Appendix C – Paramics Forecast Report

Norfolk County Council

GREAT YARMOUTH TOWN MICROSIMULATION MODEL

Forecast Report

7.2C
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PUBLIC

Norfolk County Council

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Forecast Report

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GREAT YARMOUTH TOWN MICROSIMULATION MODEL

Forecast Report

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1 INTRODUCTION

1.1 THE GREAT YARMOUTH THIRD RIVER CROSSING SCHEME

1.1.1. The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. The Scheme consists of a new dual carriageway road, including a road bridge across the river, linking the A47 at Harfrey's Roundabout on the western side of the river to the A1243 South Denes Road on the eastern side. The Scheme would feature an opening span double leaf bascule (lifting) bridge across the river, involving the construction of two new 'knuckles' extending the quay wall into the river to support the bridge. The Scheme would include a bridge span over the existing Southtown Road on the western side of the river, and a bridge span on the eastern side of the river to provide an accommodation underpass for existing businesses, enabling the new dual carriageway road to rise westwards towards the crest of the new crossing.

1.2 PREVIOUS WORK

1.2.1. As part of a wider commission providing design, engineering and consultancy support services, Mouchel (now part of WSP) was appointed by Norfolk County Council (NCC), "The Applicant", to develop a Paramics Discovery model of Great Yarmouth to produce traffic forecasts as part of the assessments for informing the design and option assessment of the Scheme. More information about this previous forecast model can be found, for example, in the *Paramics Discovery Forecast Report* prepared by Mouchel in March 2017 (1076653-MOU-GEN-XX-TN-TP-0005), which formed part of the Outline Business Case submission.

1.2.2. Additionally, WSP was appointed to produce other traffic forecasts and economic appraisal outputs as part of a Value for Money (VfM) appraisal for the Scheme. The VfM case formed part of an Outline Business Case (OBC) which was submitted to the Department of Transport (DfT) in March 2017 and was subsequently approved.

1.3 REQUIREMENT FOR AN UPDATED MODEL

1.3.1. The Great Yarmouth Paramics Discovery microsimulation model, and a SATURN highway models and CUBE demand model of Great Yarmouth and the surrounding area, were developed in 2017 with a base year of 2016 and forecast years of 2023 and 2038 to inform the OBC.

1.3.2. These models have been updated to 2018 base year to inform the Transport Assessment (TA), the Economic Appraisal Report (EAR) and the Environmental Statement (ES) which will form part of the Development Consent Order (DCO) submission. Additionally, the Great Yarmouth Town Microsimulation Model informed the final design of the Scheme.

1.4 PURPOSE OF THIS REPORT

1.4.1. The purpose of this report is to provide information related to the development of the Great Yarmouth Town Microsimulation forecast models, describing the reference case and with scheme situations, and to demonstrate their fitness for the purpose of assessing town wide impacts of the Scheme. Additionally, this report is intended to provide high-level information about the Scheme performance, which will feed back to the Transport Assessment.

1.4.2. The report includes details regarding the description of the updated highway network and the cordoning of matrices from parallel SATURN forecast models, and the process to produce the forecast matrices from these.

1.4.3. Separate to this report, the development of the 2018 base year Great Yarmouth Town Microsimulation Model is described in the DCO document 7.2B: *Great Yarmouth Town Microsimulation Model – Local Model Validation Report (GYTRC-WSP-TPS-XX-RP-TP-0003)*.

1.5 REPORT STRUCTURE

1.5.1. This report provides information related to the development of the microsimulation forecast models, describing the reference case and with scheme situations, and to demonstrate their fitness for purpose of assessing town wide impacts of the Scheme. This is covered in the sections following this Introduction chapter:

- Section 2 summarises the forecasting and appraisal requirements;
- Section 3 shows an overview of the forecasting process;
- Section 4 describes the development process of the Reference Case models;
- Section 5 describes how the scheme has been modelled;
- Section 6 records the results from the assessment using the models; and
- Section 7 summarises the previous sections.

2 FORECASTING AND APPRAISAL REQUIREMENTS

2.1 INTRODUCTION

2.1.1. Forecasting the usage and performance of transport networks is a critical component in any transport appraisal. This chapter describes the various requirements of the forecasting and appraisal process for the Scheme. These include the assumptions relating to changes in the future year highway network and the prediction of the future year travel demands.

2.1.2. The forecasting model has been developed in accordance with guidance provided by the DfT in the WebTAG series of documents, specifically those areas focussed on Forecasting and Uncertainty[1].

2.2 FUTURE YEAR CONDITIONS

2.2.1. Traffic is forecast to grow mostly because people are expected to become wealthier and to live longer, because economic activity increases, and because households are forecast to become more numerous. Traffic growth is facilitated by car ownership, which is linked to wealth. Wealth enhances economic activity and also underpins new household formation.

2.2.2. These progenitors of traffic growth are reconciled at a national level and are translated through to local changes. Local congestion levels seek to limit the impact of growth via a negative feedback process. Network improvements mitigate the levels of congestion.

2.3 FUTURE YEAR TRAVEL DEMAND SCENARIOS

2.3.1. The principal requirement of the traffic model was the provision of traffic forecasts for use in the transport assessment of the Scheme for the Opening Year (2023) and Design Year (2038). Future travel demand forecasts for the two horizons take into account the effects of future traffic growth and the additional activity due to new development activity.

2.4 FUTURE YEAR HIGHWAY NETWORK IMPROVEMENTS

2.4.1. The future year traffic models must take into account the effects of other highway or traffic management schemes that are more than likely to be in place by the scheme's Opening and Design years. Information in relation to future highway/traffic management schemes was provided by NCC. The actual highway and traffic management schemes that have been adopted in the future year traffic models are discussed in detail in Section 4.2**.**

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1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/712788/tag-unit-m4-forecasting-and-uncertainty-may-2018.pdf

3 OVERVIEW OF THE FORECASTING PROCESS

3.1 INTRODUCTION

3.1.1. This chapter presents an overview of the process followed to build the Great Yarmouth Town Microsimulation forecast models for the opening, 2023, and design, 2038, years of the Scheme. The steps followed to build these models are:

- Update the base year model;
- Update the Uncertainty Log for the opening and design years;
- Update the forecast models of the strategic model known as Great Yarmouth Traffic Model (GYTM) according to the Uncertainty Log;
- Develop the Reference Case –Do Minimum– models according to the Uncertainty Log; and
- Model the Scheme –Do Something– models.

3.2 UPDATED BASE MODEL

3.2.1. The development of the base year traffic model and its validation against observed traffic flows and journey times was documented in the DCO document 7.2B: *Great Yarmouth Town Microsimulation Model – Local Model Validation Report (GYTRC-WSP-TPS-XX-RP-TP-0003)*. Important dimensions and features of this are repeated here:

3.2.2. *Model base year* – The 2016 base year model was recalibrated to a 2018 base year using updated survey data and the updated 2018 Great Yarmouth Traffic Model.

3.2.3. *Software* – The base year model was developed using Paramics Discovery v19. Five random seed runs need to be used to replicate the results.

3.2.4. *Study Area* – The study area covers the urban area of Great Yarmouth and surrounding areas of Gorleston. The study area is shown in Plate 3-1 below.

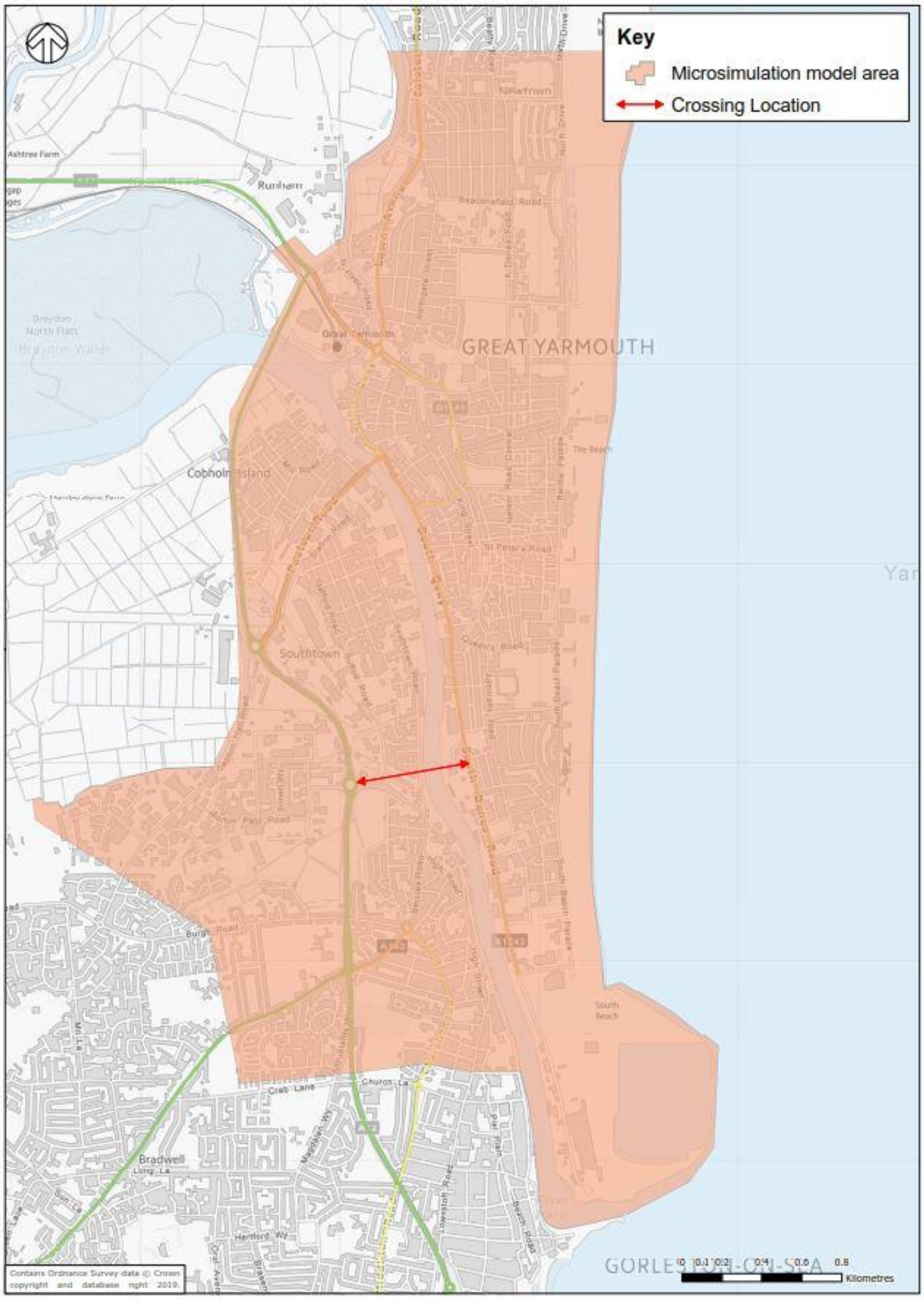

Plate 3-1 - Great Yarmouth Town Microsimulation Model Area

3.2.5. *Modelled Highway Network* – In the study area, the modelled network included all A and B class roads, some minor roads and residential roads that act as distributor routes. The network was coded in detail based on mapping, site visits, online aerial and street-level photography.

