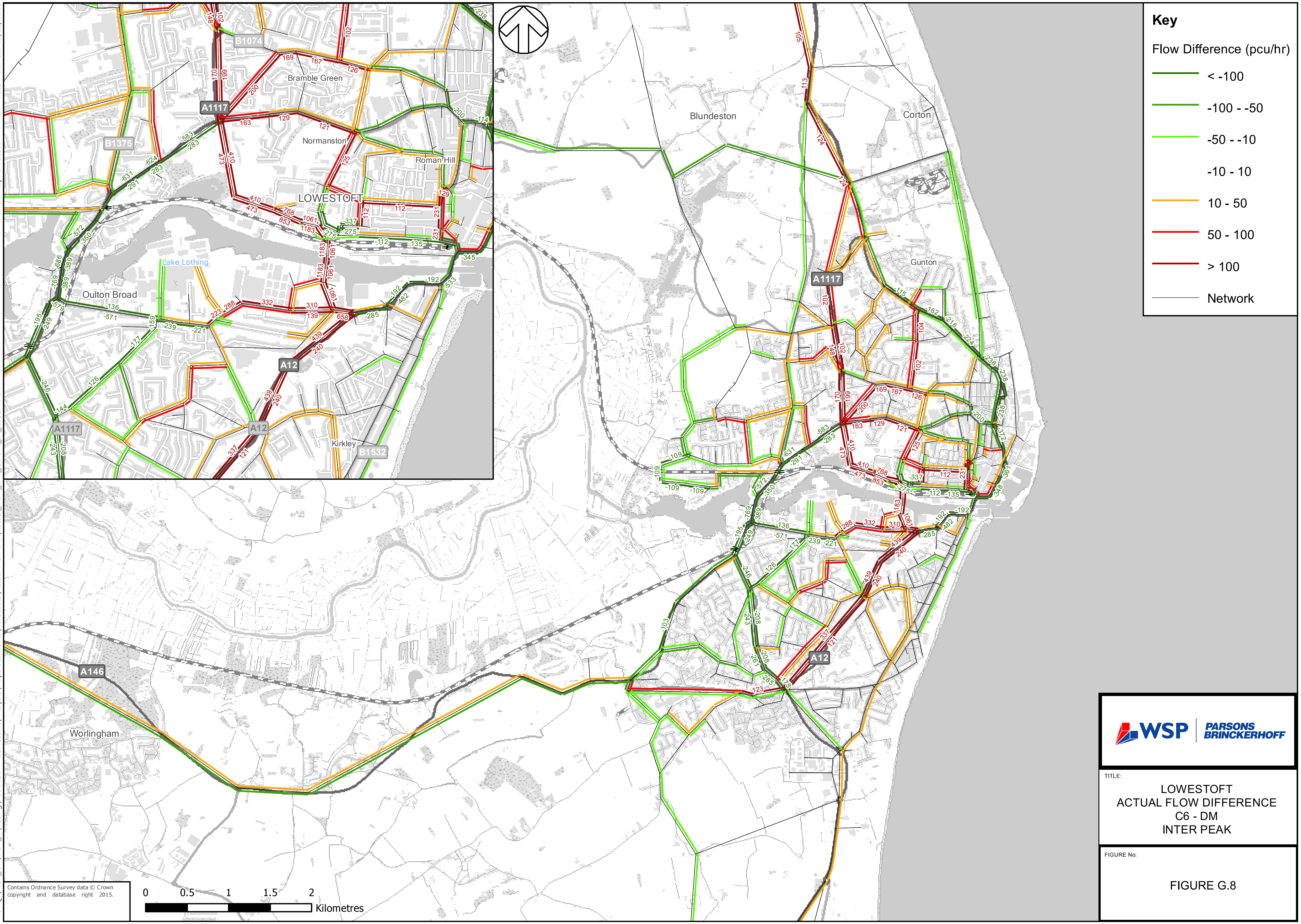
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
C6 - DM
AM PEAK

FIGURE No:

FIGURE G.7



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
C6 - DM
INTER PEAK

FIGURE No:

FIGURE G.8

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_C6-DM_IP_2035.mxd

Drawn By: ukrdt001

Date Modified: 10/12/2015

Date Modified: 10/12/2015
Drawn By: ukrdt001
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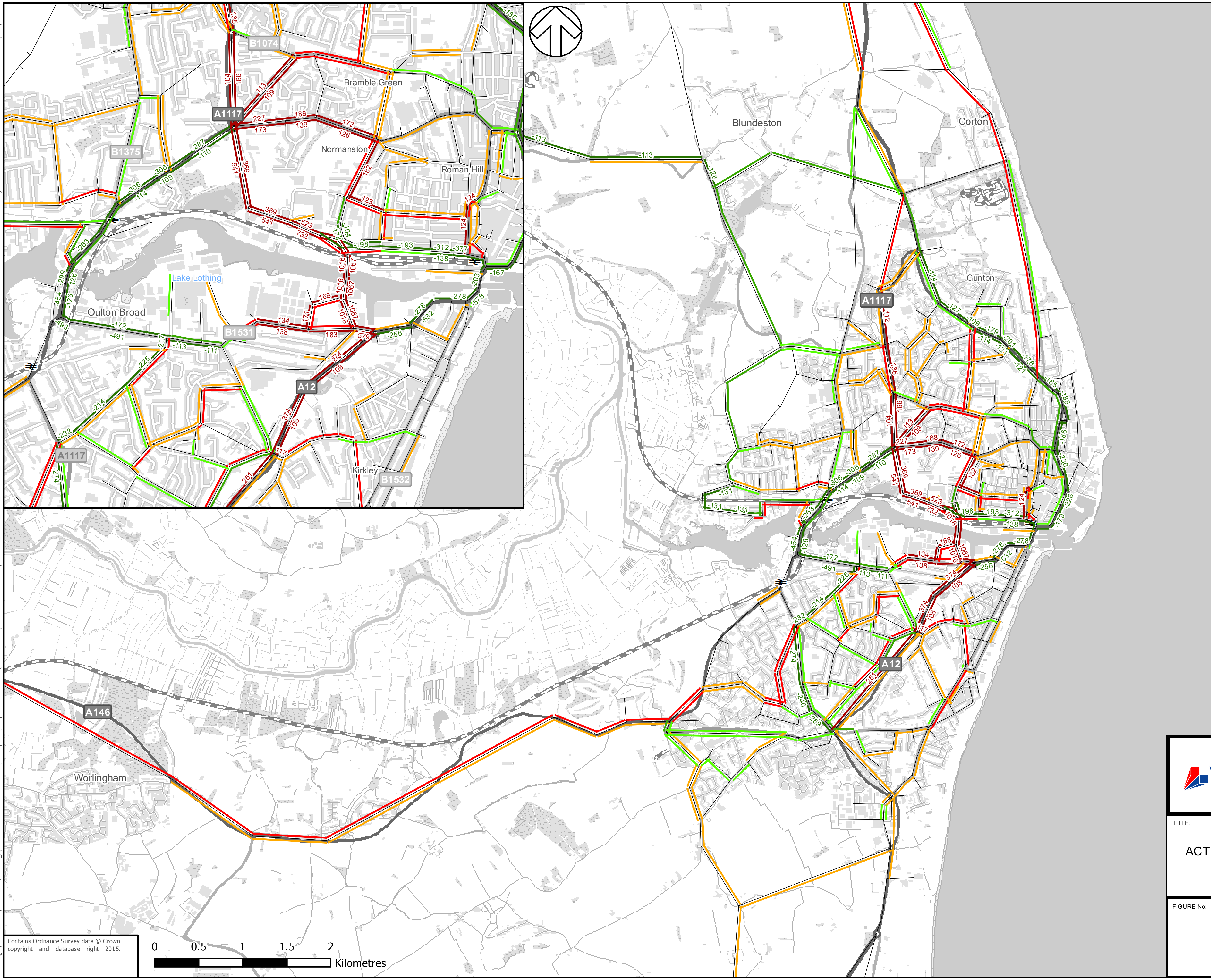


Key

Flow Difference (pcu/hr)

- < -100
- -100 - -50
- -50 - -10
- -10 - 10
- 10 - 50
- 50 - 100
- > 100
- Network

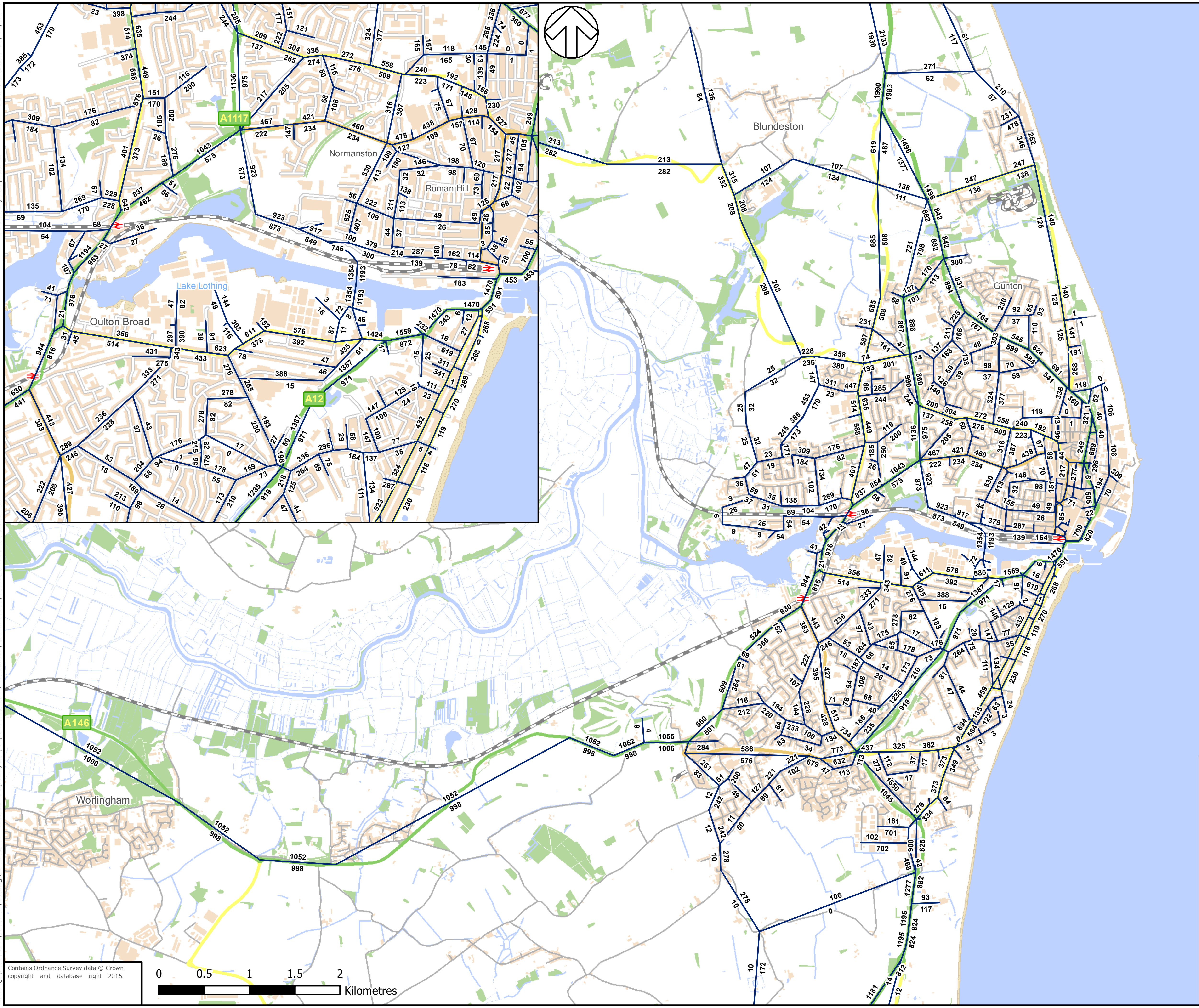
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
C6 - DM
PM PEAK

FIGURE No:

FIGURE G.9



Key

C11 Network

WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO C11
AM PEAK

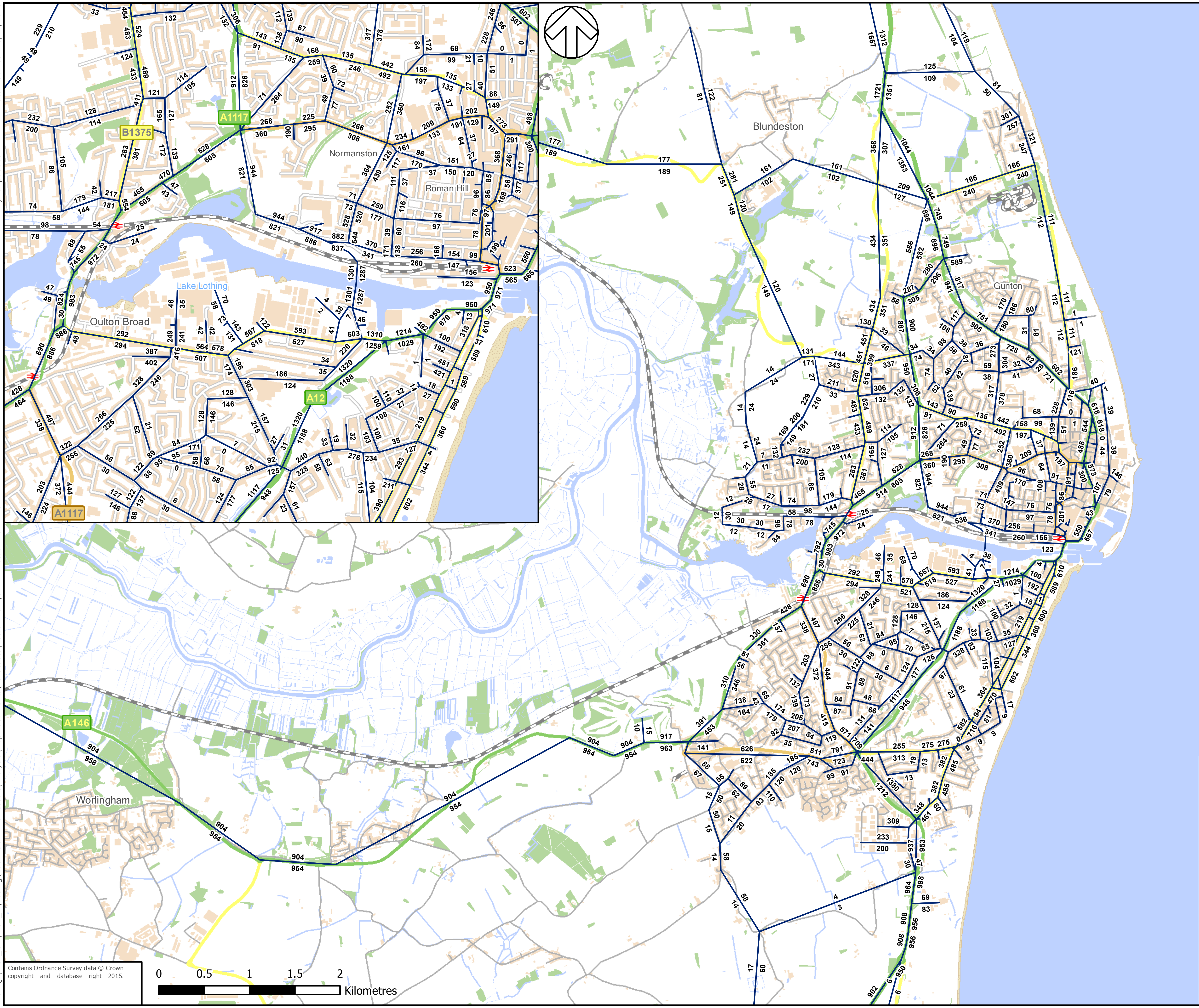
FIGURE No:

FIGURE G.10

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\C11 AM Actual Flow.mxd

Drawn By: ukpde003

Date Modified: 10/12/2015



Key

C11 Network

WSP | PARSONS BRINCKERHOFF

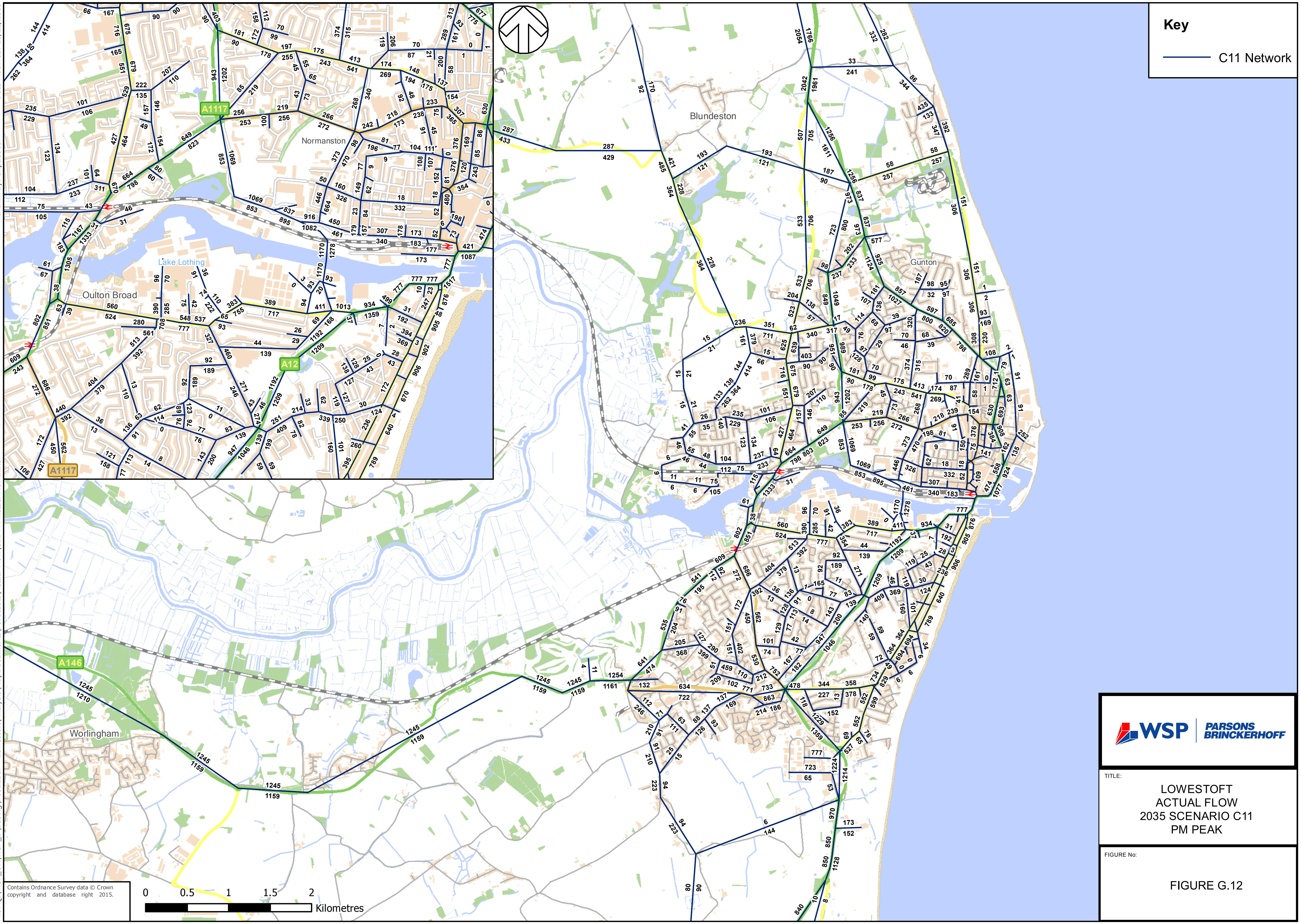
TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO C11
INTER PEAK

FIGURE No:

FIGURE G.11

Date Modified: 10/12/2015
Drawn By: ukpde003
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\C11 IP Actual Flow.mxd



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO C11
PM PEAK

FIGURE No:

FIGURE G.12

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\C11 PM Actual Flow.mxd

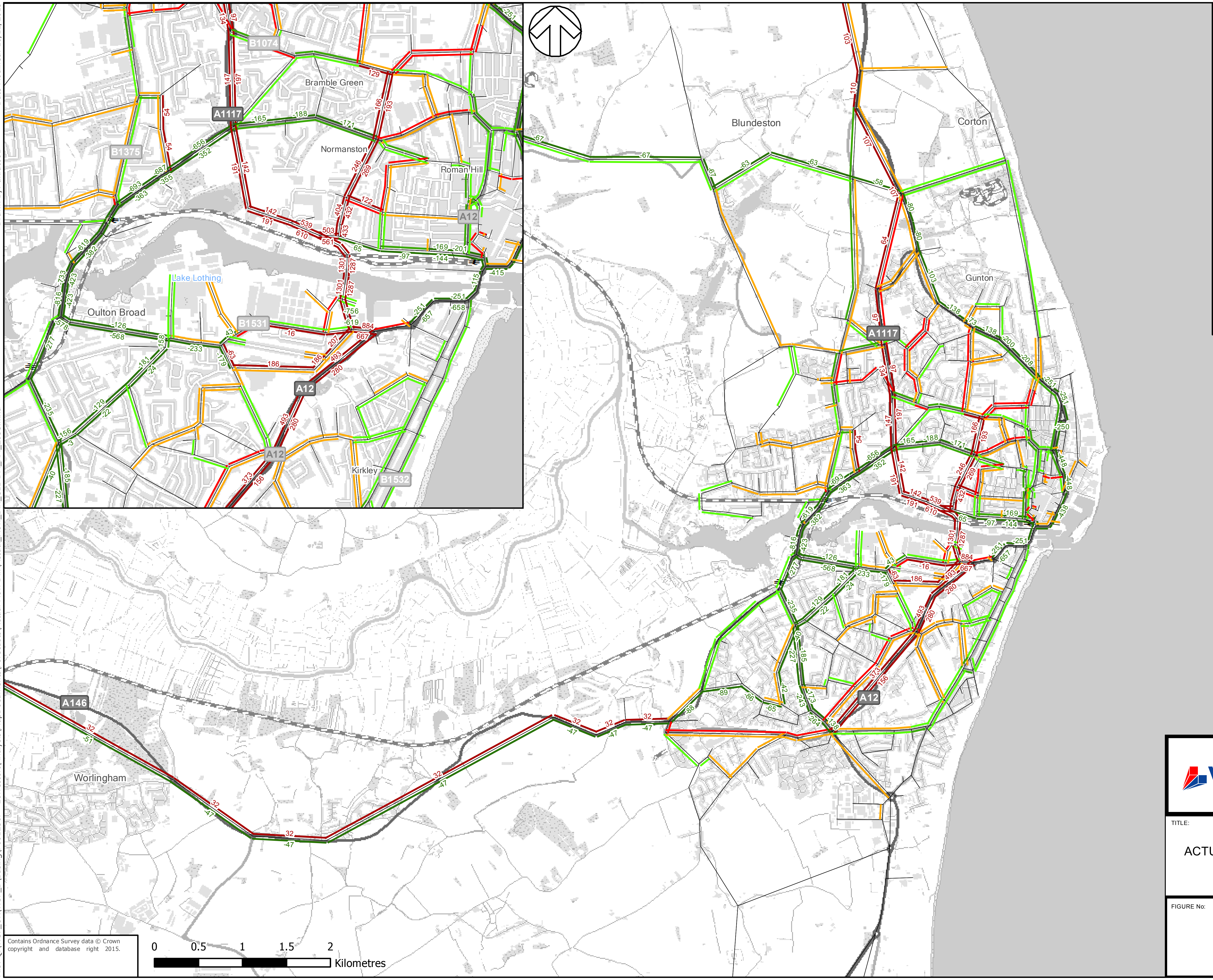
Drawn By: ukpde003

Date Modified: 10/12/2015

Date Modified: 10/12/2015

Drawn By: ukrdt001

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_C11-DM_AM_2035.mxd



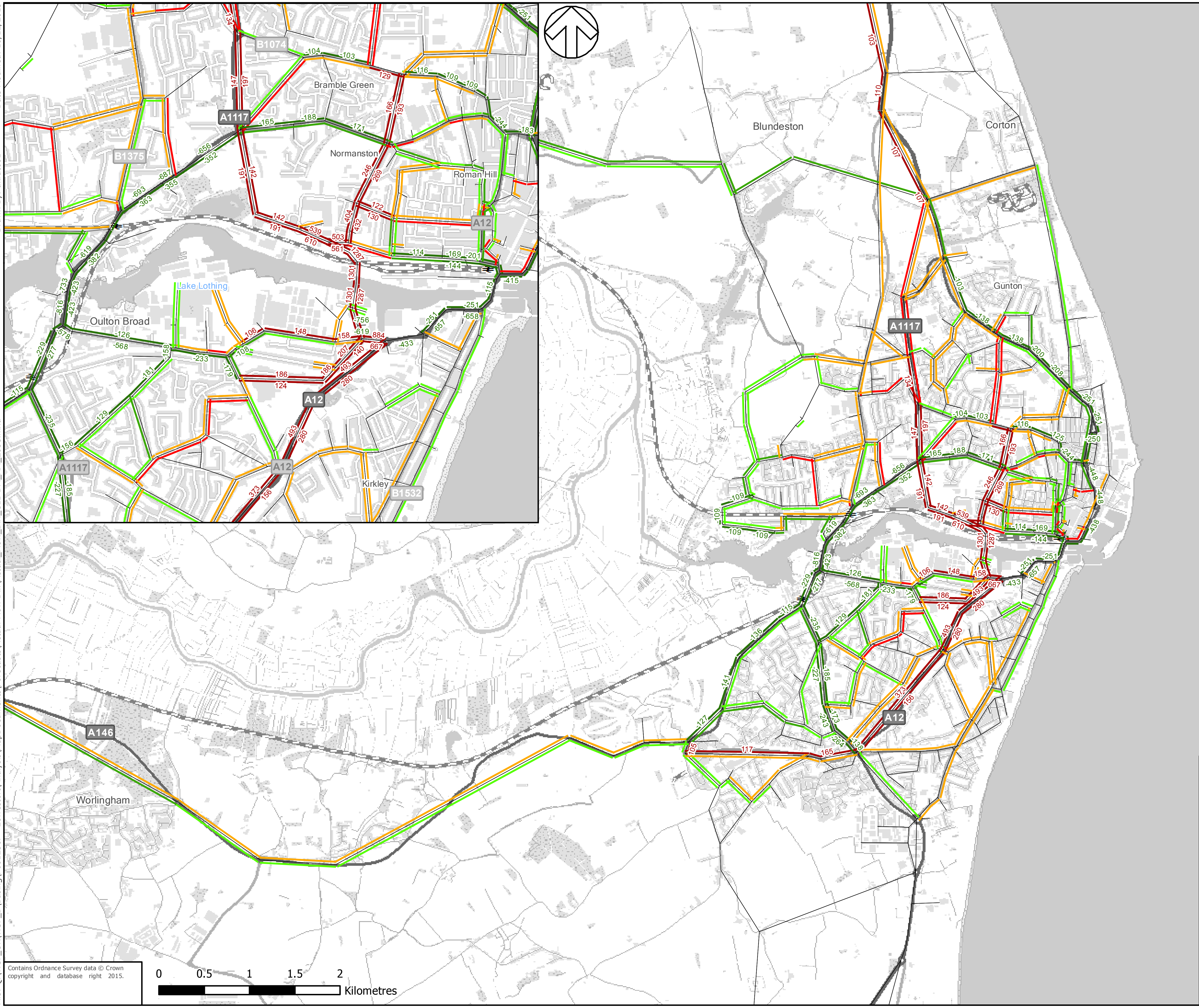
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
C11 - DM
AM PEAK

FIGURE No:

FIGURE G.13



Key

Flow Difference (pcu/hr)

- < -100
- -100 - -50
- -50 - -10
- -10 - 10
- 10 - 50
- 50 - 100
- > 100
- Network

WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
C11 - DM
INTER PEAK

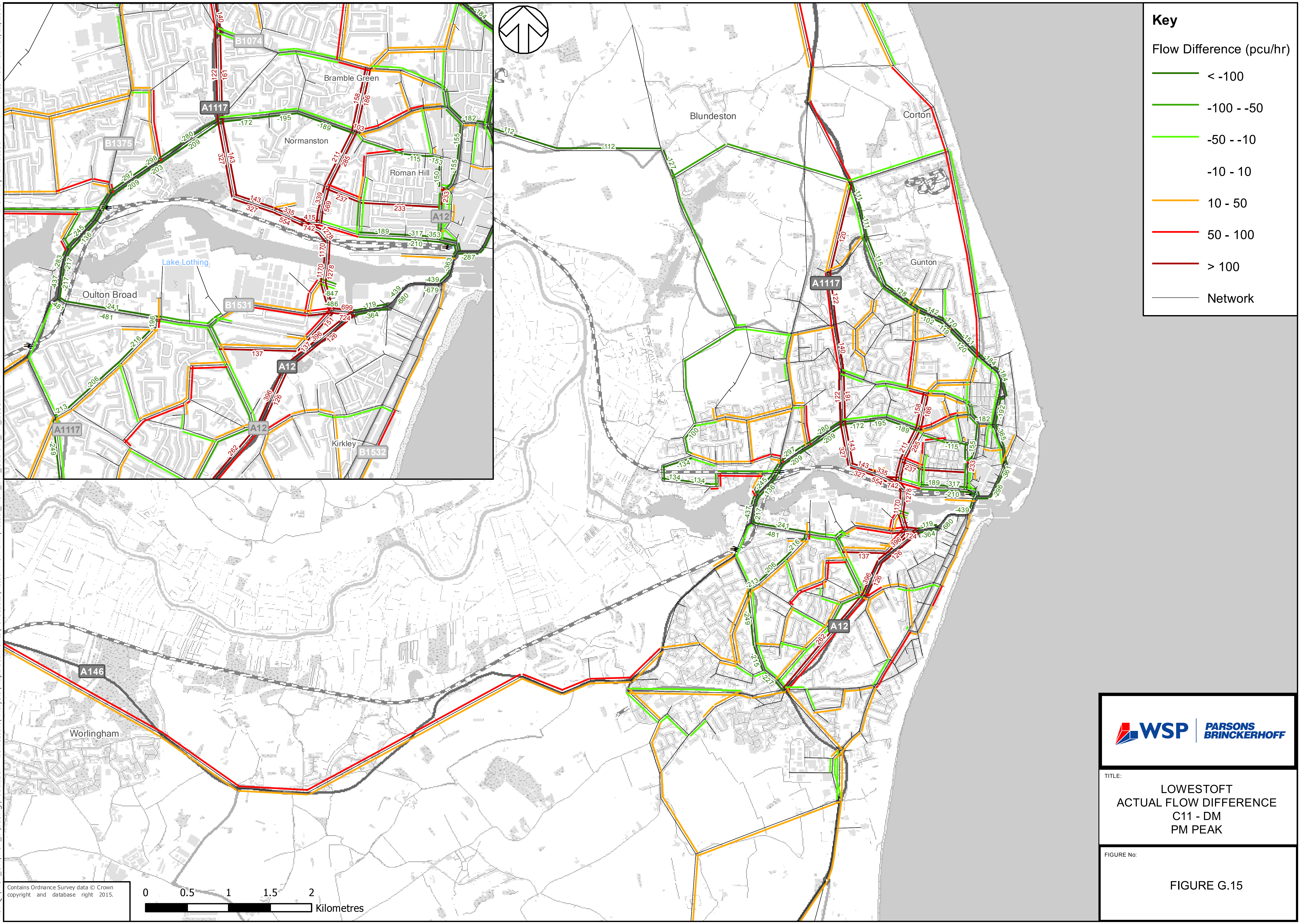
FIGURE No:

FIGURE G.14

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_C11-DM_AM_2035.mxd

Drawn By: ukrdt001

Date Modified: 10/12/2015



WSP | PARSONS BRINCKERHOFF

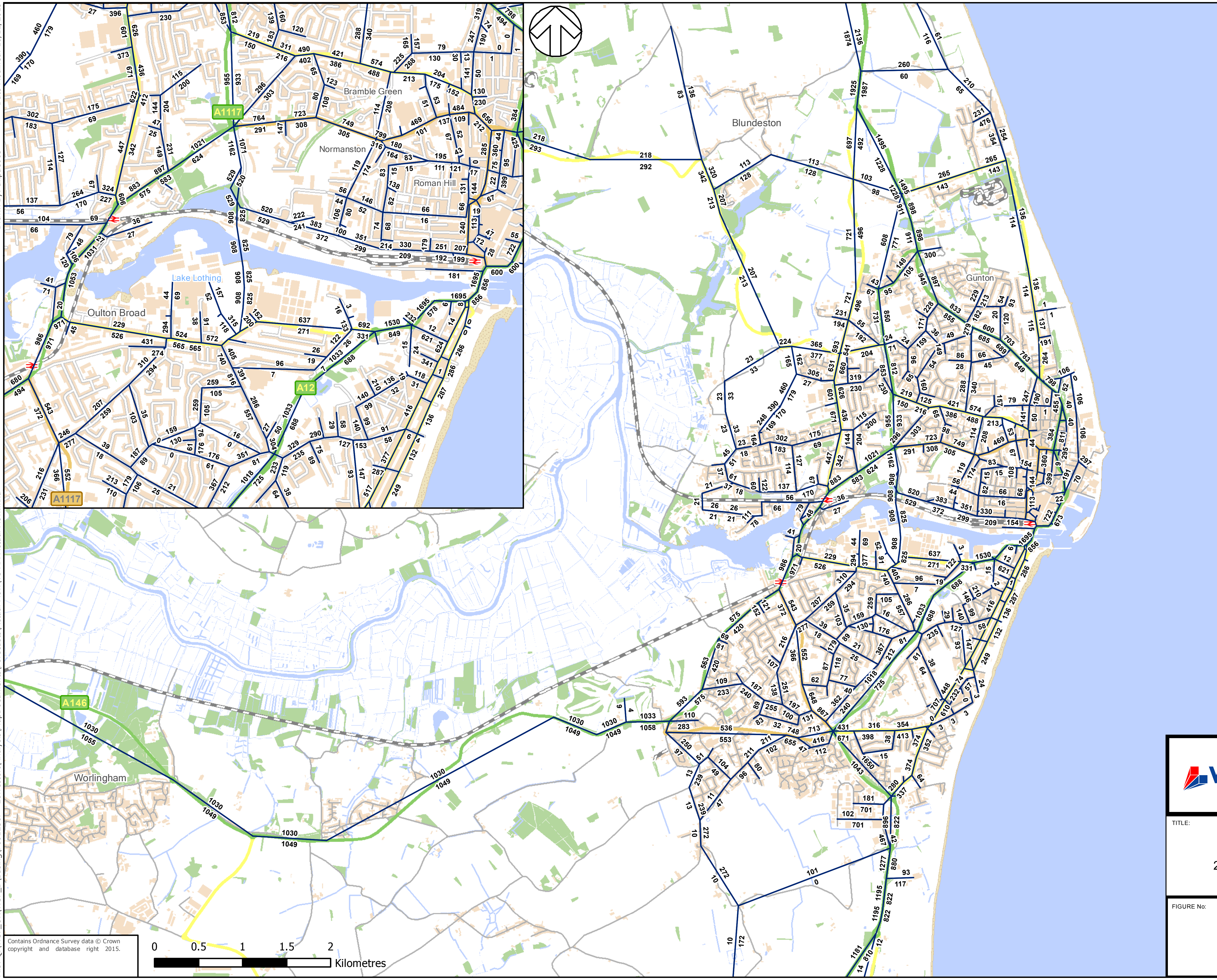
TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
C11 - DM
PM PEAK

FIGURE No:

FIGURE G.15

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_C11-DM_PM_2035.mxd
Drawn By: ukrdt001
Date Modified: 10/12/2015



Key

T3 Network

WSP | PARSONS BRINCKERHOFF

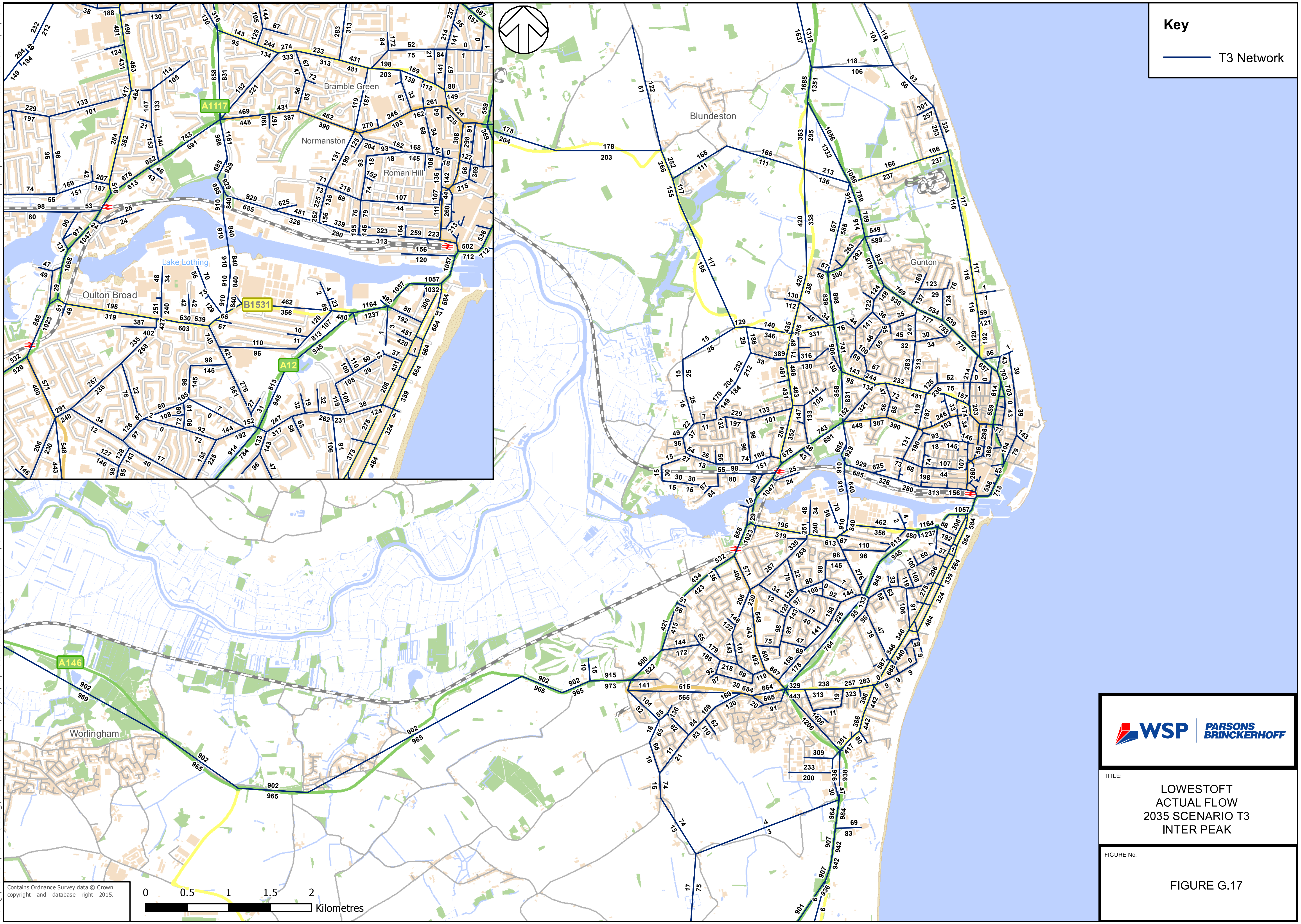
TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO T3
AM PEAK

FIGURE No:

FIGURE G.16

Date Modified: 10/12/2015
Drawn By: ukpde003
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\T3 AM Actual Flow.mxd



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO T3
INTER PEAK

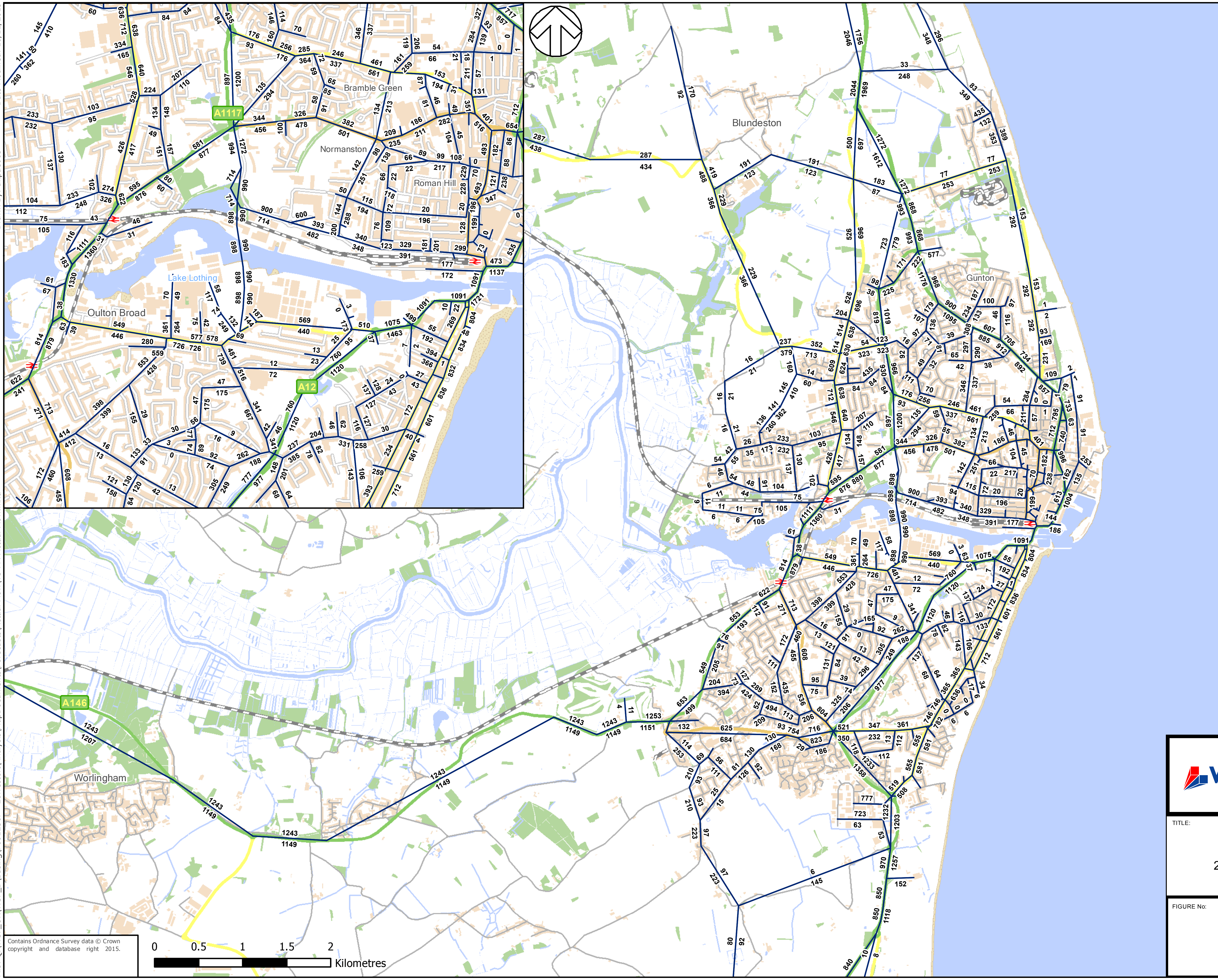
FIGURE No:

FIGURE G.17

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\T3 IP Actual Flow.mxd

Drawn By: ukpde003

Date Modified: 10/12/2015



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO T3
PM PEAK

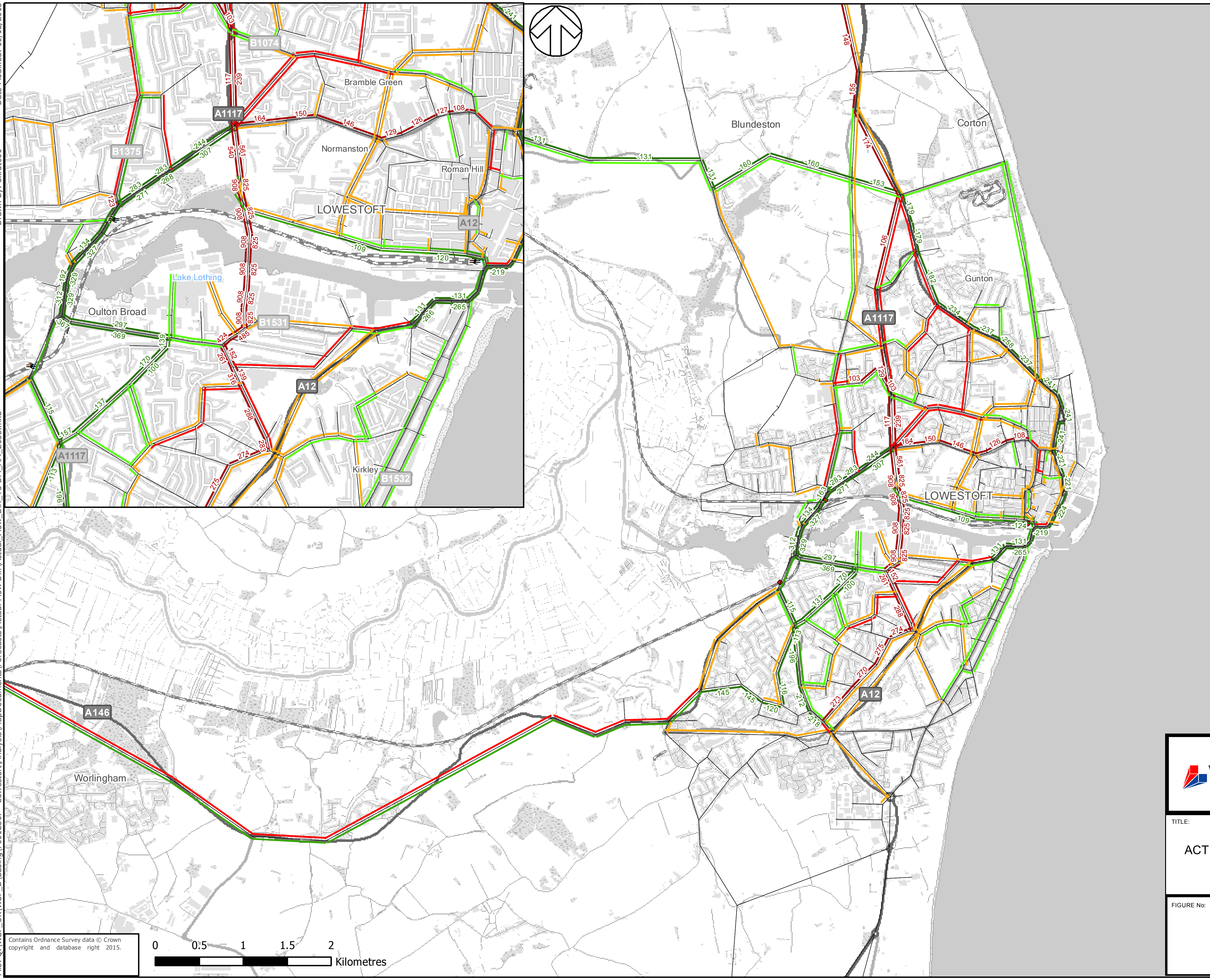
FIGURE No:

FIGURE G.18

Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\T3 PM Actual Flow.mxd



Key

Flow Difference (pcu/hr)

- < -100
- -100 - -50
- -50 - -10
- -10 - 10
- 10 - 50
- 50 - 100
- > 100
- Network

Date Modified: 10/12/2015
Drawn By: ukrdt001
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_T3-DM_AM_2035.mxd

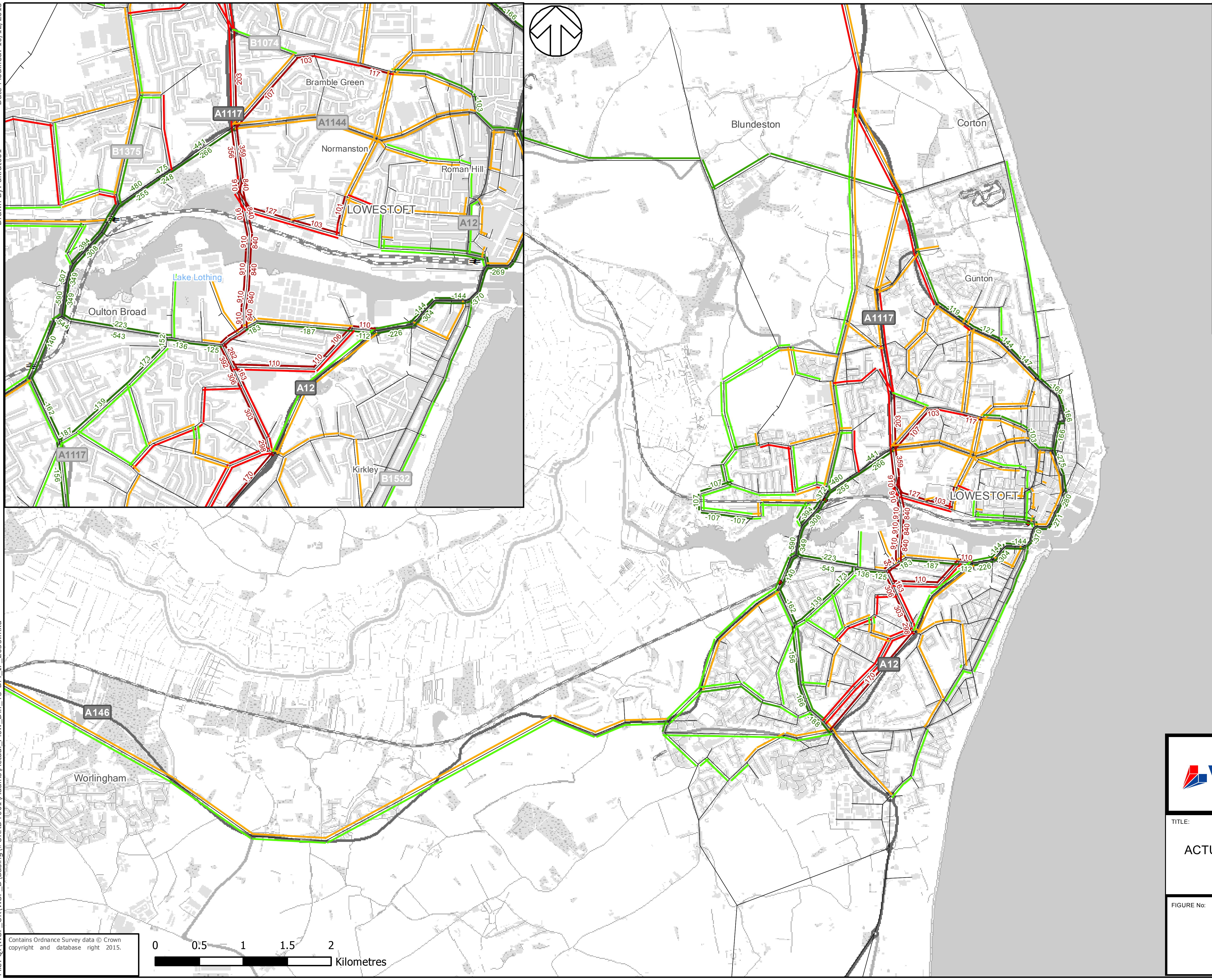
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
T3 - DM
AM PEAK

FIGURE No:

FIGURE G.19



Key

Flow Difference (pcu/hr)

- < -100
- -100 - -50
- -50 - -10
- -10 - 10
- 10 - 50
- 50 - 100
- > 100
- Network