3.2.6. *Zoning System* – The zoning system designed for the Great Yarmouth model comprised 80 zones. The model was built to create an exact one-to-one mapping between the resulting SATURN cordon model cut points —or zones—and the zones in the Paramics model, except zone 29 that was split into zones 291, 292 and 293.

3.2.7. *Modelled Time Periods* – Three time periods identified from the survey data were modelled in order to replicate different trip patterns during a typical weekday. The three time periods are 07:00–10:00, 12:00–15:00 and 15:30–18:30, representing the peak AM and PM and inter peak periods for an average Monday–Friday day. Three separate (three hour) demand matrices have been developed for different vehicle types, taking cognisance of potential differences in distribution by these different vehicle types:

- Cars
- Light Goods Vehicles; and
- Heavy Goods Vehicles (OGV1, OGV2 and Coaches).

3.2.8. *Public Transport Services* - 12 public transport services were modelled along with their complete timetables and bus stops within the study area during the winter period.

3.3 UPDATED UNCERTAINTY LOG

3.3.1. Assumptions relating to future developments are outlined in the Uncertainty Log used in developing the alternative scenarios in accordance with the Department's guidance included in the WebTAG Unit M4 (May 2018)[2]. The Uncertainty Log has been updated to reflect the latest assumptions relating to future developments and highway network improvements.

3.3.2. The future developments will feed the forecast demand. The demand of the microsimulation model was based on the strategic model known as Great Yarmouth Traffic Model (GYTM). Section 3.4 summarises the process carried out to obtain the GYTM forecast models. More detailed information, including the updates in the Uncertainty Log, can be found on the DCO document 7.6 Appendix B: Traffic Forecast Report developed by WSP.

3.3.3. The future network improvements will feed into the development of the Reference Case models, more information about these improvements can be found on Section 4.2.

3.4 UPDATED GREAT YARMOUTH TRAFFIC MODEL

3.4.1. WSP has also developed a SATURN highway and a CUBE demand model of Great Yarmouth. These models were used to support the construction of the matrices of the Paramics Discovery model, which is described in more detail in Section 4.1. More information about these models can be found in the DCO document 7.6 Appendix B: Traffic Forecast Report (*GYTRC-WSP-TPS-XX-RP-TP-0007*).

3.4.2. The GYTM was developed in accordance with the WebTAG Unit M4 guidance.

3.4.3. Plate 3-2 below provides a summary of the Forecasting Process and shows the Base Model Calibration (GYTM) and Forecasting Model. The processes involved in creating the Forecast model output matrices are discussed in this section. This follows distinct stages of:

- Apply growth from TEMPro 7.2 (updated from TEMPro 7);

[2]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/712788/tag-unit-m4-forecasting-and-uncertainty-may-2018.pdf

- Build development Matrices;
- Merge development and background growth matrices;
- Control to TEMPro 7.2; and
- Output the Future Calibrated Segmented Matrices.

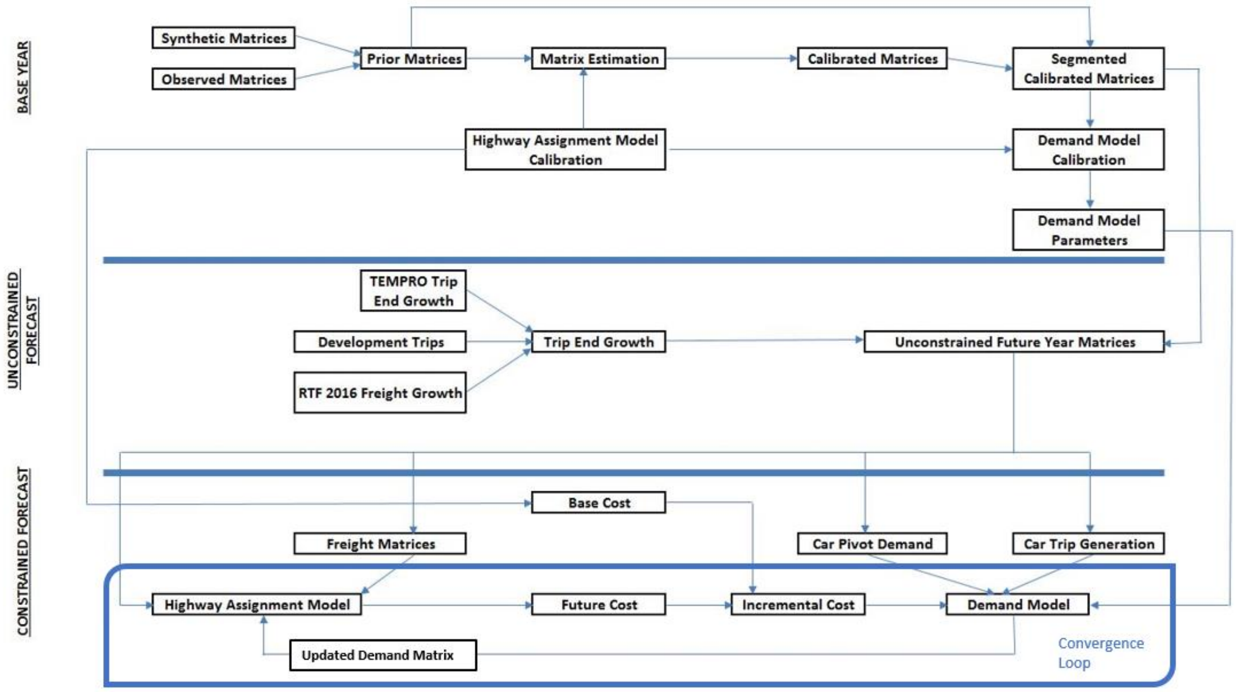

Plate 3-2 - GYTM Forecast Development Process

4 REFERENCE CASE DEVELOPMENT

4.1 FORECAST DEMAND

4.1.1. As mentioned in Section 3, the strategic SATURN model known as the GYTM has been used to inform the distribution and traffic growth through the model area. The GYTM considered numerous growth scenarios and forecast years that weren't included in the microsimulation model. The scenarios considered were:

- 2023 CORE scenario with Variable Demand Modelling (VDM); and
- 2038 CORE scenario with VDM.

4.1.2. Cordon matrices from the GYTM, matching the model area, were extracted for each of the previous scenarios for the one AM, IP and PM hour for the five user classes (UCs) present in that model.

4.1.3. Changes to the zone system and user classes were made to the cordon matrices in order to be suitable for the microsimulation model. The microsimulation model was built to create a one-to-one mapping between the resulting SATURN cordon model cut points and the zones in the Paramics Discovery model, except zone 29 that was split into zones 291, 292 and 293. The synthetic matrices were combined into AM, IP and PM one-hour matrices describing Cars (UC1..3), LGVs (UC4) and HGVs (UC5).

4.1.4. The process followed to build the microsimulation forecast matrices from the cordon matrices extracted from the GYTM is as follow:

- A set of sectors were defined to avoid outliers caused by lack of data for small zones;
- Growth factors from the GYTM base and forecast matrices were calculated using the sectors already defined;
- The growth factors were applied to the 2018 validation matrices produced after Matrix Estimation. More information about these matrices can be found on the *DCO Document 7.2B Paramics LMVR;* and
- The development trips were added to the forecast matrices.

4.1.5. This process is summarised in Plate 4-1.

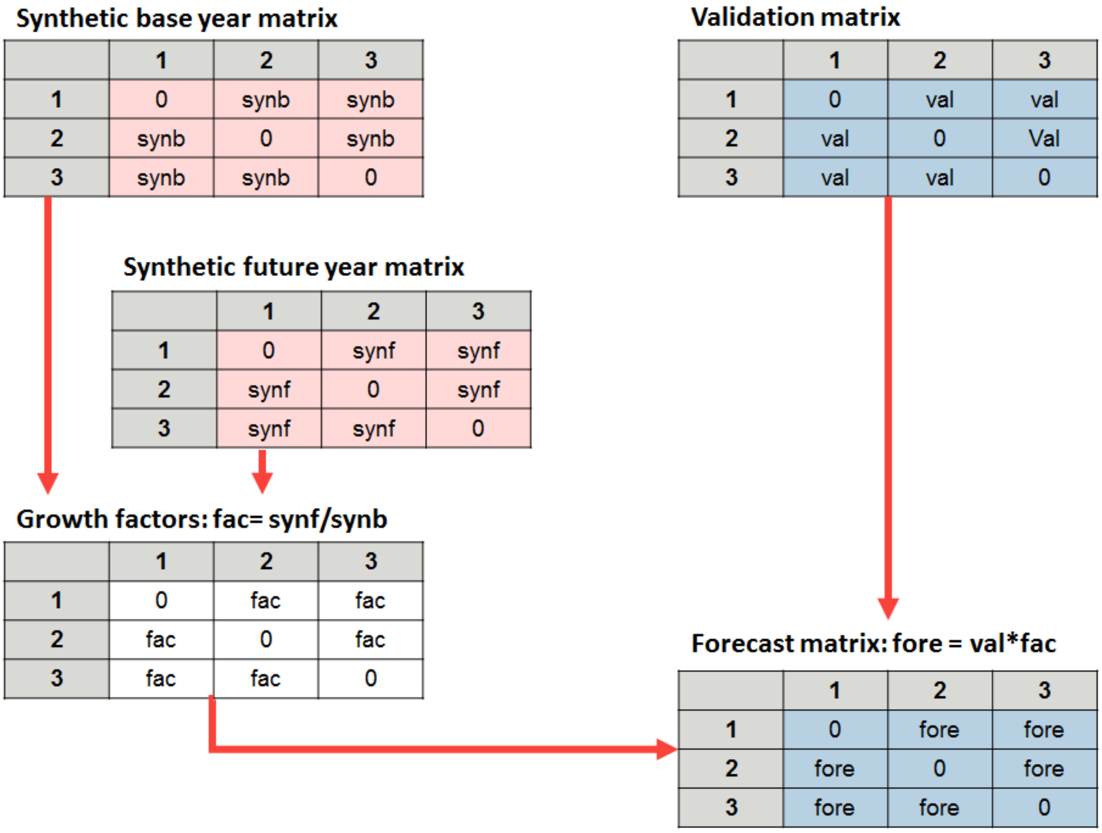

Plate 4-1 - Forecast Matrices Development Process

4.2 HIGHWAY IMPROVEMENTS

4.2.1. Extensive liaison with NCC highways officers was undertaken in order to develop an Uncertainty Log that contains information on potential schemes that are anticipated within the study area and their status, this is listed in Table 4-1. Dependent upon scheme timing and level of certainty inclusion has been referenced by modelled year in columns 7 to 9 of the table. The table also shows whether each scheme will have an impact in the model or not. Most of the schemes will have a traffic impact on the network except the improvements to the rail station forecourt and Trafalgar Road which do not alter the operational highway layout significantly.