0 0.5 1 1.5 2 Kilometres

WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
T3 - DM
INTER PEAK

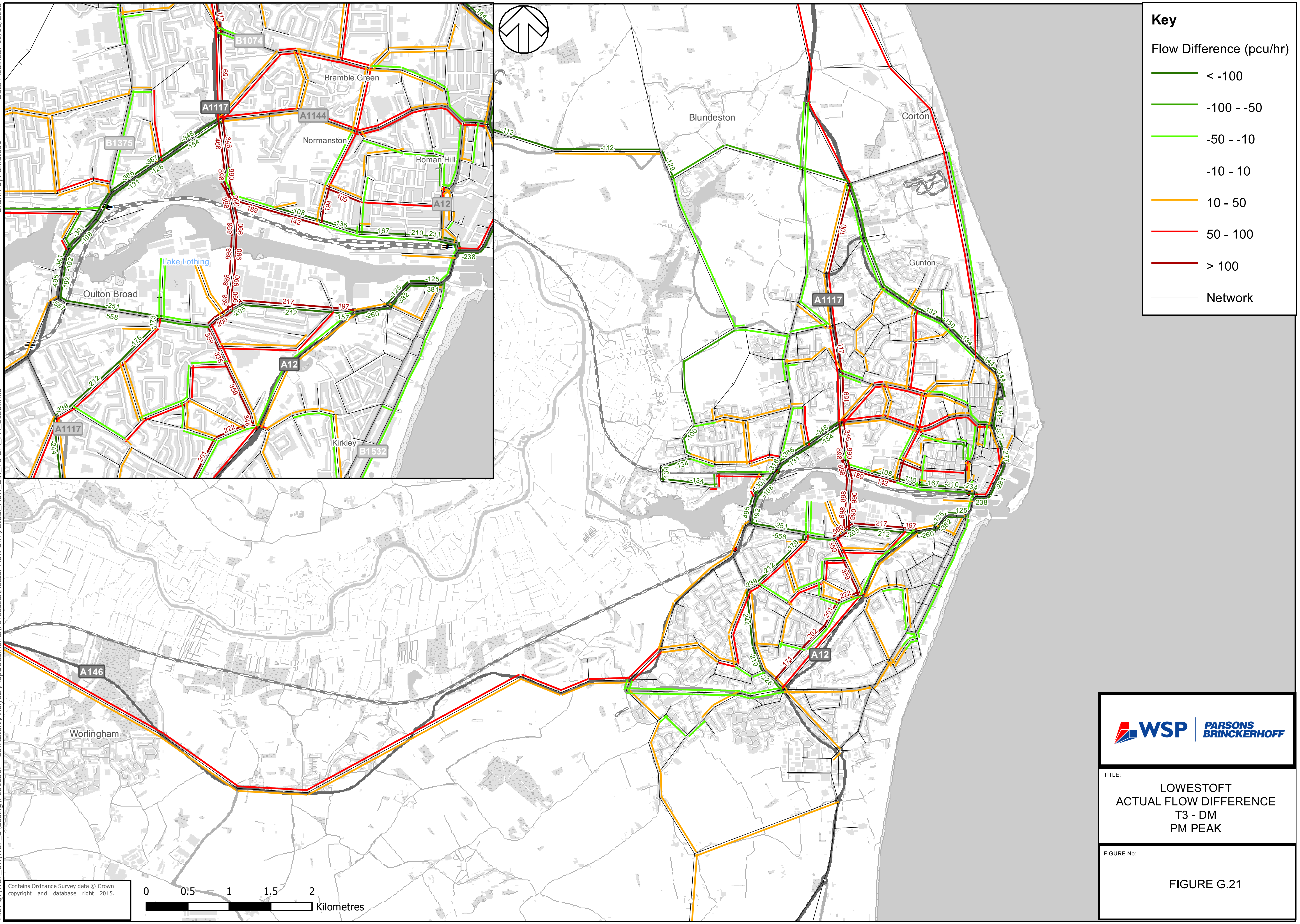
FIGURE No:

FIGURE G.20

File: Q:\WSP_UK\WSP_D\Basing\#UKRDT001\Addins\Actual_Flow_Diff_T3-DM_IP_2035.mxd

Drawn By: ukrdt001

Date Modified: 10/12/2015



WSP | PARSONS BRINCKERHOFF

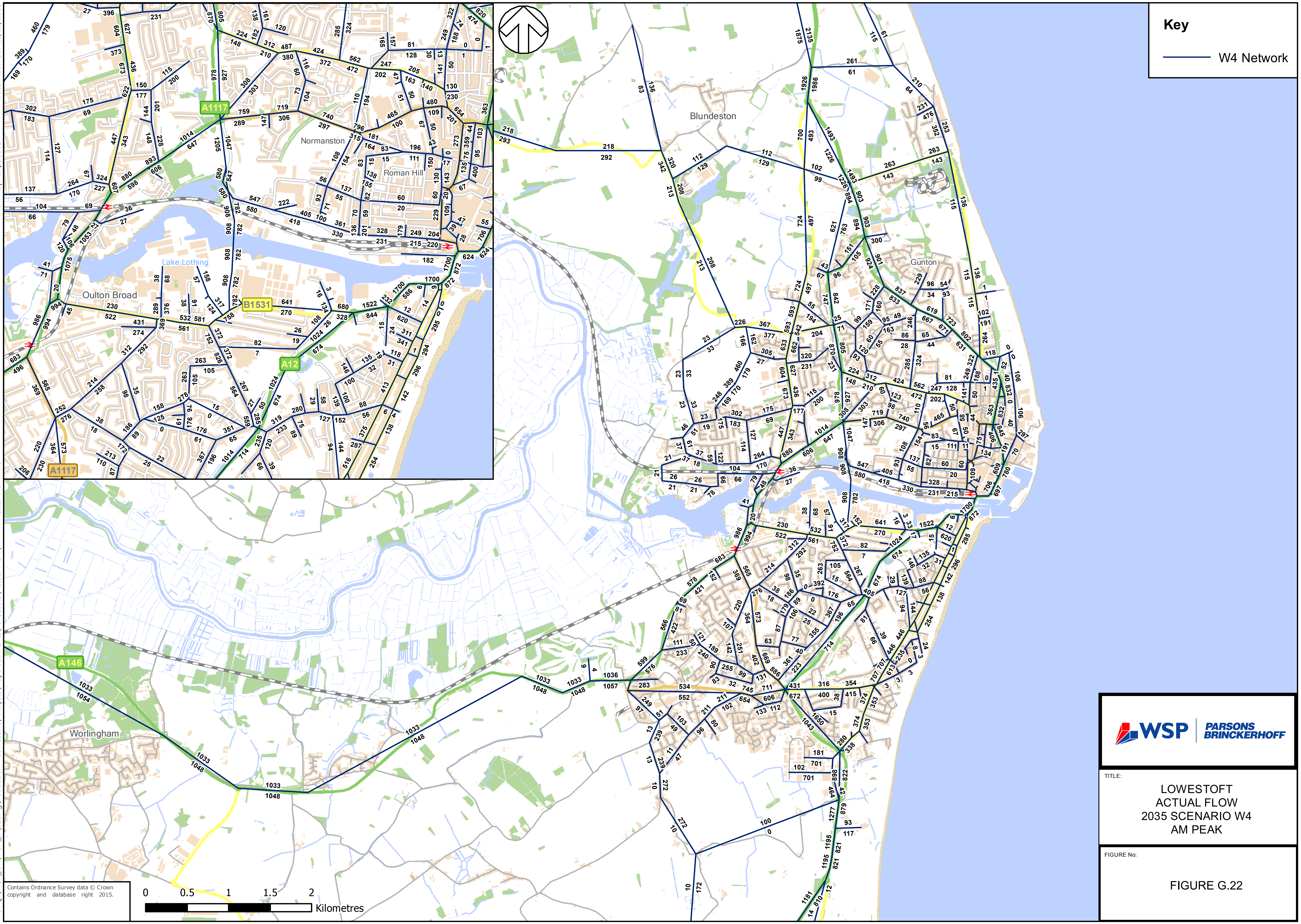
TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
T3 - DM
PM PEAK

FIGURE No:

FIGURE G.21

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_T3-DM_PM_2035.mxd Drawn By: ukrdt001 Date Modified: 10/12/2015



Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D(Basing)\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\W4 AM Actual Flow.mxd

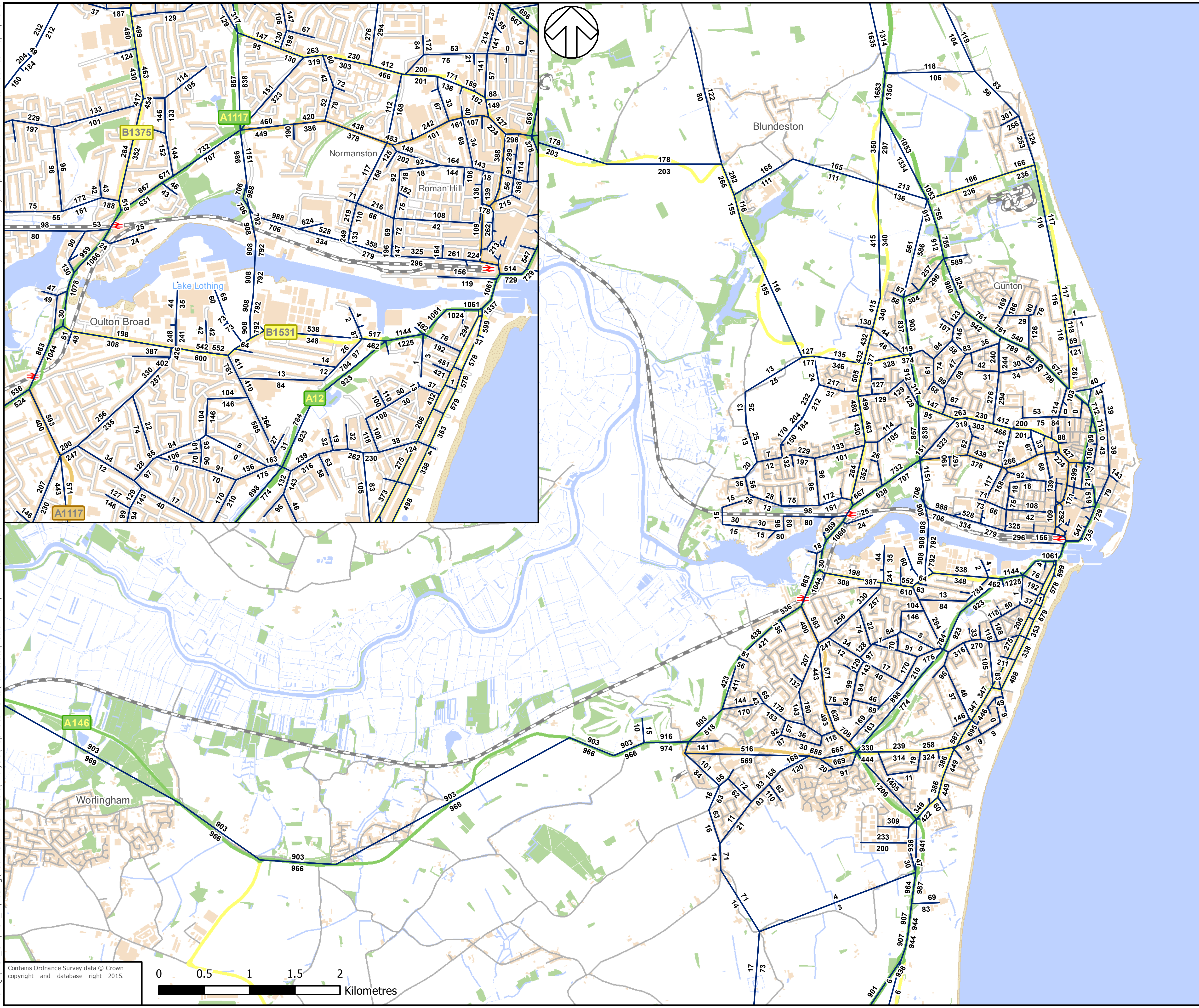
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO W4
AM PEAK

FIGURE No:

FIGURE G.22



Key

W4 Network

WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO W4
INTER PEAK

FIGURE No:

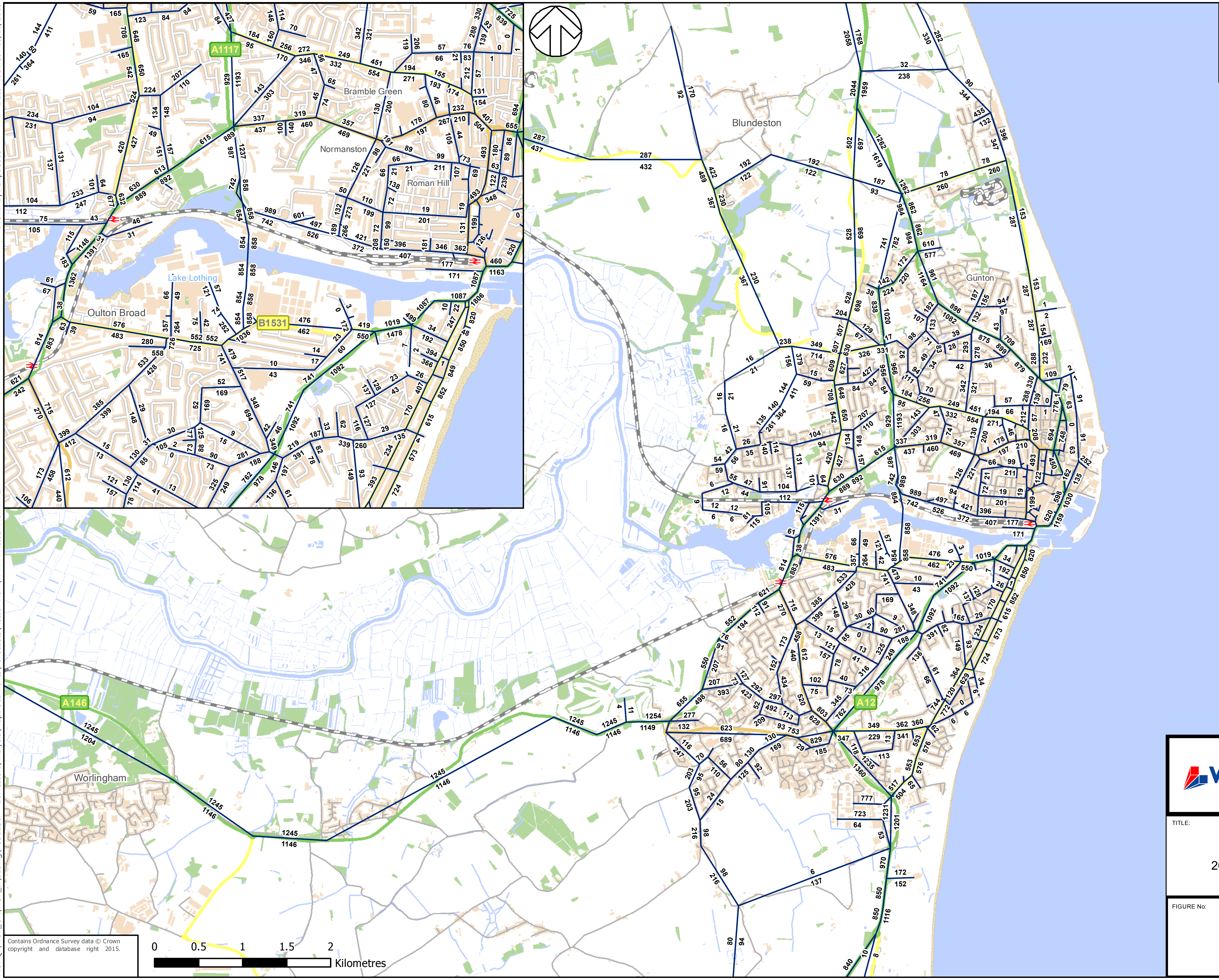
FIGURE G.23

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\W4 IP Actual Flow.mxd

Drawn By: ukpde003

Date Modified: 10/12/2015

Date Modified: 10/12/2015
Drawn By: ukpde003
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow\W4 PM Actual Flow.mxd



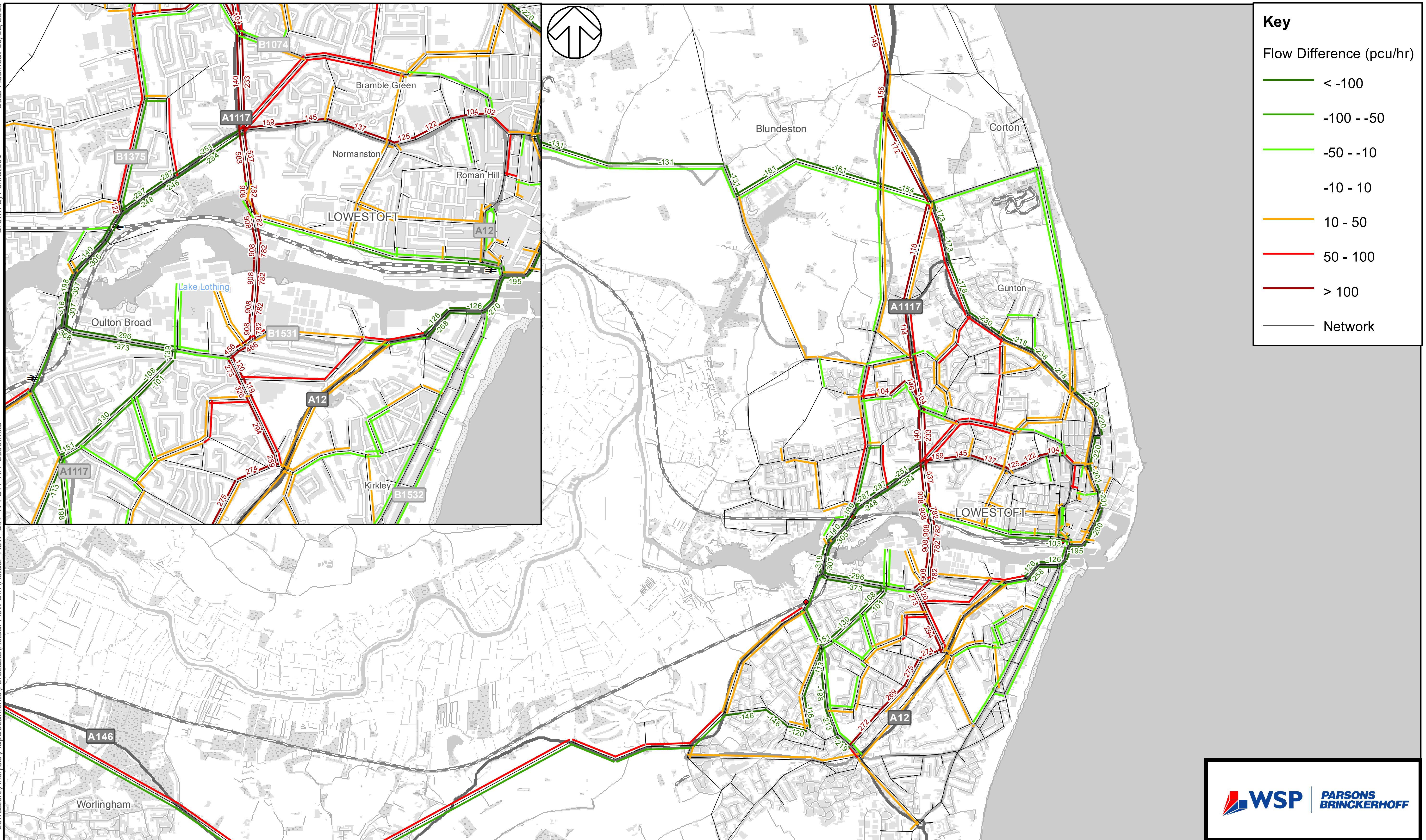
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW
2035 SCENARIO W4
PM PEAK

FIGURE No:

FIGURE G.24



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
W4 - DM
AM PEAK

FIGURE No:

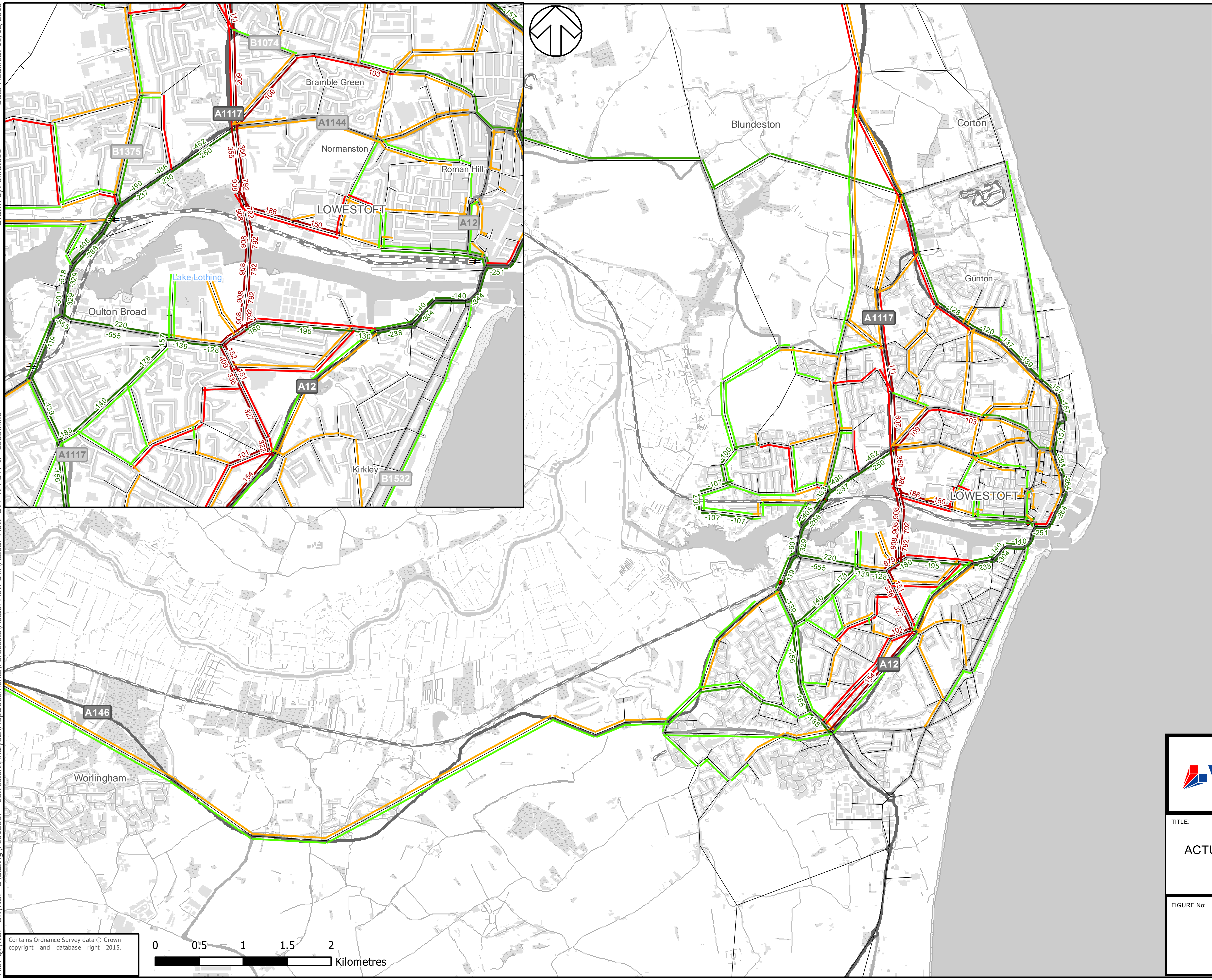
FIGURE G.25

0 0.5 1 1.5 2 Kilometres

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_W4-DM_AM_2035.mxd

Drawn By: ukrdt001

Date Modified: 10/12/2015



Key

Flow Difference (pcu/hr)

- < -100
- -100 - -50
- -50 - -10
- -10 - 10
- 10 - 50
- 50 - 100
- > 100
- Network

WSP | PARSONS BRINCKERHOFF

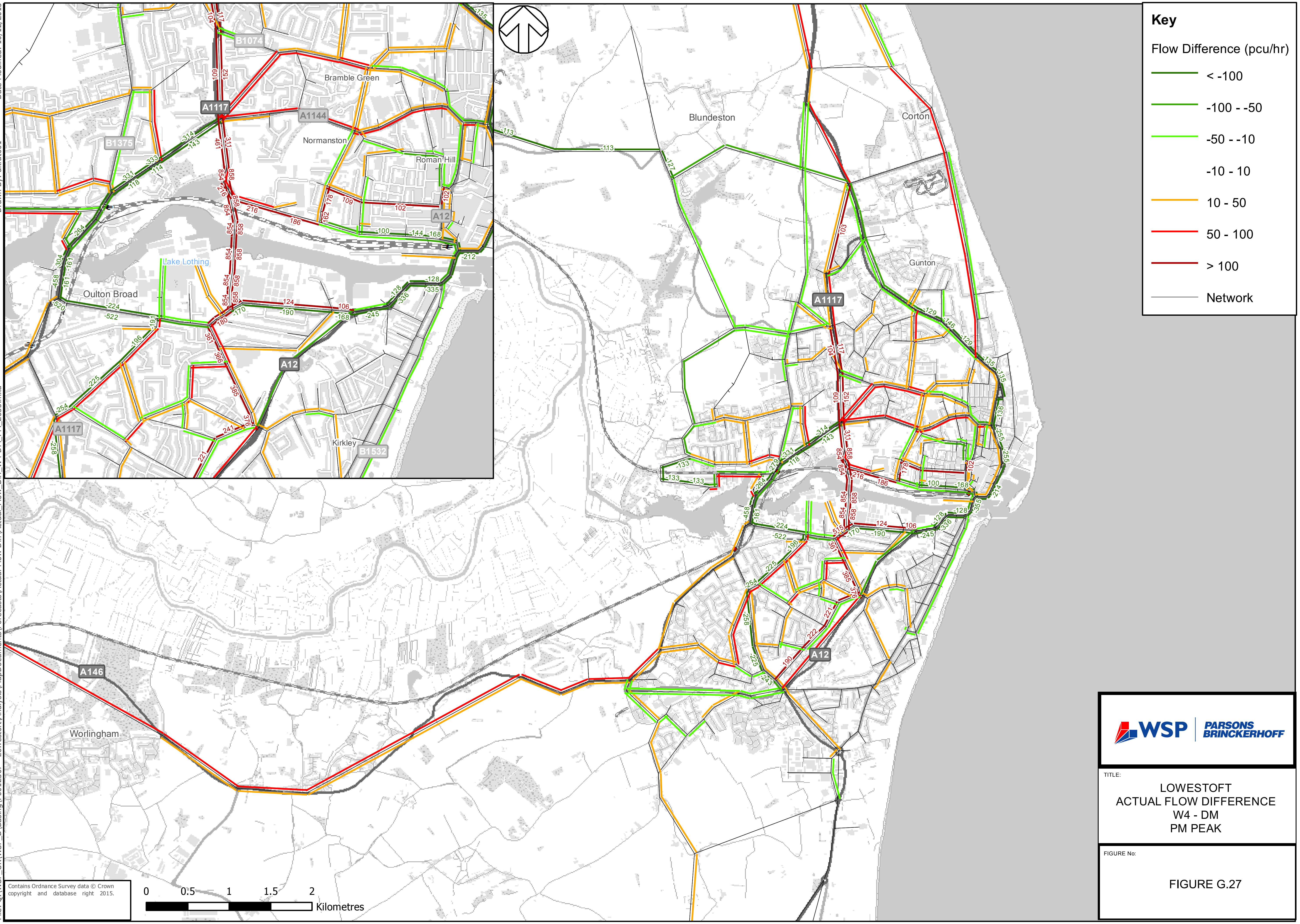
TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
W4 - DM
INTER PEAK

FIGURE No:

FIGURE G.26

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_W4-DM_IP_2035.mxd
Drawn By: ukrdt001
Date Modified: 10/12/2015



TITLE:

LOWESTOFT
ACTUAL FLOW DIFFERENCE
W4 - DM
PM PEAK

FIGURE No:

FIGURE G.27

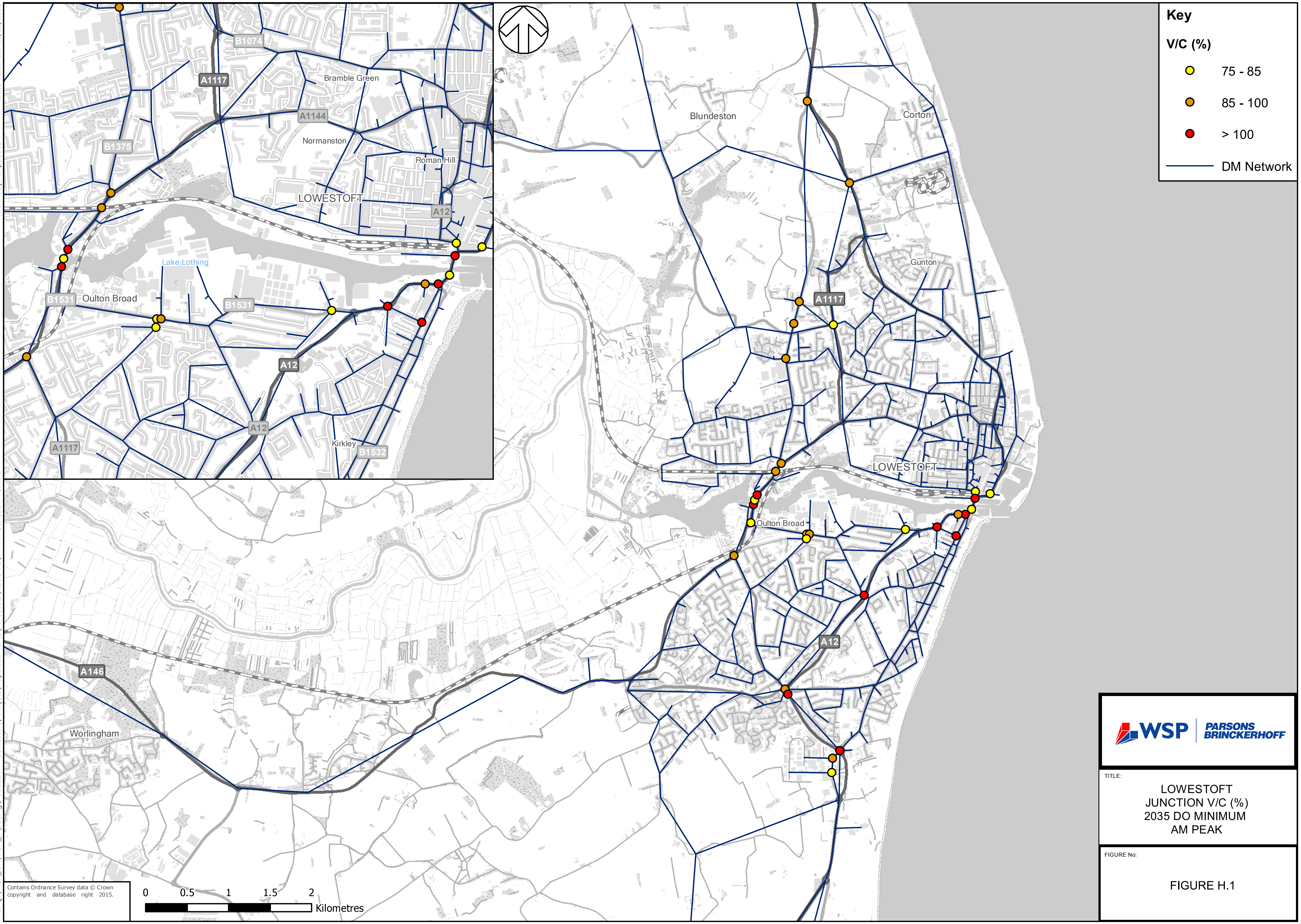
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Actual Flow Diff\Actual_Flow_Diff_W4-DM_PM_2035.mxd

Drawn By: ukrdt001

Date Modified: 10/12/2015

Appendix H

V/C PLOTS



WSP | PARSONS BRINCKERHOFF

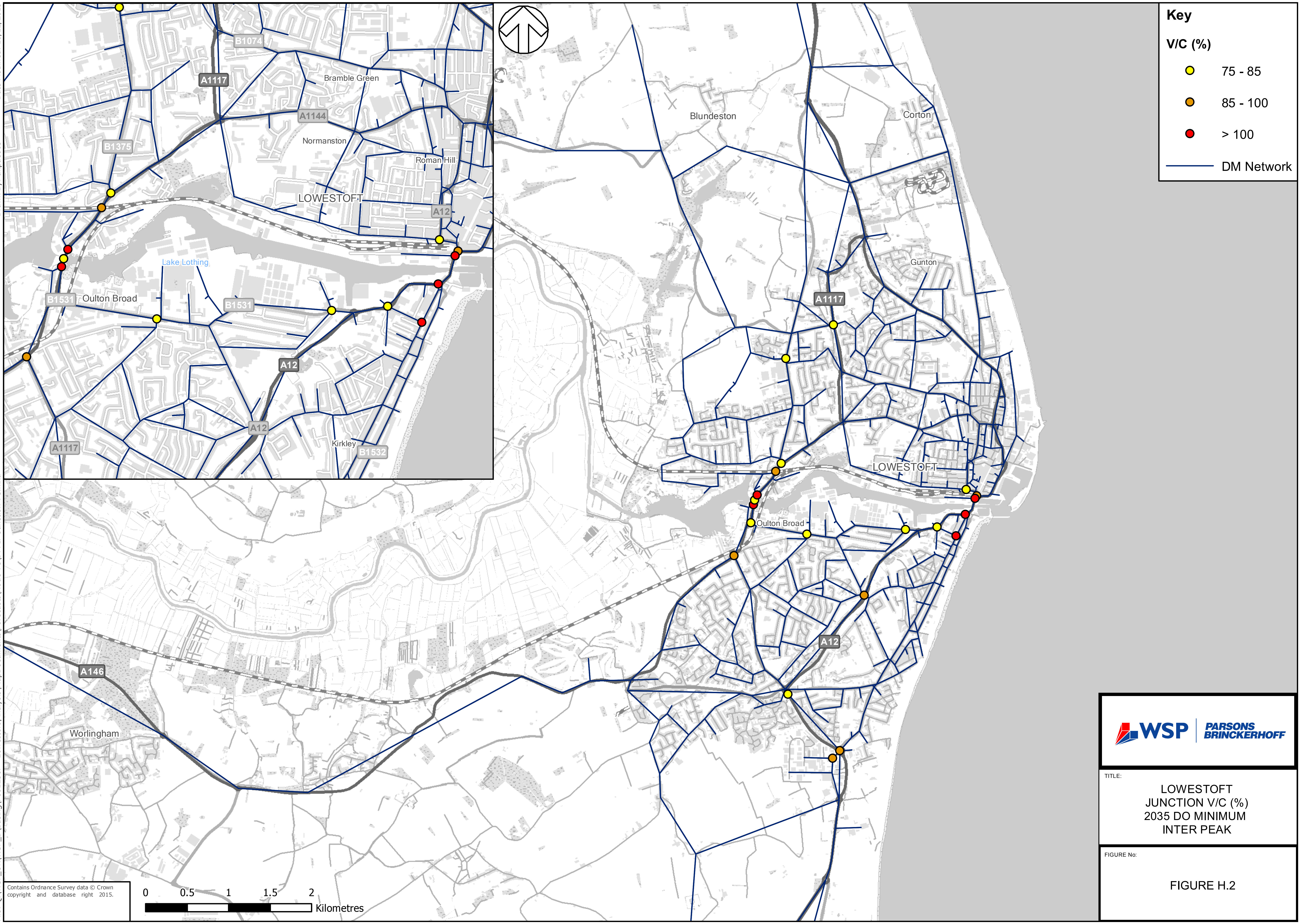
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 DO MINIMUM
AM PEAK