Table 4-1 - Highway Improvements for Forecast Networks

Scheme	Location	Owner	Description	Certainty	Impact in model	Base Model	2023 Model	2038 Model
Vauxhall Junction	A47/ Runham Rd/ A149 Acle Rd/ A12	HE	Option 2, HE551491-ACM-HGN-VR-DR-HE-00011	More than likely	Yes	No	Yes	Yes

Great Yarmouth Station Access	A149 Acle New Rd /Station Access	HE	Option 9, HE551491-ACM-HGN-VR-DR-HE-00014-P01.3	Near Certain	Yes	No	Yes	Yes
Gapton Junction	A47 / Pasteur Road	HE	Option 1, HE551491-ACM-HGN-GR-DR-HE-00011	More than likely	Yes	No	Yes	Yes
Harfreys Junction	A47 / William Adams Way	HE	Option 1, HE551491-ACM-HGN-HR-DR-HE-00011	Hypothetical	Yes	No	No	No
James Paget Hospital	A47 Lowstoft Rd/ JP Hospital Access	HE	Option 1, HE551491-ACM-HGN-JP-DR-HE-00011	Hypothetical	Yes	No	No	No
Bridge Rd	A47 Lowstoft Rd/ Bridge Rd	HE	Option 1, HE551491-ACM-HGN-BR-DR-HE-00011	Hypothetical	Yes	No	No	No
Improvements to Rail Station Forecourt and Surrounding Highways	Station Forecourt	NCC	PK6060-HP1-037 Consultation Plan One	Near Certain	No	No	Yes	Yes
Great Yarmouth Trafalgar Rd Improvements	Trafalgar Rd/ Marine Parade/ Nelson Rd	NCC	PE1022-HP1-013 Phase 1 - Shared Use Facility Only	Near Certain	No	No	Yes	Yes
Possible congestion improvement	South Quay/Yarmouth Way	NCC		Reasonably Foreseeable	Yes	No	Yes	Yes
Southtown Road improvements	Southtown Road/Station Road	NCC	PKA009-TS-003	Near Certain	Yes	No	Yes	Yes
Possible congestion improvement	Town centre locations TBD	NCC		Reasonably Foreseeable	Yes	No	No	No

4.2.2. The table above shows that there is a lot of uncertainty about any network improvement beyond the Opening Year, and therefore the schemes included in the 2023 and 2038 models are the same. These are:

- Great Yarmouth Station Access: this scheme is already built. This scheme wasn't included in the 2018 base model as when the 2018 traffic surveys were carried out, it was under construction;
- Vauxhall Junction;
- Gapton Hall Junction; and
- Southtown Road improvements.

4.2.3. Plate 4-2 shows the location of these schemes.

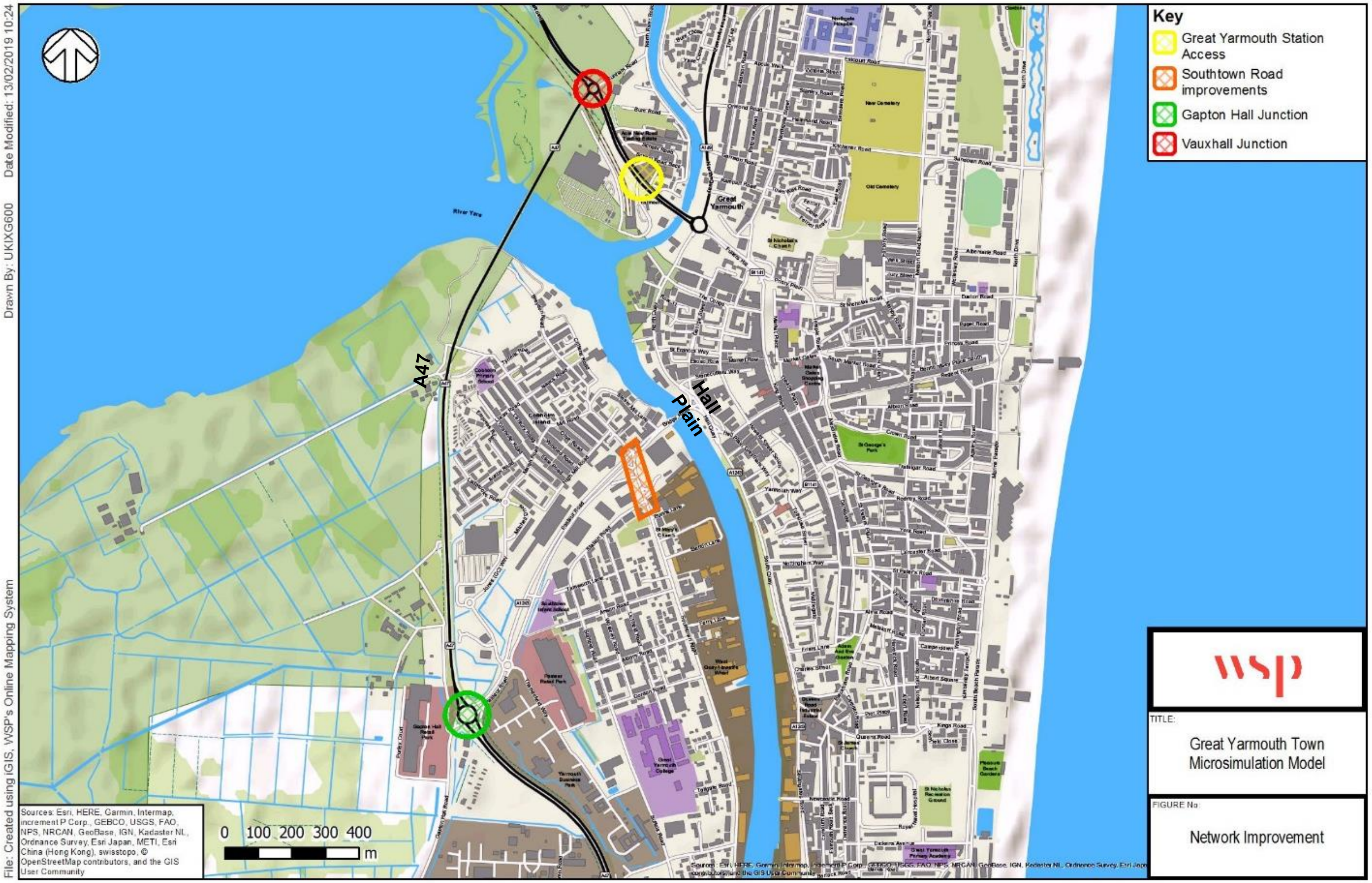

Plate 4-2 - Location of the highway improvements included in the Reference Case Model

4.2.4. Traffic signal adjustment was applied to the junctions that experienced a significant redistribution of the pattern of flow through them, including the 4 locations of the highway improvements and the Hall Plain junction.

4.3 FUTURE COST PARAMETERS

4.3.1. The values of time and operating costs for the future years, that feed into the generalised cost equation, were taken from the December 2017 TAG databook (release v1.9.1). This is consistent with the updated GYTM. Table 4-2 presents the cost parameters adopted for this study for the base year, the opening and the design year respectively.

Generalised Cost = a * Time + b *i * Distance

Where:

a = Time coefficient

b = Distance coefficient

i = Distance unit conversion factor (60)

Table 4-2 - Generalised Cost Parameters (units in seconds)

Vehicle type	2018		2023		2038	
	a (unitless)	b (min/mile)	a (unitless)	b (min/mile)	a (unitless)	b (min/mile)
Car	1	0.22	1	0.21	1	0.15
LGVs	1	0.39	1	0.37	1	0.28
HGVs	1	0.57	1	0.58	1	0.49

5 MODELLING THE SCHEME

5.1 DESCRIPTION OF THE SCHEME

SCHEME DETAIL

5.1.1. When constructed, the Scheme will include the following:

- A new dual carriageway road, crossing the River Yare in an east-west orientation, comprising:
  - A double leaf bascule bridge providing an opening span for vessel movement;
  - A new five-arm roundabout connecting the new crossing with Suffolk Road, William Adams Way and the western end of Queen Anne's Road; and
  - A single span bridge over Southtown Road joining that bridge to the new roundabout at William Adams Way.
- The closure of Queen Anne's Road at its junction with Suffolk Road, and the opening of a new priority junction onto Southtown Road providing access to the Queen Anne's Road residential area;
- Revised access arrangements for existing businesses onto the local highway network including, a new structure to allow vehicular access under the proposed crossing on the eastern bank;
- Dedicated provision for cyclists and pedestrians which ties into existing networks;
- A control tower structure located in proximity to the crossing on the western side of the river. The control tower will facilitate the 24/7 operation of the opening span of the new double leaf bascule bridge;
- The demolition of an existing pedestrian bridge on William Adams Way;
- Associated changes, modifications and/or improvements to the existing local highway network as informed by traffic modelling. This could include improvements within the existing highway boundary to some existing junctions within the Application Site, in addition to amended parking arrangements.
- Additional signage to assist the movement of traffic in response to network conditions and the openings / closings of the double leaf bascule bridge.

5.1.2. The General Arrangement plans can be found in the DCO document 2.2.

5.2 SCHEME MODELLING

5.2.1. The scheme was modelled to match the GA plans, which describe the physical features of the highway and the junction layouts, thereby allowing faithful replication of kerb lines and stop/give way line positions. This ensures, for example, the vehicle paths through the Scheme are appropriate and reflect the relative conflict between traffic streams at junctions.

5.2.2. For consistency, link categories have been used according to the rest of the network, and the time and distance parameters of the Generalised Cost Equation have been remained unaltered.

5.2.3. Traffic signal adjustment was applied to the junctions that experienced a significant redistribution of the pattern of flow through them, including the new signalised junction at South Denes Road, the A47 signalised junctions and the two junctions at both sides of Haven Bridge (Southtown Road/Pasteur Road and Hall Plain junctions).

5.2.4. Proposed pedestrian crossings at the new roundabout have been modelled with a two minutes frequency.

5.2.5. The main part of the Scheme is a new dual carriageway road, crossing the river Yare by a double leaf bascule bridge. The proposed bridge will open on demand for any commercial vessel when required. When the bridge is raised the route for road traffic will be closed. Section 5.3 describes the statistical analysis done to calculate the schedule of opening times.

5.2.6. A Variable-Message Sign (VMS) system will inform drivers about the status of the bridge, so drivers can decide whether to take another alternative route or wait for the bridge to be lowered again. Section 5.4 describes how this have been modelled.

5.3 BRIDGE OPENING STATISTICAL ANALYSIS

INTRODUCTION

5.3.1. The Scheme will need to lift to allow larger boats to pass. This will impact on the highway network through delays, and potentially rerouting, for traffic when the lifting process is ongoing. The process includes the transit time for the boat pass and the bridge operating time. A set of bridge opening times are therefore required to be coded into the model.

5.3.2. Observed data had been provided by the Port Authority. This consisted of a detailed database of vessel movements along the river at the location of the Scheme. As part of the DCO application, further statistical analysis of the observed data has been undertaken. This subsection documents the statistical analysis and outcomes.

ASSUMPTIONS

Variables Defining a Bridge Opening

5.3.3. The following variables define a bridge opening, referred to hereafter as an “event”.

- Start time: time when the process of raising the bridge will start, and therefore it’ll be inoperative for road traffic;
- End time: time when the bridge will become operative to road traffic;
- Duration; total time that the bridge will be inoperative to road traffic;
- Direction: direction of the vessel that will cause a bridge raise (outbound or inbound);
- Length Overall (LOA) in metres: LOA of the vessel; and
- ‘Require pilot boat’.

5.3.4. The following dependencies were defined.

- If LOA > 40m then a pilot boat is required.
- Direction is only relevant for the analysis if a pilot boat is required. This determines whether a supplementary event for the pilot boat occurs before or after the main event.
- End time is a function of start time and duration.
- Duration (secs) is a function of LOA (metres) given by the formula:

$$\boldsymbol{Duration = Operation\ Time + Transit\ Time + Approach\ Time}$$

$$\mathbf{Duration} = \mathbf{260} + \frac{\boldsymbol{LOA}}{\mathbf{0.517}} + \boldsymbol{Max}\left(\mathbf{2} \times \frac{\boldsymbol{LOA}}{\mathbf{0.517}} - \mathbf{160}, \mathbf{0}\right)$$

Scope of Analysis and Methodology

5.3.5. Based on the dependencies listed, there are three independent variables required to define an event.

- Start time;
- Length Overall; and
- Direction (if LOA > 40m).

5.3.6. The analysis sought to determine a set of these values for a 'typical' day (paragraph 5.3.36) and a 'high' day (paragraph 5.3.37).

Independence of Events

5.3.7. It was assumed for this study that events are independent. This means that the occurrence and properties of a specific event does not impact on the time or characteristics of another event within a single day.

Pilot Boat Schedule

5.3.8. Pilotage is compulsory for any vessels over 40 m LOA, there are exemptions but the most conservative approach is to assume anything over 40 m takes a pilot. The pilot will go from the pilot boat station to the location of the vessel, then will pilot the vessel and finally will come back to the pilot boat station.

5.3.9. The pilot boat station is seaward of the new bridge. As the air draft of the pilot boat is higher than 4.5 metres, the pilot boat will require the bridge to be raised either 30 mins in advance for an outbound or 30 mins after for an inbound move, and the actual time for the pilot boat to pass the bridge in conjunction with the larger vessel move is negligible.

5.3.10. The impact of pilot boats is not affected by the assumption that events are independent since they are not included as events in the analysis. The analysis will determine the LOA and direction for modelled events and the pilot boat schedule is determined from that output.

OBSERVED DATA AND FILTERING

Data Availability

5.3.11. A database of observed vessel movements through the proposed location of the Scheme was provided by the Port Authority. The dataset covered the period 1 January 2008 to 31 August 2016 inclusive.

5.3.12. There were 79,939 observed vessel movements in this period, recording date, time and direction of travel, plus the boat and its characteristics, including LOA.

5.3.13. Of those observed movements, 30,434 were identified as requiring a bridge lift, as their movement will cross the new bridge and the air draft of the vessel is over 4.5 metres. Therefore, the unfiltered dataset consisted of 30,434 events.

Combining Adjacent Events

5.3.14. Two cases were for combining events were considered. These are illustrated in Plate 5-1.

- Case 1: Overlapping events. The start time of Event 2 is within the duration of Event 1. In this instance the events were combined into one event.

- Case 2: Simultaneous events. The start time of Event 2 is X seconds after Event 1 where X is a short period of time and the bridge may be unlikely to reopen to traffic. These may form one extended event. The time to the next event was derived for each observation and the 2.5th percentile from this distribution was defined to be the minimum time X for this analysis. Events within range X of each other were combined. This percentile was chosen based on removing extreme small values and the outturn value was X = 122 seconds.

5.3.15. In both cases the aggregated duration is the sum of the Operating Time (counted once) plus the Approach Time and Transit Time for each event. This principal extended to more than two overlapping events in some cases.

5.3.16. The outcome was that 2,858 (9.4%) events were aggregated into other events. Consequently, the final dataset consisted of 27,576 events.

5.3.17. However, after the proceeding data filtering stage it was established that those 2,858 events occurred at weekends and/or outside the neutral months and so they were ultimately removed from the dataset on that basis prior to the final analysis. The data filtering process and the reasons for exclusion of survey observations on weekends and non-neutral months are evidenced and explained through the following sections 5.3.18 to 5.3.32

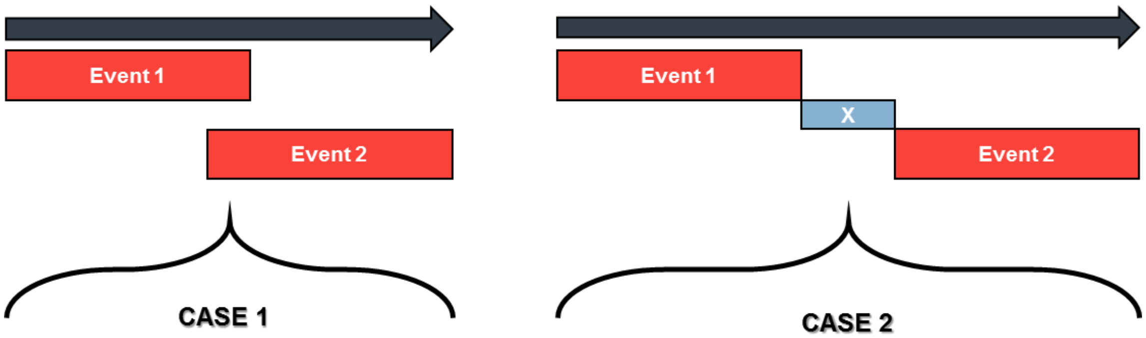

Plate 5-1 - Cases for Combining Events

Data Filtering

5.3.18. The Great Yarmouth Town Microsimulation Model represents a neutral weekday. A review of traffic patterns in Great Yarmouth (see 2016 Traffic Data Collection Report) confirms April as a neutral month.

5.3.19. The final dataset of 27,576 events was analysed to investigate the impacts of daily, monthly and annual variation in the daily average number of events. This was to ensure consistency between the model specification and the period(s) over which subsequent analysis and calculations were undertaken.

Daily Variation

5.3.20. The Great Yarmouth Town Microsimulation Model represents a neutral weekday.

5.3.21. Table 5-1 and Plate 5-2 summarise the average number of events by day type. The average number of events on a weekday is 9.8.

- The average number of events for any specific weekday is close to this value (at most 3% difference).

- The average number of events on a Saturday or Sunday is much lower (over 32% decrease).

5.3.22. Based on this analysis, all data from weekdays was retained and all data from weekends was removed.

Table 5-1 - Average Number of Events per Day by Day

Day	Events	Surveyed Days	Average
Monday	4,409	450	9.8
Tuesday	4,327	452	9.6
Wednesday	4,528	451	10.0
Thursday	4,300	450	9.6
Friday	4,458	448	10.0
Saturday	2,957	444	6.7
Sunday	2,597	438	5.9

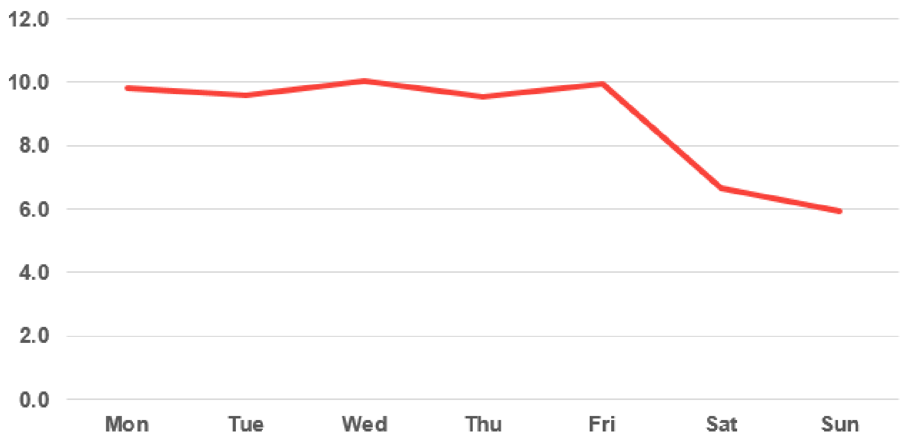

Plate 5-2 - Average Number of Events per Day by Day

Monthly Variation

5.3.23. The traffic model represents April as a neutral month.

5.3.24. Table 5-2 and Plate 5-3 summarise the average weekday number of events by month. The average number of events on an April weekday is 9.8.

5.3.25. All months with an average value within 10% of 9.8 were retained. These are highlighted in red: February, March, May, June, October and November.

5.3.26. There is an increase in events the summer months and decrease in the winter, which mirrors the general traffic patterns for the local area.