FIGURE No:

FIGURE H.1

Date Modified: 10/12/2015
Drawn By: ukpde003
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\DM AM Junction VC.mxd



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 DO MINIMUM
INTER PEAK

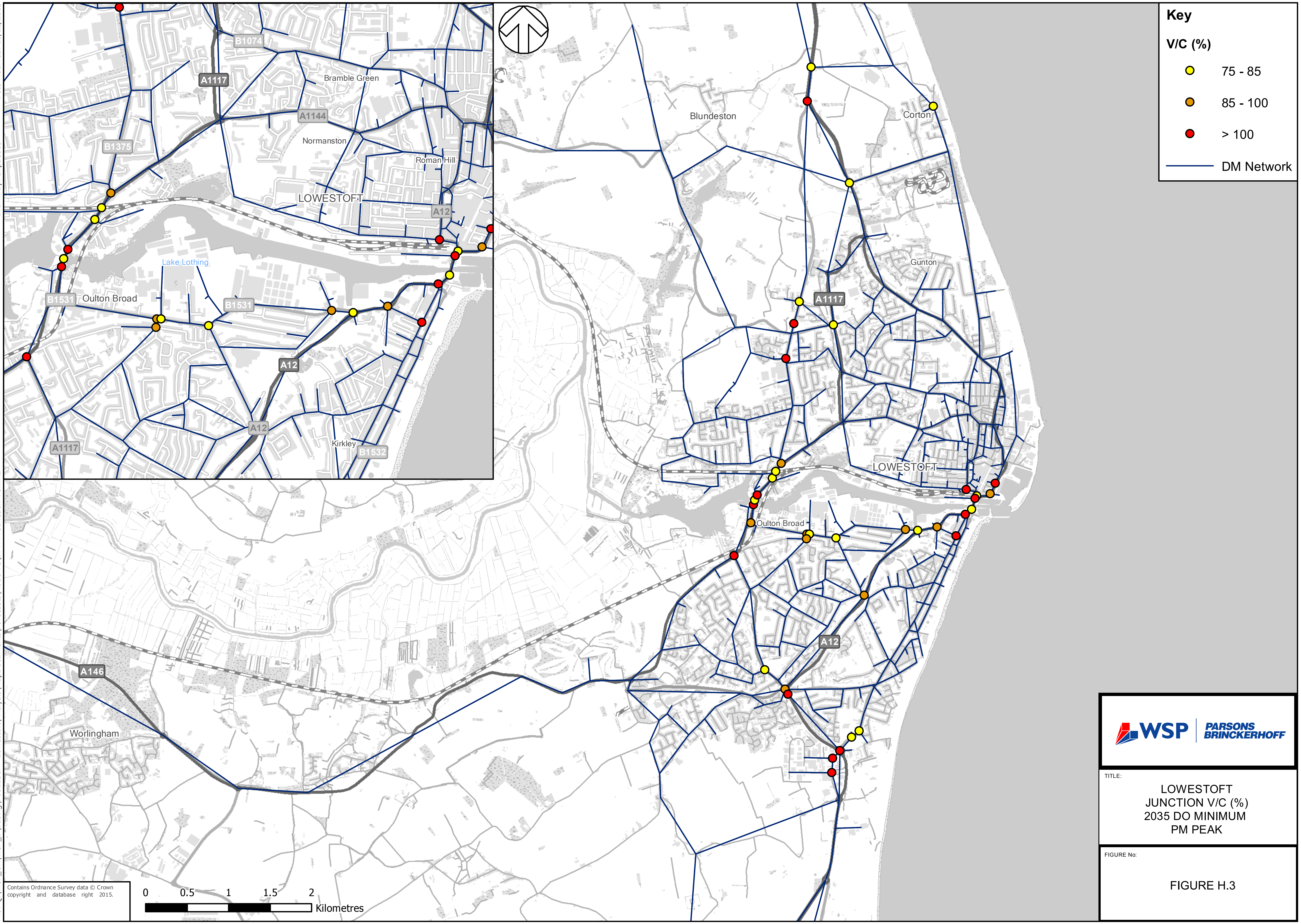
FIGURE No:

FIGURE H.2

File: Q:\WSP_UK\WSP_D(Basing)\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\DM IP Junction VC.mxd

Drawn By: ukpde003

Date Modified: 10/12/2015



Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\DM PM Junction VC.mxd

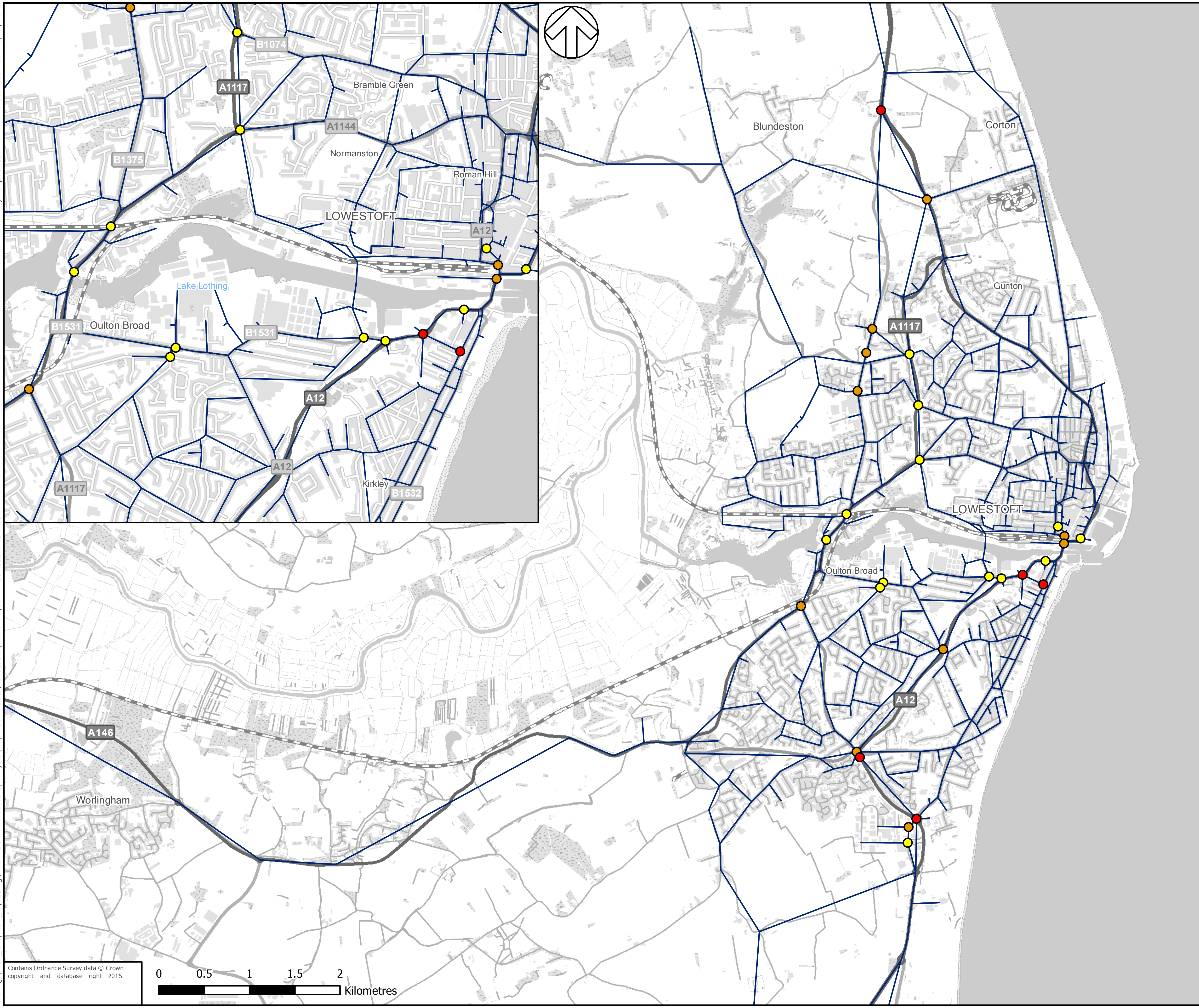
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 DO MINIMUM
PM PEAK

FIGURE No:

FIGURE H.3



Key

V/C (%)

- 75 - 85
- 85 - 100
- > 100
- C6 Network

WSP | PARSONS BRINCKERHOFF

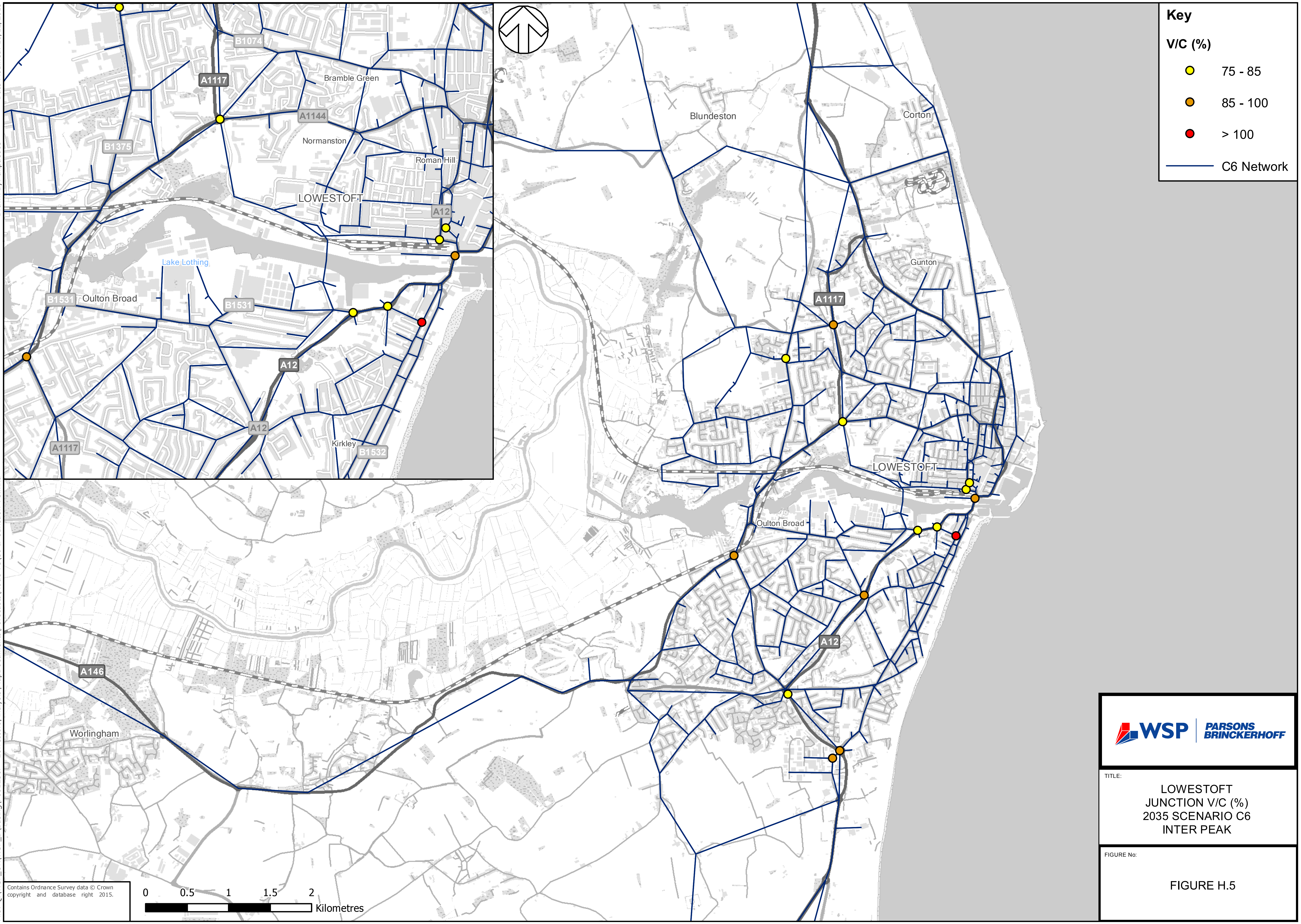
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO C6
AM PEAK

FIGURE No:

FIGURE H.4

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\C6 AM Junction VC.mxd Drawn By: ukpde003 Date Modified: 10/12/2015



WSP | PARSONS BRINCKERHOFF

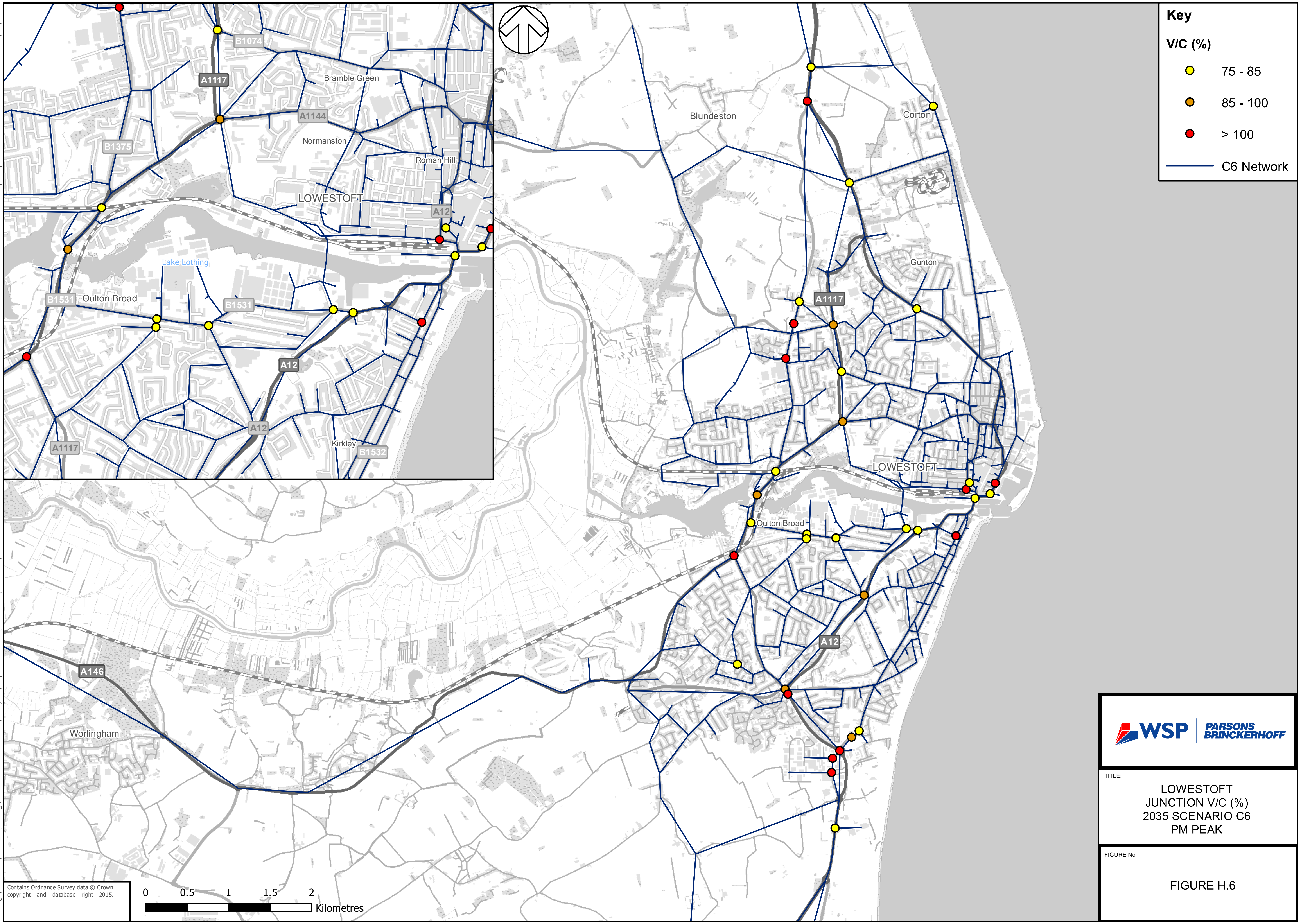
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO C6
INTER PEAK

FIGURE No:

FIGURE H.5

Date Modified: 10/12/2015
Drawn By: ukpde003
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\C6 IP Junction VC.mxd



WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT JUNCTION V/C (%) 2035 SCENARIO C6 PM PEAK