Table 5-2 - Average Number of Events per Day by Month (Weekdays)

Month	Events	Surveyed Days	Average
January	1,551	198	7.8
February	1,613	182	8.9
March	1,867	197	9.5
April	1,903	195	9.8
May	1,942	197	9.9
June	2,026	193	10.5
July	2,453	201	12.2
August	2,221	197	11.3
September	1,883	173	10.9
October	1,657	177	9.4
November	1,559	168	9.3
December	1,347	173	7.8

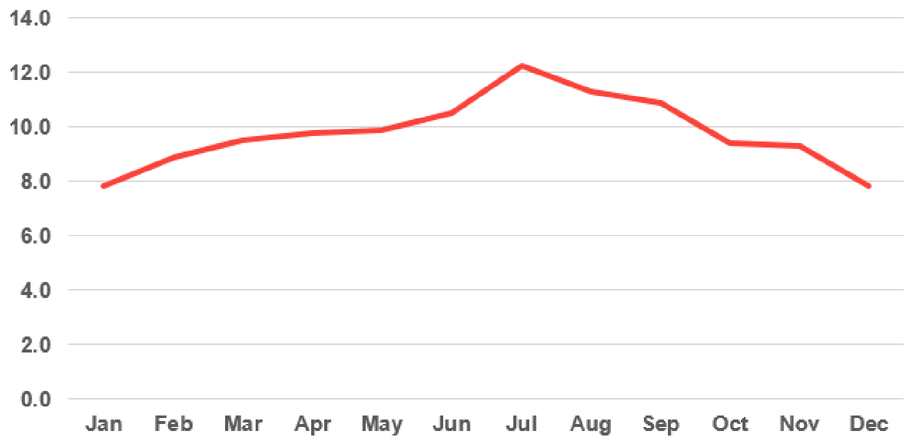

Plate 5-3 - Average Number of Events per Day by Month (Weekdays)

Annual Variation

5.3.27. Plate 5-4 summarises the average weekday number of events by year.

5.3.28. There is no clear trend in this data and specific annual circumstances may play a part in yearly peaks or troughs. Whilst there is an increase from 2014 to 2016, that follows a sharp decrease from 2012 to 2014.

5.3.29. The drop from 2008 to 2009 indicates the impact of the recession. It was also observed, whilst checking the dataset, that there was partially complete information for some necessary fields in the

2008 and 2009 data which made those unusable. On this basis, all data from 2010 onwards was retained to provide a larger and more representative sample through the years but excluding the two earliest years for the two reasons mentioned.

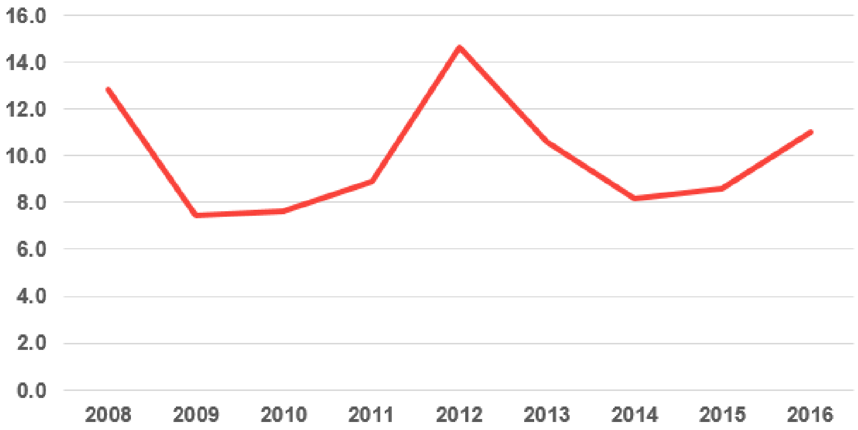

Plate 5-4 - Average Number of Events per Day by Year (Weekdays)

Summary of Data Filtering

5.3.30. The following text summarises the sample size post data filtering, referred to hereafter as the 'filtered dataset'.

- 1,011 days were retained out of 3,133 (32%).
- 9,766 events were retained out of 30,434 (32%).

5.3.31. These values account for the removal of weekends, two years and non-neutral months.

5.3.32. Roughly a third of the data was retained but the number of events in both sample definitions (by number of days and by number of events) represented a large dataset for the next phase of the analysis.

DETERMINING THE NUMBER OF EVENTS

Number of Events per Day

5.3.33. Having derived the filtered dataset, the next stage of the analysis was to determine the number of events that occur on a 'typical' day and a 'high' day.

5.3.34. The summary statistics corresponding to the number of events per day in the filtered dataset are presented in Table 5-3. The outcome required was an integer value that best represents the number of events on a 'typical' day.

5.3.35. For a symmetric distribution the mean and median would be equal. The distribution in Plate 5-5 shows a level of positive skewness. The mean (9.66) and median (9) are similar however the mean would round up to 10 using conventional rounding. The disadvantage of the mean is that it can be susceptible to the influence of large outliers. That may be the case here since the 85th percentile (14) is much closer to the median than the maximum (26). In such instances the median is often considered to give the best indication of central tendency since it is not as strongly influenced by skewed values. Mode represents the most frequent score however it may not necessarily indicate central tendency. However, in this case it has the same value as the median.

5.3.36. On this basis, the number of events on a 'typical day' was taken forward to be modelled as 9.

5.3.37. The number of events to be modelled on a 'high' day was taken forward as the 85% percentile which was 14.

Table 5-3 - Filtered Dataset – Summary Statistics

Statistic	Value
Mean	9.66
Median	9
Mode	9
Minimum	1
Maximum	26
85^{th} Percentile	14

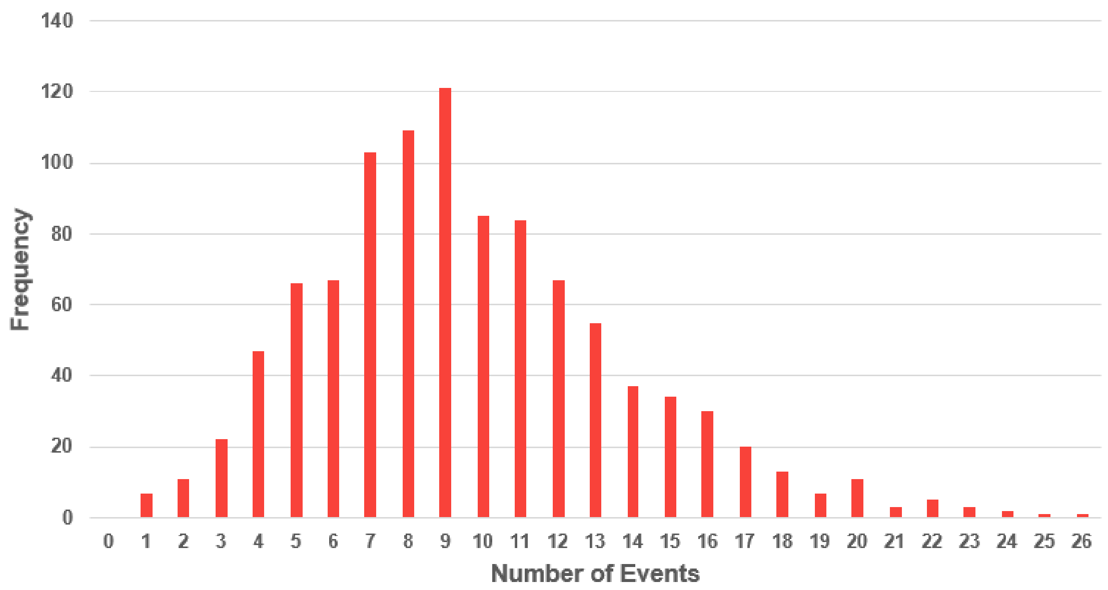

Plate 5-5 - Filtered Dataset – Number of Events per Day

CHARACTERISTICS OF THE EVENTS

Modelling Time of Day

5.3.38. Having established the number of events to be included in the schedule, the next step was to determine the times of day the scheduled events would occur at. To determine a suitable methodology, the frequency of events was plotted.

5.3.39. Plate 5-6 illustrates the time profile for events from the dataset between 06.00 and 19.00.

- There is a large peak around 07:50–08:00 in the morning and a shorter peak around 16.00.
- There is also substantial noise in the plot due to the precision of the data to the nearest minute.

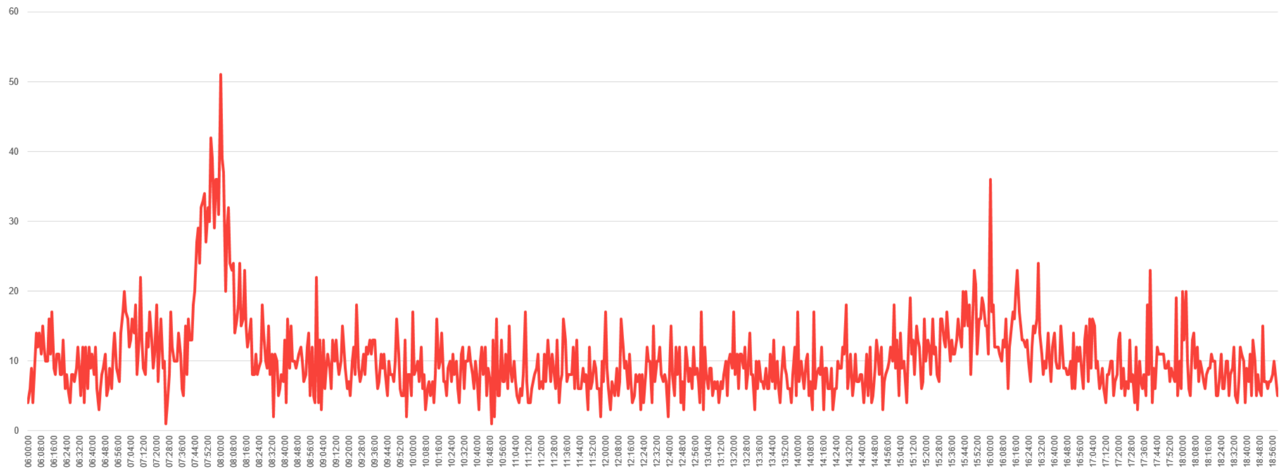

Plate 5-6 - Frequency of Events – Observed Data (Nearest Minute)

5.3.40. Plate 5-7 and Plate 5-8 present the same data in five and ten minute intervals respectively. This has the effect of smoothing most of the noise which can make it easier to observe high level trends or patterns in the data.

- The peak around 07:50–08:00 is still observed;
- The shape of the peak around 16:00 is shorter but wider; and
- Between the two peaks the distribution appears largely uniform.

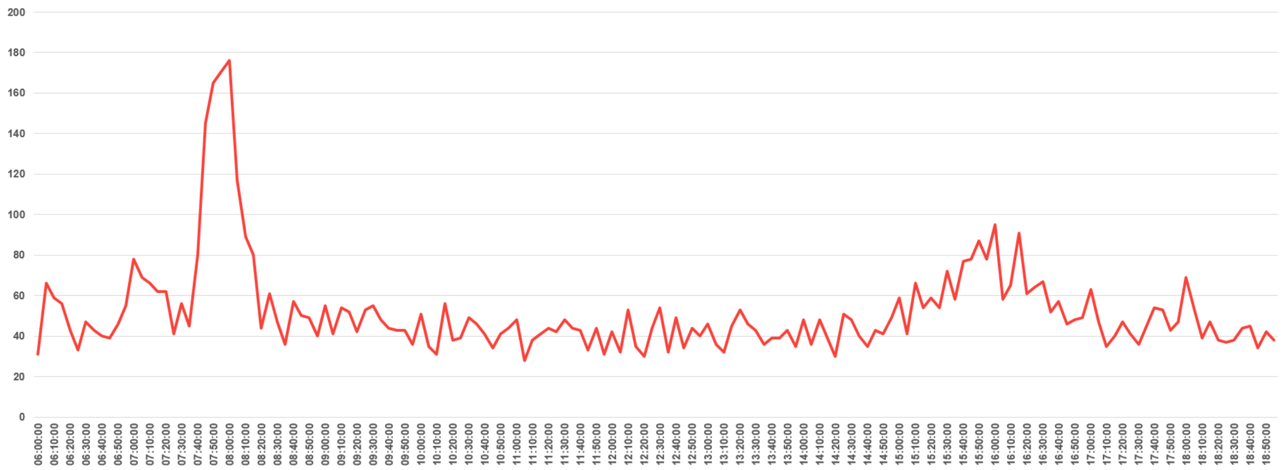

Plate 5-7 - Frequency of Events – Five Minute Intervals

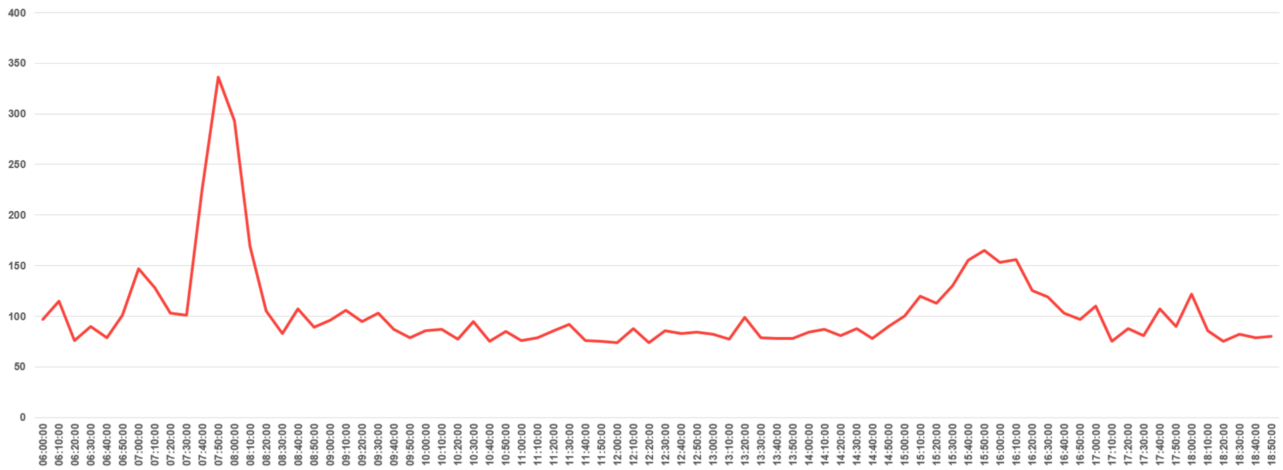

Plate 5-8 - Frequency of Events – Ten Minute Intervals

5.3.41. One option considered was to model the time of events as a Poisson process.

5.3.42. The Poisson distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time (or space) given that:

- An event occurs independently of the time since the last event;
- The rate that events occur is constant throughout; and
- Two events cannot occur at the same instance.

5.3.43. Based on the analysis in Plate 5-6, Plate 5-7 and Plate 5-8, the second bullet point does not hold at a daily level, or even at model period level. The presence of the peaks indicates that the rate is not constant. Therefore, to apply this approach the day would have to be partitioned into multiple time segments not necessarily corresponding to modelled periods.

5.3.44. In addition, the scheduled times of events would have to be simulated using a random generator for the derived distributions in the Poisson process. This means that the outputs would have been based on a random process. If the analysis were to be repeated with new additional data and/or a change to the data filtering this could lead to changes to the output.

5.3.45. Therefore, a deterministic approach was defined which made best use of the observed data.

- A subset was formed from the 'filtered dataset' to only include days with nine events. This left 121 days, which still represents a large sample (i.e. greater than 30) for analysis and deriving representative and robust statistical summary values;
- For those days with nine events, the events were labelled from 1 to 9 in ascending start time order;
- This provided nine subsets corresponding to the start times of the first event, second event, third event etc. on a day with nine events; and
- These distributions were used to determine the nine start times to be modelled. The median time in each distribution was taken as the value to be used.

5.3.46. It was observed for this analysis that the mean was susceptible to being skewed by outliers and the mode would not be appropriate for this dataset which is precise to the nearest minute.

5.3.47. Table 5-4 lists for each event number:

- The median start time; and
- An approximate 95% confidence interval for the median start time.

5.3.48. A confidence interval for the median is interpreted in the same way as that for the mean. That is, with the confidence level 95% the median start time for a specific event number lies between the lower and upper bounds based on the derived sample median. It is referred to as 'approximate' for the median since the calculation is based on the rank of observations in the ordered sample and therefore the bounds can only take values from the sample. (The median itself is defined as the central value in an ordered sample and so it follows that this calculation is also based on rank).

5.3.49. Using a standard method, the study also determined the probability that the true median start time lies between the two bounds stated is 0.9549 for each specific event number.

5.3.50. This table also gives an indication for the range of start times for a specific event number. In several cases the length of the confidence interval is close to or even longer than an hour. However, event 2 is much tighter and focussed around the morning peak observed in Plate 5-6, Plate 5-7 and Plate 5-8.

5.3.51. This process was repeated for a 'High' day but based on those days with 14 surveyed events.

Table 5-4 - Median Start Times for Events

Event No.	Start Time		
	Median	95% CI on Median	
1	06:36:00	06:14:00	07:01:00
2	07:49:00	07:39:00	07:58:00
3	08:52:00	08:26:00	09:13:00
4	10:35:00	10:11:00	11:16:00
5	12:50:00	12:00:00	13:32:00
6	14:52:00	14:11:00	15:14:00
7	16:12:00	15:47:00	16:35:00
8	17:40:00	17:05:00	18:02:00
9	19:28:00	19:03:00	20:07:00

Determining LOA and Direction

5.3.52. Having established the times of events for the schedule, the two remaining variables to be determined were LOA and direction. (Duration and the requirement for a pilot boat are directly dependent on these values).

5.3.53. Similar to the time of day analysis, a deterministic approach was defined to make best use of the observed data and avoid random generation in the output. The starting point was the filtered dataset since further disaggregation of the dataset subset corresponding to days with nine events would have led to small sample groups.

5.3.54. The LOA for each scheduled event was defined as the median LOA for events with that start time in the filtered dataset.

5.3.55. The distribution for LOA is shown in Plate 5-9. This is bimodal with the largest peak around 15–20m and a second, smaller but wider, peak around 55–75m. The mean would not be appropriate since it may have generated several values around the 35–55m range, which are not common values.

5.3.56. The direction for each scheduled event was defined as the mode direction for events with that start time in the filtered dataset. Mode is appropriate measure for categorical data.

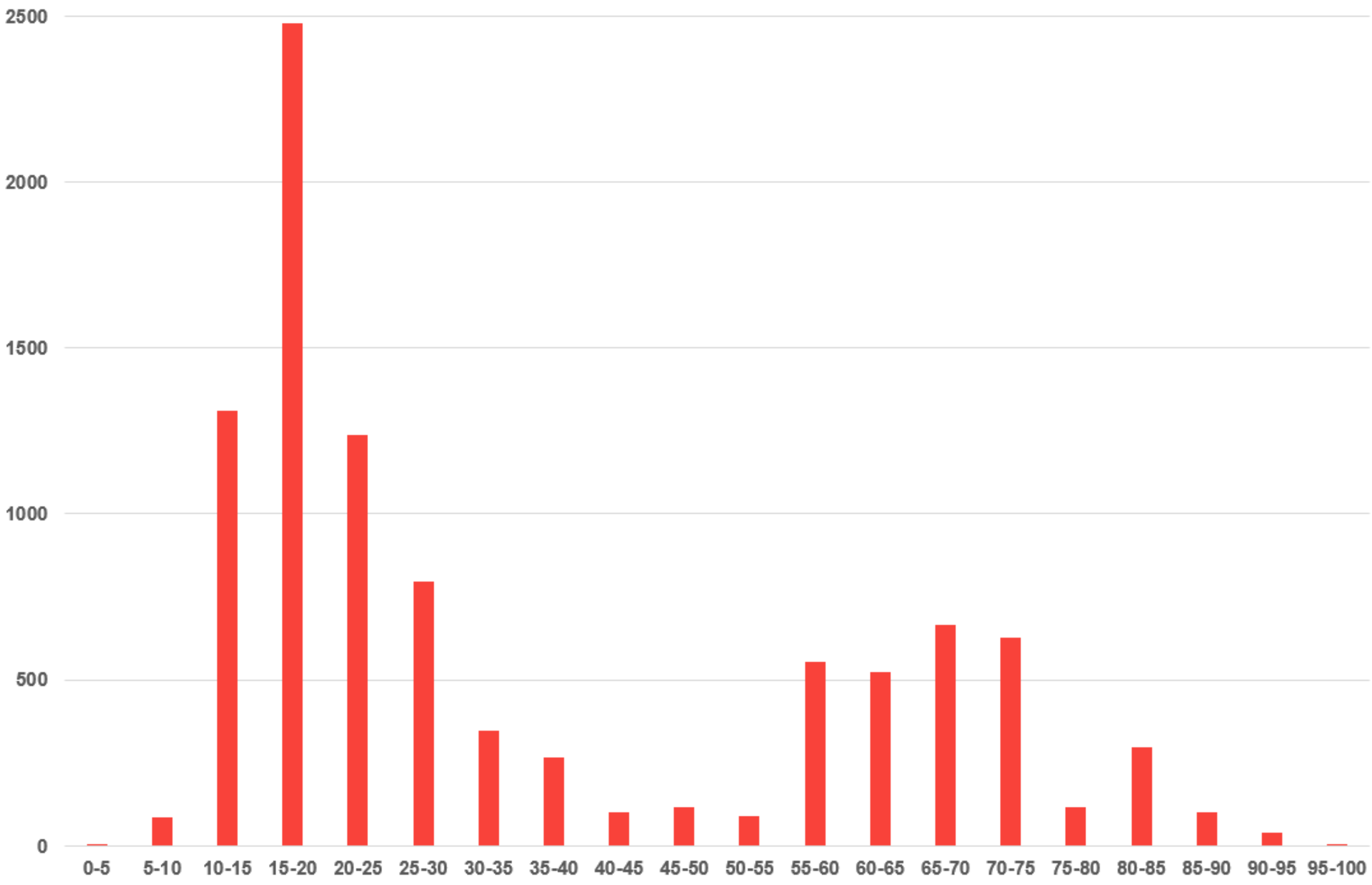

Plate 5-9 - Number of Events by LOA (m) – Filtered Dataset

OUTTURN SCHEDULE OF EVENTS

Derived Schedule – 'Typical' Day

5.3.57. The derived bridge opening schedule for a 'typical day' is summarised in Table 5-5.

5.3.58. This is derived over a twenty-four hour period so that the impact of pilot boats and events which cross modelled and non-modelled periods are represented.