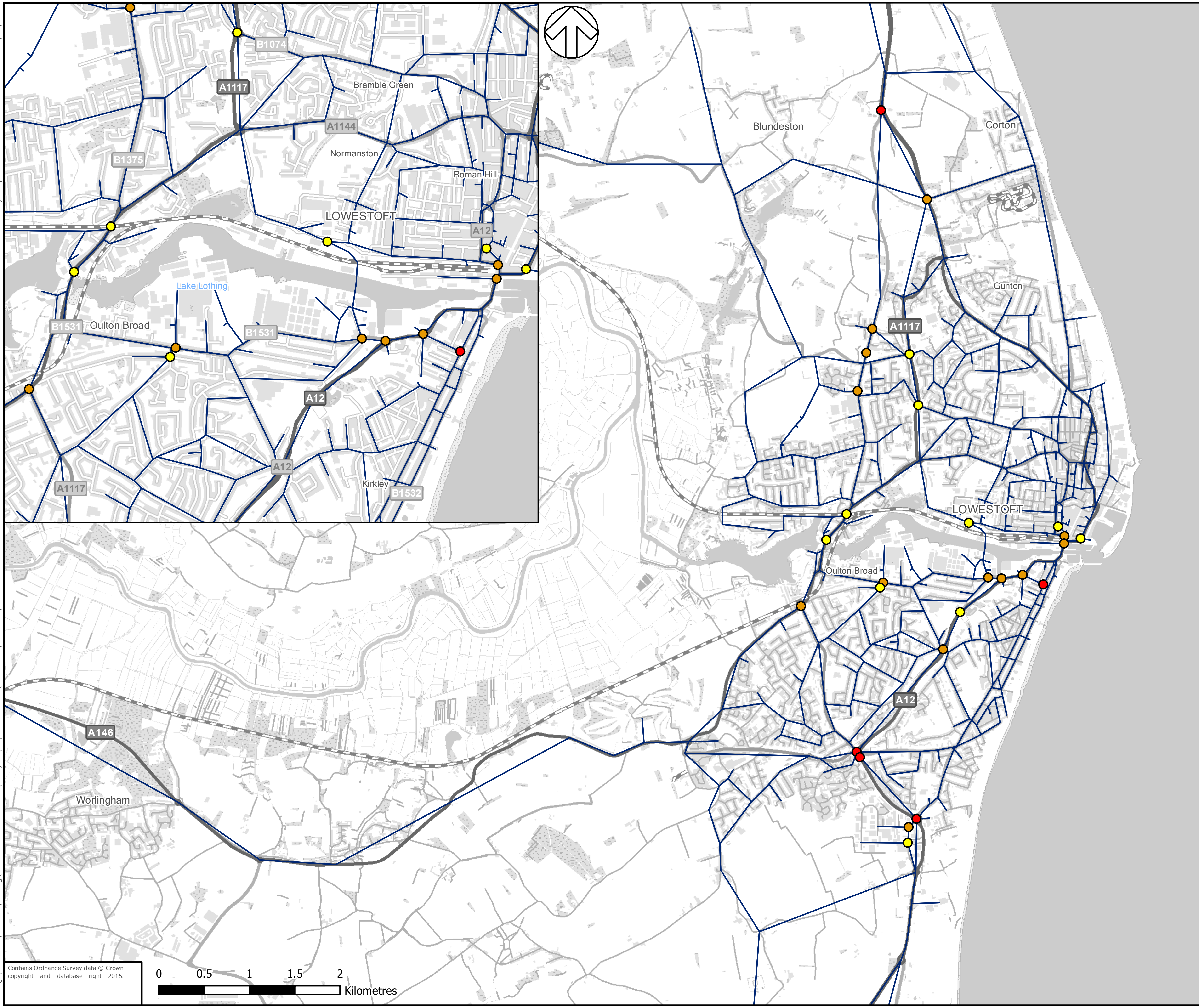
FIGURE No:

FIGURE H.6

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\C6 PM Junction VC.mxd

Drawn By: ukpde003

Date Modified: 10/12/2015



File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\C11 AM Junction VC.mxd

Drawn By: ukpde003

Date Modified: 10/12/2015

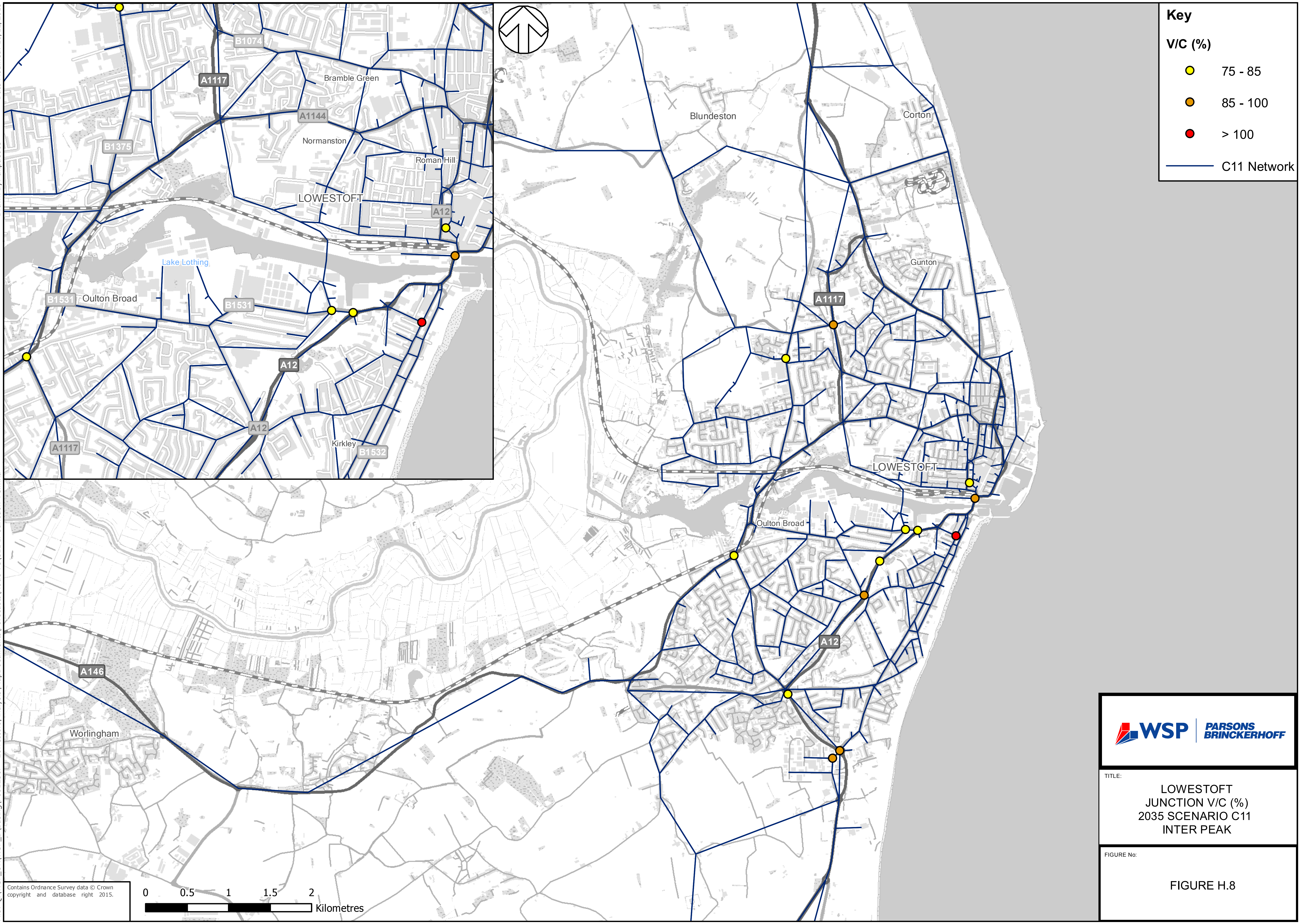
WSP | PARSONS BRINCKERHOFF

TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO C11
AM PEAK

FIGURE No:

FIGURE H.7



WSP | PARSONS BRINCKERHOFF

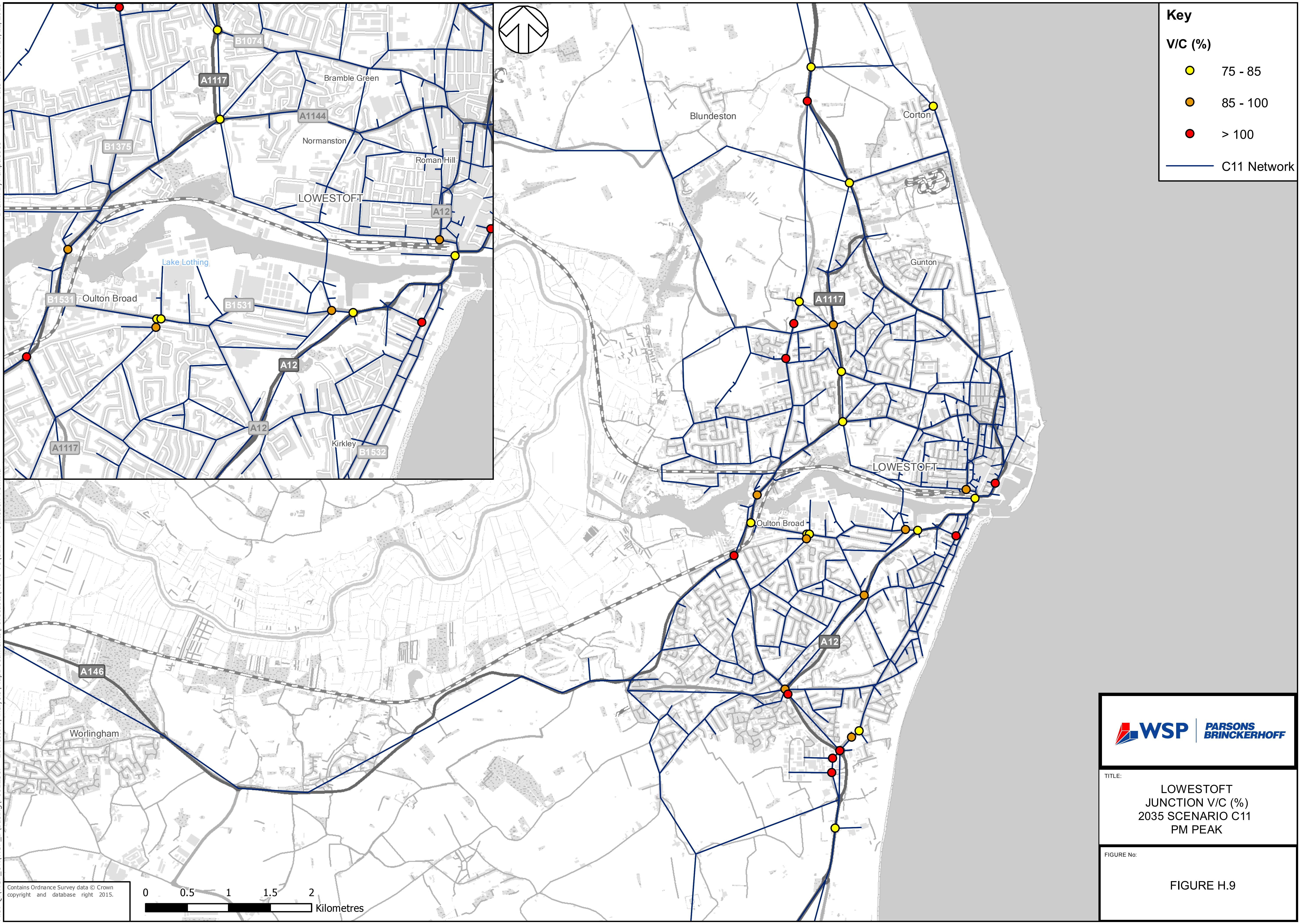
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO C11
INTER PEAK

FIGURE No:

FIGURE H.8

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\C11 IP Junction VC.mxd
Drawn By: ukpde003
Date Modified: 10/12/2015



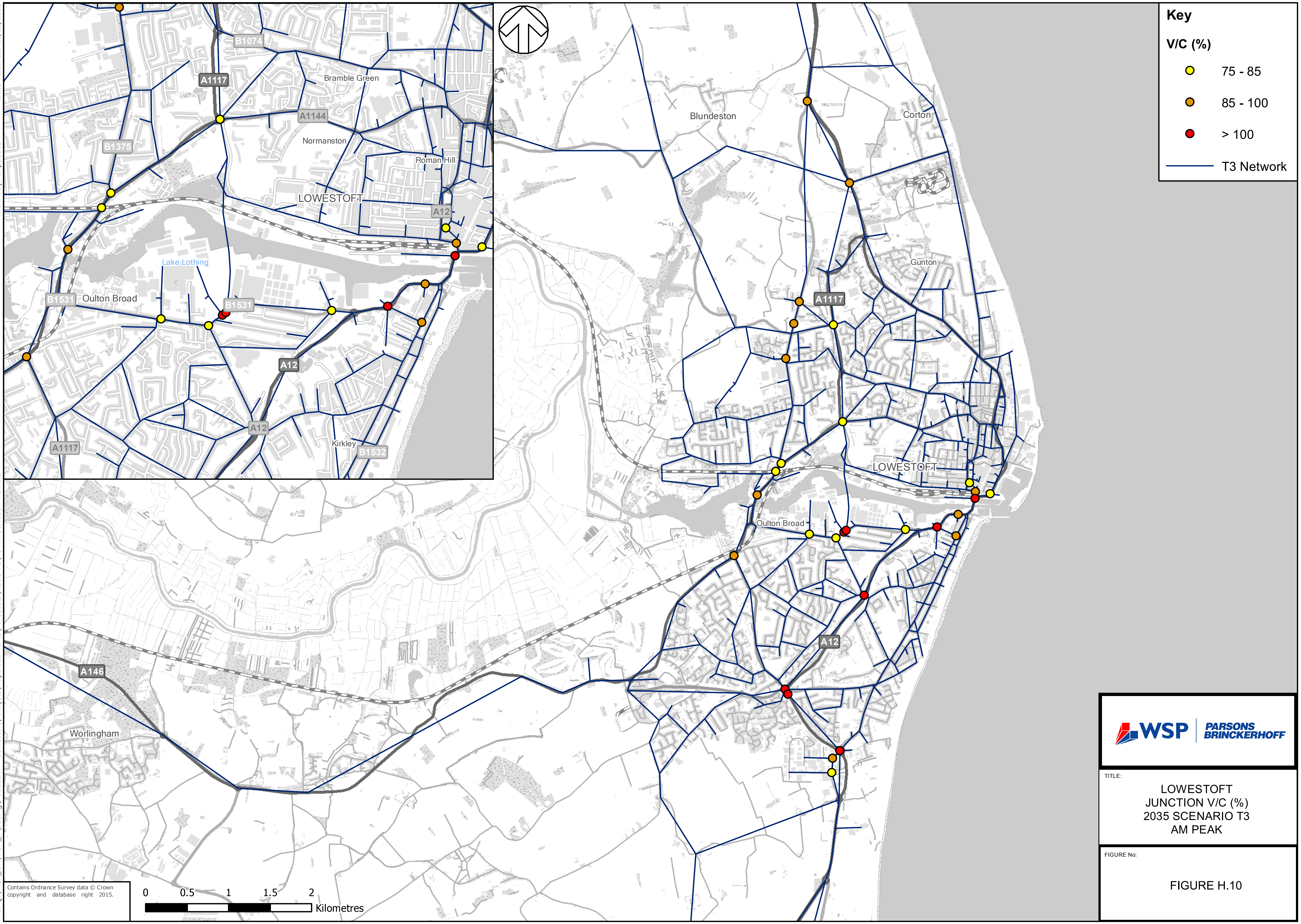
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO C11
PM PEAK

FIGURE No:

FIGURE H.9

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\C11 PM Junction VC.mxd
Drawn By: ukpde003
Date Modified: 10/12/2015



WSP | PARSONS BRINCKERHOFF

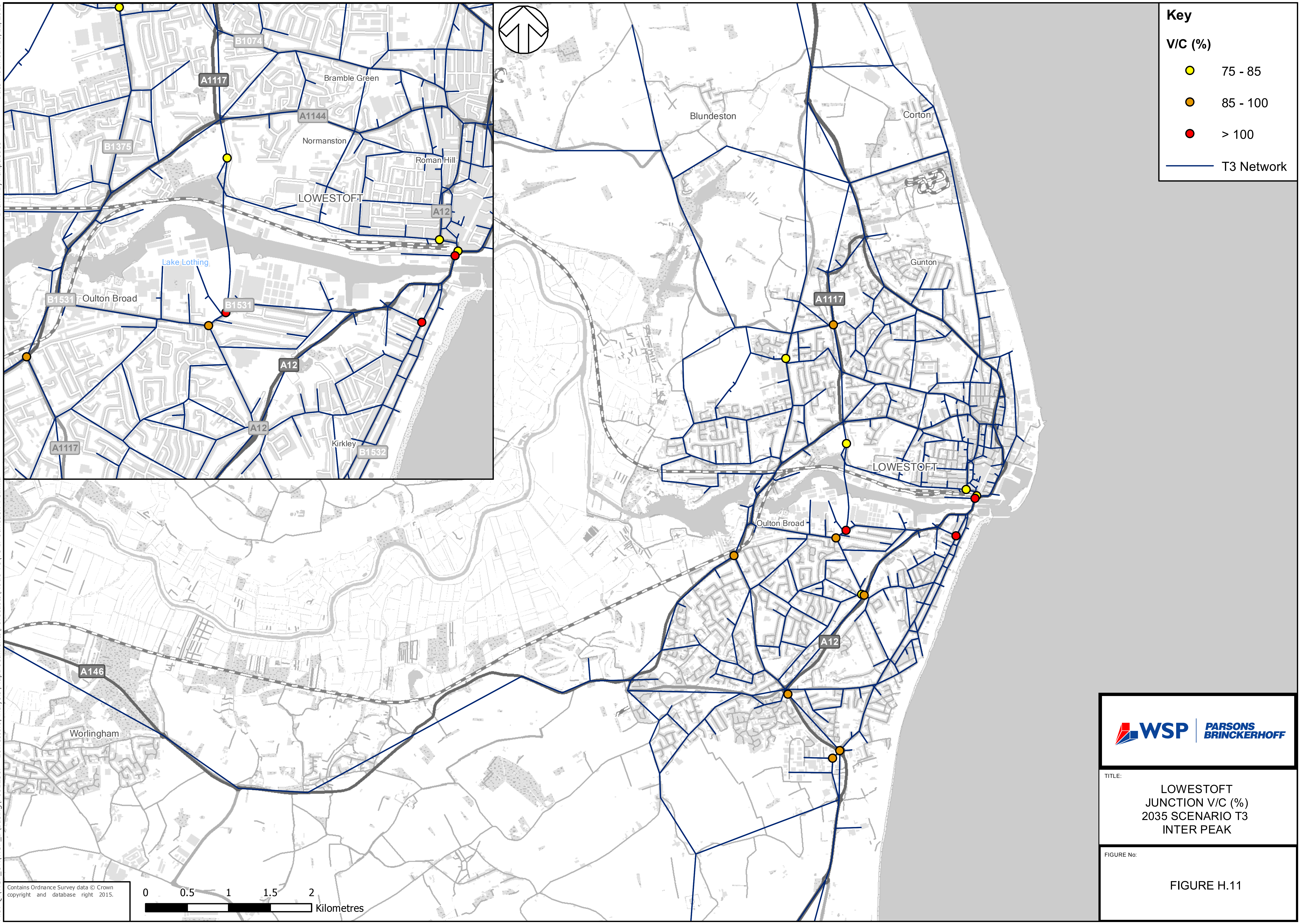
TITLE:

LOWESTOFT JUNCTION V/C (%) 2035 SCENARIO T3 AM PEAK

FIGURE No:

FIGURE H.10

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\T3 AM Junction VC.mxd
Drawn By: ukpde003
Date Modified: 10/12/2015



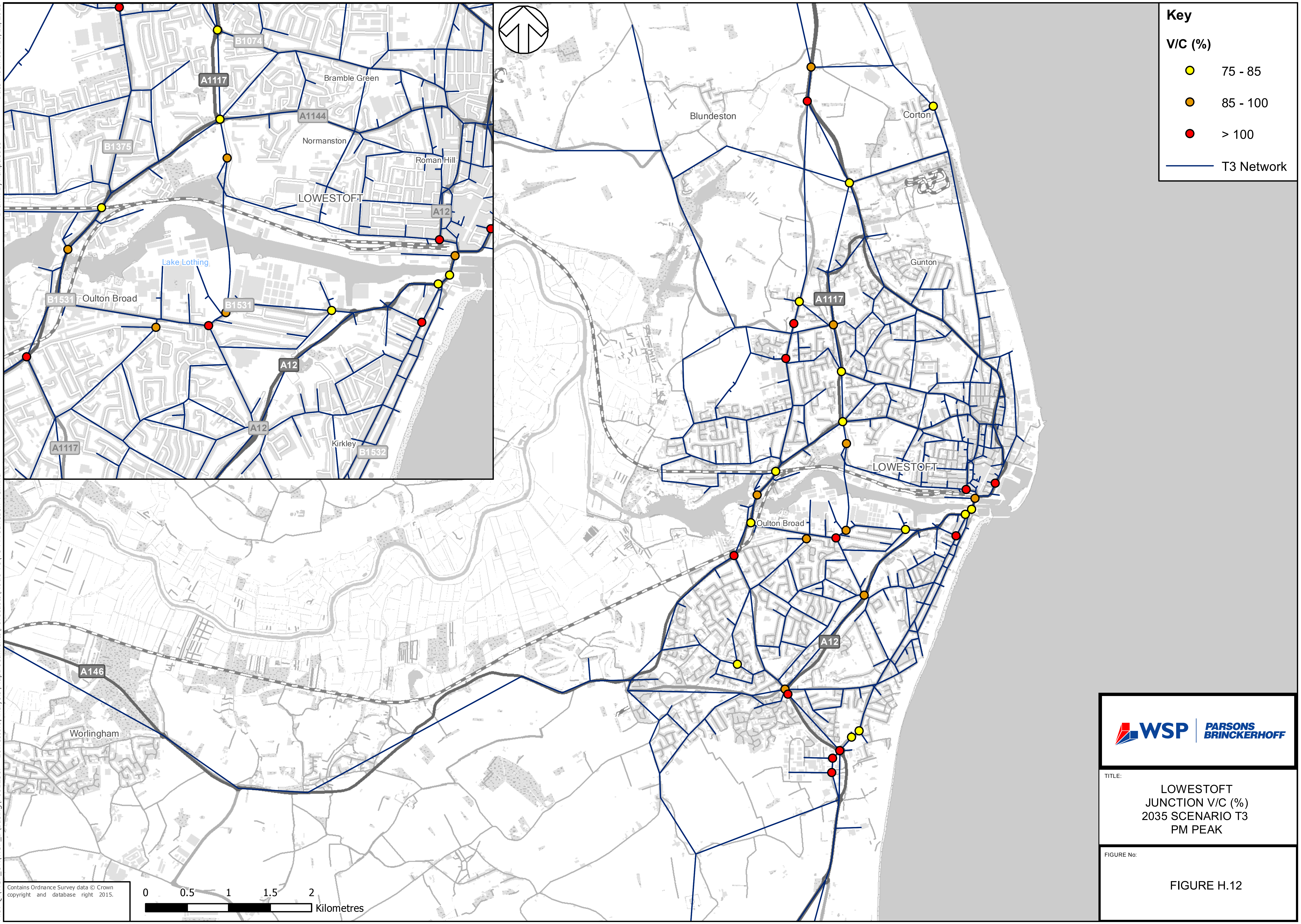
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO T3
INTER PEAK

FIGURE No:

FIGURE H.11

File: Q:\WSP_UK\WSP_D(Basing)\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\T3 IP Junction VC.mxd Drawn By: ukpde003 Date Modified: 10/12/2015



TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO T3
PM PEAK

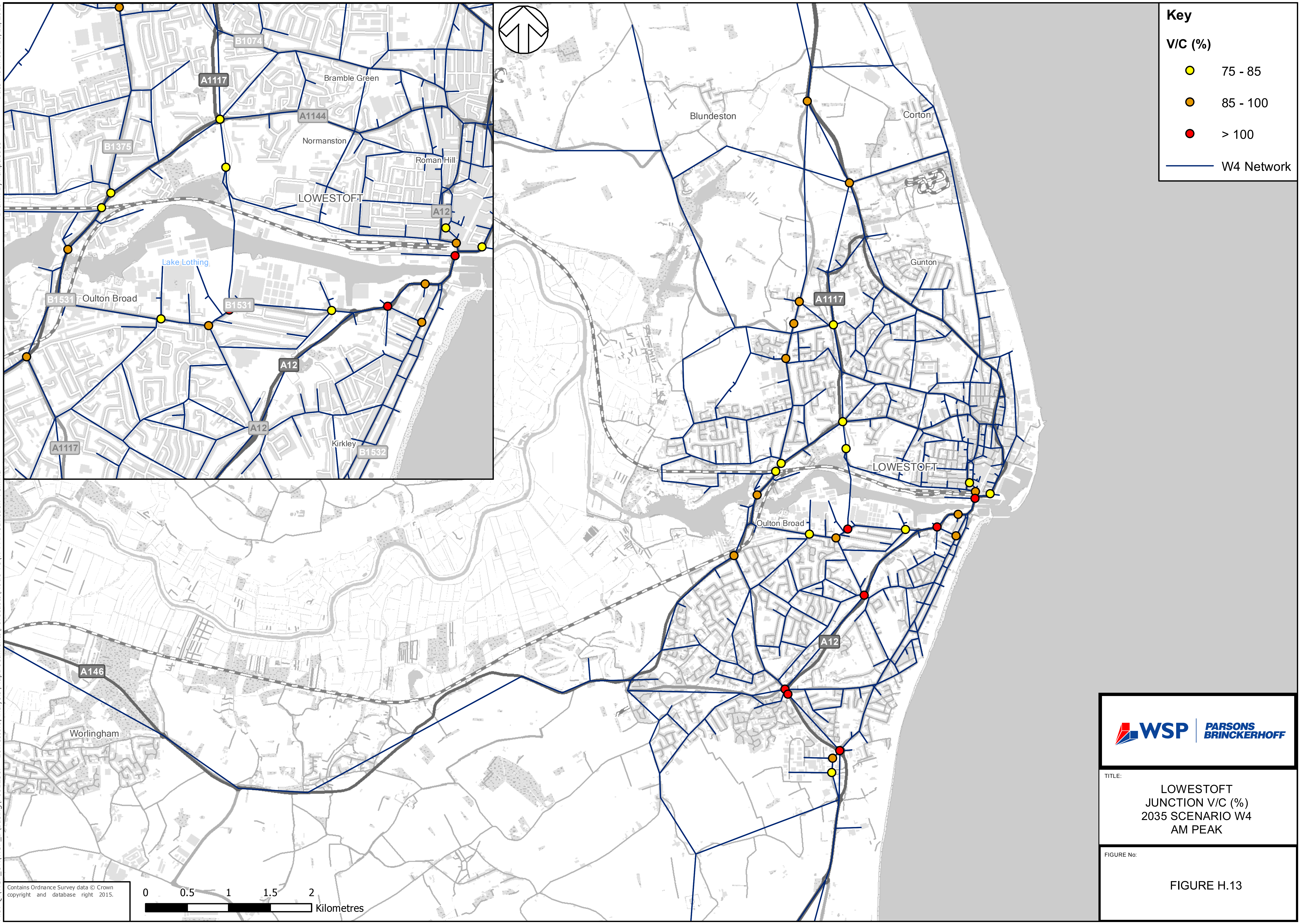
FIGURE No:

FIGURE H.12

Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\T3 PM Junction VC.mxd



TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO W4
AM PEAK

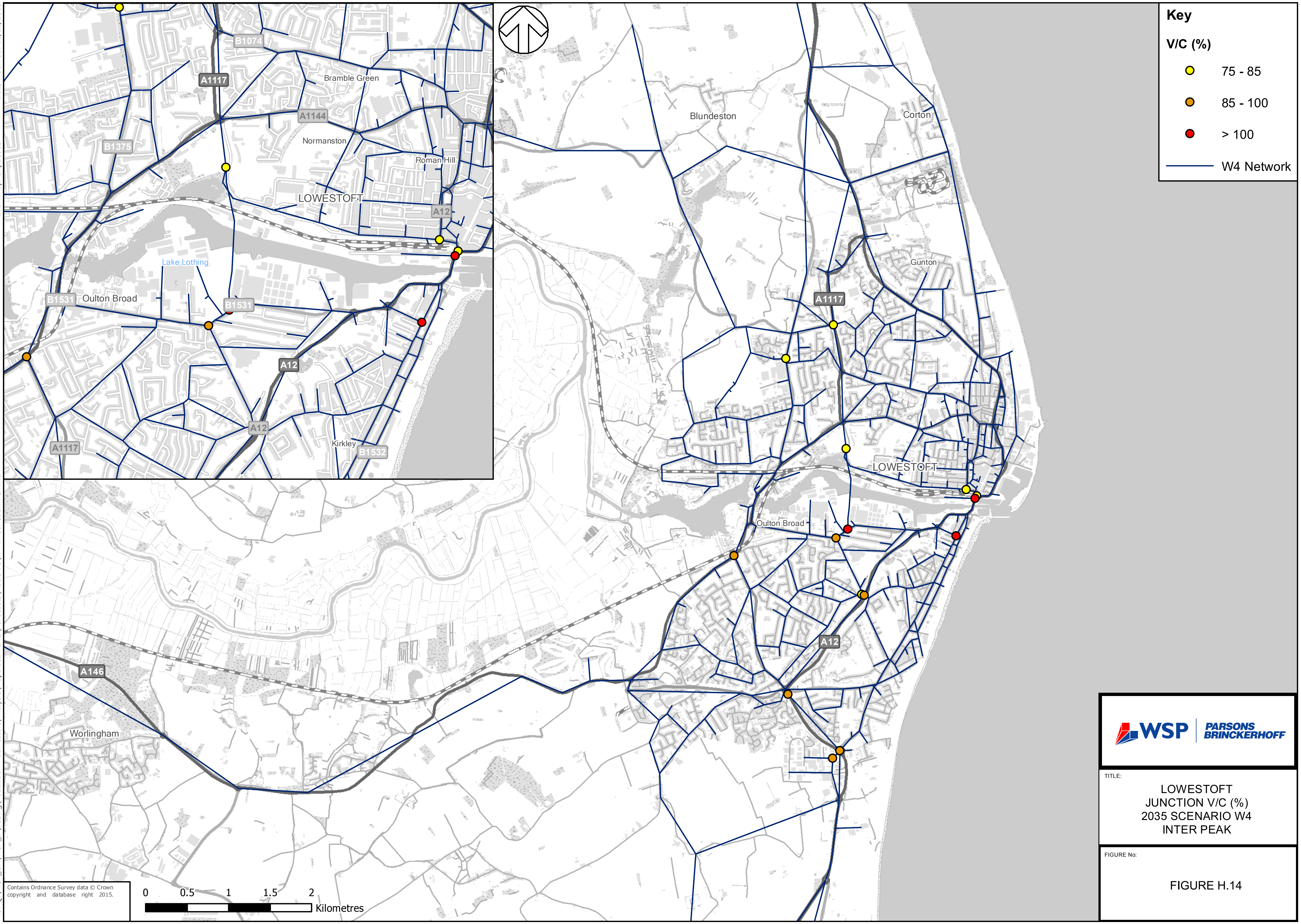
FIGURE No:

FIGURE H.13

Date Modified: 10/12/2015

Drawn By: ukpde003

File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\W4 AM Junction VC.mxd



Key

V/C (%)

- 75 - 85
- 85 - 100
- > 100
- W4 Network

WSP | PARSONS BRINCKERHOFF

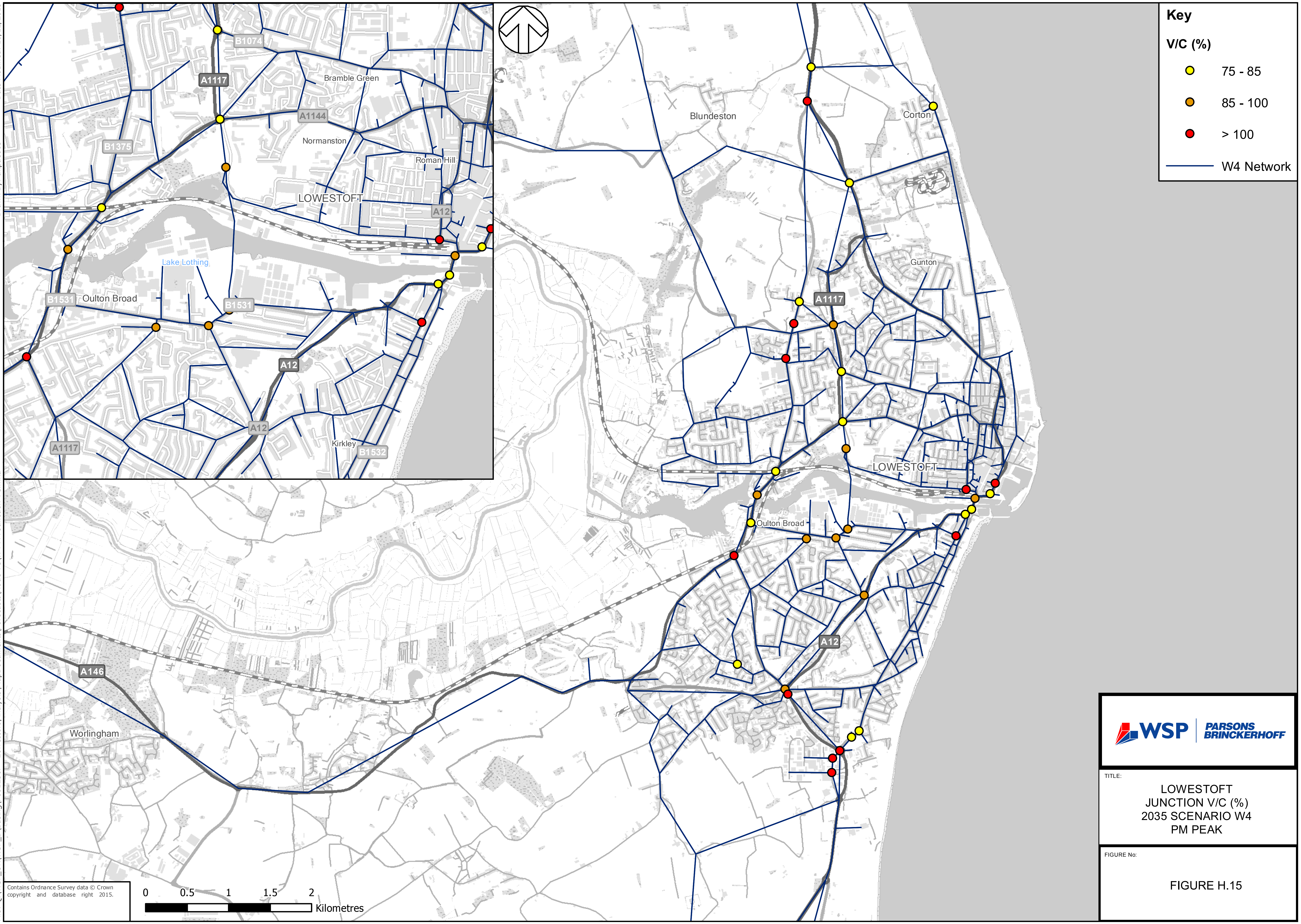
TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO W4
INTER PEAK

FIGURE No:

FIGURE H.14

Date Modified: 10/12/2015
Drawn By: ukpde003
File: Q:\WSP_UK\WSP_D\Basing\70012367 - Lowestoft\Analysis\MapDocuments\Forecasts\Node VC\W4 IP Junction VC.mxd



TITLE:

LOWESTOFT
JUNCTION V/C (%)
2035 SCENARIO W4
PM PEAK

FIGURE No:

FIGURE H.15