5.3.59. This does not include the bridge lifts for pilot boats. However, the requirement and characteristics for those are directly determined by this data. The pilot boat bridge lifts were added to this schedule to create the final timetable coded in the microsimulation model.

Table 5-5 - Derived Bridge Opening Schedule – 'Typical' Day

Event No.	Start Time	End Time	Duration	LOA (m)	Pilot Required?	Direction
1	06:36:00	06:43:40	00:07:40	62.00	Yes	Arrival
2	07:49:00	07:53:51	00:04:51	16.00	No	Departure
3	08:52:00	08:56:51	00:04:51	16.00	No	Arrival
4	10:35:00	10:40:09	00:05:09	25.58	No	Departure
5	12:50:00	12:54:58	00:04:58	19.65	No	Departure
6	14:52:00	14:56:52	00:04:52	16.75	No	Arrival
7	16:12:00	16:16:49	00:04:49	15.25	No	Arrival
8	17:40:00	17:45:37	00:05:37	40.00	Yes	Arrival
9	19:28:00	19:33:20	00:05:20	30.98	No	Departure

5.3.60. The outturn schedule was compared against some key observations.

- There is an event at 07:49 which is close to the apex of the morning peak identified in the 'filtered dataset' (see Figures 5.6 to 8).
- There is an event at 16:12 which is close to the apex of the evening peak identified in the 'filtered dataset' (see Figures 5.6 to 8).
- There are two events which require a pilot boat. For a day with nine events:
  - The number of events which require a pilot boat has mean 3.48 and median 3.
  - However, that mean value is skewed to when one (or more) of the nine events occur in the very early or late hours.
  - Given that nine events all have a start time between 06:36 and 19:28 the mean is 2.68 and median 3.
- Plate 5-10 illustrates the proportion of events (for a day with nine events) that required a pilot boat in half hour intervals. (The patterns are similar using the whole 'filtered dataset').
  - In the derived schedule, a pilot boat is required for the events at 06:36 and 17:40, which are when the proportion in Figure 5-10 is greater than 50%.
  - The proportion is generally lowest in the middle of the day when no events in the schedule require a pilot boat.
  - The event at 19:28 does not have a pilot boat in the schedule but occurs when the proportion is greater than 50% in the half hour intervals. This suggests there is some variation around this time which may be sensitive to the time interval considered. This event occurs outside of the modelled periods and the impact of a pilot boat would not affect the modelling. The mean value is for between 2 and 3 events that require a pilot boat.

5.3.61. Based on those findings, the schedule was considered to overall provide a sensible and plausible listing of events that could be taken forward for the microsimulation modelling.

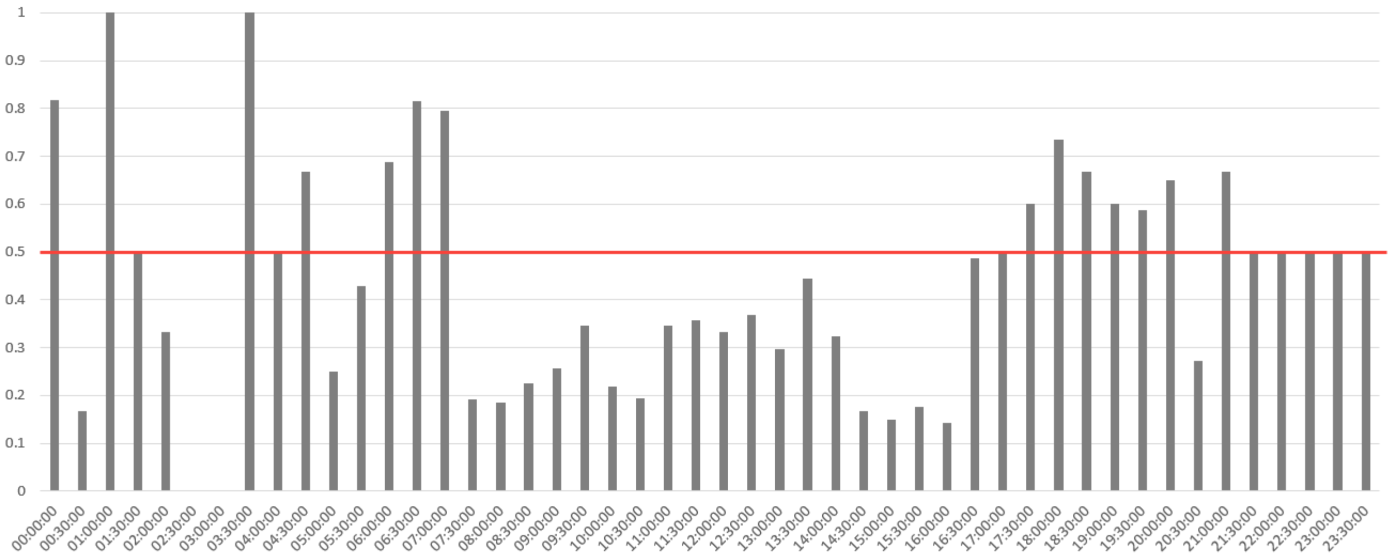

Plate 5-10 - Proportion of Events which Required a Pilot Boat – Half Hour Intervals

Derived Schedule – 'High' Day

5.3.62. The derived bridge opening schedule for a 'high' day is summarised in Table 5-6 replicating the method applied for a 'typical' day but based on 14 events instead of 9.

5.3.63. The outturn schedule has two events near to the morning peak (see Plate 5-6, Plate 5-7 and Plate 5-8) at 07:42 and 08:08 plus an event at 15:35 close to the afternoon peak.

5.3.64. The number of events requiring a pilot boat on a day with 14 events has mean 3.82 and median 4.

5.3.65. The schedule has three such events however that includes one in both of the modelled inter peak and PM peak periods. Therefore, if another event in the schedule were to require a pilot boat it could be expected that this would occur in the off peak (non-modelled) periods and so that would not affect the modelling.

5.3.66. Based on those findings, the schedule was similarly considered to overall provide a sensible and plausible listing of events for the 'high' day.

Table 5-6 - Derived Bridge Opening Schedule – 'High' Day

Event No.	Start Time	End Time	Duration	LOA	Pilot?	Direction
1	04:43:00	04:47:57	00:04:57	19.20	No	Departure
2	06:27:00	06:32:11	00:05:11	26.46	No	Departure
3	07:42:00	07:47:12	00:05:12	26.92	No	Departure
4	08:08:00	08:12:54	00:04:54	17.60	No	Departure
5	09:20:00	09:24:59	00:04:59	20.00	No	Arrival
6	10:15:00	10:19:56	00:04:56	18.50	No	Arrival
7	11:21:00	11:25:58	00:04:58	19.76	No	Departure

8	12:42:00	12:47:40	00:05:40	41.35	Yes	Arrival
9	14:25:00	14:29:59	00:04:59	20.02	No	Arrival
10	15:35:00	15:39:58	00:04:58	19.50	No	Arrival
11	16:55:00	17:00:15	00:05:15	28.55	No	Arrival
12	18:06:00	18:14:00	00:08:00	65.54	Yes	Departure
13	19:27:00	19:33:23	00:06:23	48.81	Yes	Arrival
14	20:46:00	20:51:36	00:05:36	39.30	No	Departure

5.4 MODELLING OF THE BRIDGE LIFTS

5.4.1. The bridge lifts—or closures to traffic— and the effect of the VMS have been modelled using a combination of different features of Paramics Discovery:

- Two fixed schedules, time varying vehicle restrictions were modelled to control whether the bridge is raised or lowered. The first restriction, called ‘Bridge Opened’, controls the times when the bridge is lowered: the one called ‘Bridge Closed’ controls the times when the bridge is raised.
- Two overlapping routes (in each direction) were used to model the lifting bridge, one of them is affected by the ‘Bridge Opened’ restriction while the other has the ‘Bridge Closed’ restriction.
- In order to model some number of vehicles expected to be willing to wait while the bridge is raised, a combination of extra link based costs and traffic lights have been included. The traffic lights are activated at the same time that the bridge is raised. The length of the red-light stage is equal to the duration of time that the bridge is raised.

5.4.2. The ‘Bridge Opened’ restriction is a closure-type restriction that specifies the time between the bridge openings. This is applied across all lanes on the links forming the alternative route. The ‘Bridge Closed’ restriction, another closure specifying the times the bridge lifts, is applied across all lanes on the links forming the prime route, which is usually open to traffic.

5.4.3. Using overlapping routes (resulting in collinear links), vehicle restrictions and traffic lights together means that a route is always available across the Scheme. This is done in such a way (with the traffic lights) that the alternative route cannot be and is never used as it’s available only when the bridge is raised.

5.4.4. This configuration is illustrated in the following figure, with the overlapping routes separated.

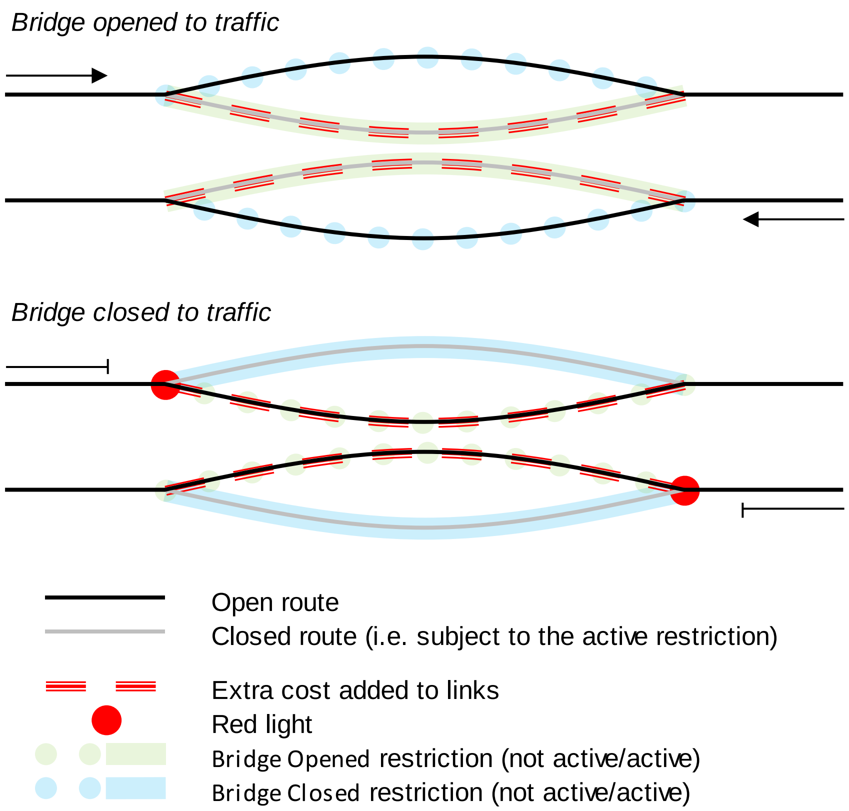

Plate 5-11 - Modelling of the Bridge Lifts

5.4.5. The inclusion of extra link-based costs on the overlapping set of links means, at the start of the closure to traffic at least, only some vehicles perceive a benefit from using another route to complete their journey instead of waiting until the bridge is lowered again.

SIMULATION ELEMENTS

5.4.6. There are three parts to the simulation acting together to affect the routes simulated vehicles use, including routes using the Scheme:

- Drivers' route selection based on the principle of generalised cost
- Drivers' knowledge of available routes to travel to their destination
- Drivers' knowledge of current conditions, which is fed back to them

5.4.7. Firstly, each driver will choose one of the routes that minimises, or is perceived to minimise, the generalised cost of the trip, with some variance according to the perturbation value. This cost is based on combining travel time and travel distance and any extra cost involved in traversing the route. Different vehicle types are set to weight these elements differently in the Great Yarmouth Microsimulation Model (e.g. with large goods vehicles perceiving greater distance as being costlier than cars and vans).

5.4.8. This results in a stochastic assignment.

5.4.9. Costs applied on the alternative route over the opening span apply the extra link costs, which are then (when the alternative route across the Scheme is open) considered in a driver's assessment of generalised cost. The toll level in generalised cost units translates to approximately 5 minutes travel time, meaning if the other route to their destination is not at least this much quicker and shorter the driver will wait until the bridge is lowered again.

5.4.10. The extra link costs apply only to cars and LGVs. Larger goods vehicles do not perceive these extra costs, meaning drivers of these vehicles will almost always chose to route via the new crossing if this forms part of their cheapest route.

5.4.11. Secondly, as drivers enter the network at their origin zone, they identify, from the set of all possible routes, the cheapest route between the link they're loaded onto and their destination zone. This translates as all drivers having perfect knowledge of all the costs to reach their destination in any way when they select their route.

5.4.12. If the network changes during their trip, this prompts a review; the driver will again identify (and start using) the (perhaps different) cheapest route from their current link to their destination zone. Network changes include link (or lane) and turn closures and restrictions, like 'Bridge Opened' and 'Bridge Closed'.

5.4.13. At the instant of a network change, all drivers presently in the network, wherever they are in the network, will re-evaluate their route selection taking account of the changed routes and any resulting changed costs. It could be, for example:

- that the links forming part of their previous cheapest route are no longer open, or
- a new, cheaper route has opened.

5.4.14. Drivers do not get advanced warning of an imminent network change, or, in particular, that a certain network change is about to activate that will affect their route. This means, for example, some vehicles will begin to cross the scheme, and not know until they are on the bridge that it will imminently close.

5.4.15. In the setup used in modelling the Scheme there is always a route available. The re-evaluation of route selection prompted by the network change, which is triggered by the vehicle restriction changing (i.e. closure of the prime route and opening of the alternative), allows drivers needing to cross the River Yare to consider at that instant whether the alternative route across the Scheme is cheaper than the other longer routes.

5.4.16. Thirdly, the dynamic assignment feature allows some drivers to re-route based on their knowledge of current traffic conditions and delays, which is fed back to them. Rather than, say, reacting to some on-street or in-vehicle ITS that's updating drivers on every congestion hotspot across the whole network in real-time, this should be regarded as knowledge acquired by drivers through time about conditions en route to their destination (e.g. what's the quickest route to work if I leave now and does this change is I leave in 10 minutes).

5.4.17. In the Great Yarmouth Town Microsimulation Model: 60% of vehicles have the opportunity to change their route every two minutes based an assessment of costs that considers the average of the previous delay and delay in the last minute.

5.4.18. The effect is to see drivers changing to avoid congested routes and junctions. This changes the assignment.

5.4.19. The opportunity to change route to a cheaper route is separate from that related to a network change, such as a vehicle restriction. In the same way the opportunity to switch to a newly opened route is not linked to dynamic assignment.

5.4.20. In the case of modelling the scheme, in the time the bridge is raised, the effect of the delay because of the traffic lights builds and further increases the perceived cost of using the alternative route over the bridge. This will make it less and less likely vehicles will wait for the bridge to re-open during the closure to traffic.

5.4.21. After the bridge has re-opened to traffic, the effect of the drivers who had waited at the traffic signals increases the perceived costs of using the prime route over the bridge. This diminishes (with successive averages) in the minutes after the bridge is lowered again.

6 MODEL OUTPUTS

6.1 INTRODUCTION

6.1.1. Given the large number of outputs, this section only provides a summary the main results of the forecasting process. More detailed model outputs can be found in the DCO document 7.2: Transport Assessment.

6.2 NETWORK STATISTICS

6.2.1. Table 6-1, Table 6-2 and Table 6-3 indicate how the total travel time and distance and number of vehicles varies between the separate forecast models, for all three time period models.

6.2.2. Paramics Discovery only records statistics from vehicles that at the end of the simulation have finished their trips. In very congested networks, as '*Do Minimum 2038*', vehicles tend to form gridlocks and therefore lots of vehicles cannot finish their trips. This can be seen on drop of the total number of vehicles in every period. When this happens the rest of the network statistics of this model become unreliable, as the network doesn't have enough capacity to accommodate all the demand. In this case the only conclusion that can be extracted from the network statistics of the '*Do Minimum 2038*' is that an intervention is needed.

6.2.3. The network statistic comparison for the rest of the scenarios show that:

- Traffic is expected to increase by around 10% between 2018 and 2023;
- The Scheme is expected to counteract the additional delay caused by the traffic growth from 2018 to 2023. This can be seen by comparing the average time in 2018 with the DS 2023 for the three periods;
- The average travel distance per vehicle is expected to decrease by 3-4% with the Scheme; and
- The average speed can increase up to 32% during the PM period with the Scheme.

Table 6-1 - Network statistic comparison (AM period)

	2018	Do Minimum 2023	Do Something 2023	Do Minimum 2038	Do Something 2038
Total Time Taken (h)	2,551	2,879	2,736	2,791*	4,435
Total Distance (km)	92,550	98,951	98,690	70,646*	114,816
Total Vehicles	30,645	32,166	33,113	24,628	38,248
Average Time (s) / Vehicle	300	322	297	400*	417
Average Time (s) / Mile	160	169	161	225*	224
Average Distance (m) / Vehicle	3,020	3,076	2,980	2,854*	3,002
Average Speed (mph)	23	21	22	16*	16
Average Speed (kph)	36	34	36	26*	26

*These values are unreliable due to the congestion problems in ‘*2038 Do Minimum*’.

Table 6-2 - Network statistic comparison (IP period)

	2018	Do Minimum 2023	Do Something 2023	Do Minimum 2038	Do Something 2038
Total Time Taken (h)	2,369	2,788	2,606	5,754*	3,650
Total Distance (km)	92,983	102,409	99,465	111,600*	118,365
Total Vehicles	33,086	35,502	35,772	37,953	42,042
Average Time (s) / Vehicle	258	283	262	547*	313
Average Time (s) / Mile	148	158	152	299*	179
Average Distance (m) / Vehicle	2,810	2,885	2,781	2,940*	2,815
Average Speed (mph)	24	23	24	12*	20
Average Speed (kph)	39	37	38	20*	32

*These values are unreliable due to the congestion problems in ‘*2038 Do Minimum*’.

Table 6-3 - Network statistic comparison (PM period)

	2018	Do Minimum 2023	Do Something 2023	Do Minimum 2038	Do Something 2038
Total Time Taken (h)	3,160	4,077	2,944	7,008*	4,641
Total Distance (km)	103,245	109,830	106,073	91,289*	121,853
Total Vehicles	34,497	35,822	35,968	30,910	41,293
Average Time (s) / Vehicle	330	410	295	814*	405
Average Time (s) / Mile	177	215	161	443*	221
Average Distance (m) / Vehicle	2,993	3,066	2,949	2,951*	2,951
Average Speed (mph)	20	17	22	8*	16
Average Speed (kph)	33	27	36	13*	26

*These values are unreliable due to the congestion problems in ‘*2038 Do Minimum*’.

6.3 FLOW IMPACTS

6.3.1. Traffic flow on the TRC and traffic relief on the other River Crossings is indicated below in Table 6-4, Table 6-5 and Table 6-6. As mentioned in paragraph 6.2.2, data from a Paramics Discovery model when conditions are very congested are unreliable, this is the case of the traffic flows of the '*2038 Do Minimum*'. Therefore, the data coming from this model should be treated with caution.

6.3.2. The Scheme is expected to have a negligible impact on the traffic flow over Breydon Bridge. However, Haven Bridge is expected to experience a reduction in traffic flows of 41-45%, depending on the time period.

Table 6-4 - River Screenline Traffic Relief (AM peak) – two way traffic flows

Road	2018	2023 DM	2038 DM	2023 DS	2038 DS
Breydon Bridge	2,803	2,730	1850 *	2,728	2,883
Haven Bridge	1,937	2,436	2480 *	1,359	1,666
TRC	-	-	-	1,731	1,982
Sum	4,741	5,166	4,330 *	5,818	6,531
Flow Change		Increase from Base	Increase from DM 2023	Increase from DM 2023	Increase from DM 2038
Breydon Bridge	-	-73	-880 *	-2	1,033 *
Haven Bridge	-	499	44 *	-1,078	-814 *
TRC	-	-	-	1,731	1,982 *
Sum	-	426	-836 *	652	2,201 *

*These values are unreliable due to the congestion problems in '*2038 Do Minimum*'.

Table 6-5 - River Screenline Traffic Relief (IP peak) – two way traffic flows

Road	2018	2023 DM	2038 DM	2023 DS	2038 DS
Breydon Bridge	2,352	2,491	2612 *	2,393	2,738
Haven Bridge	1,777	2,174	2525 *	1,191	1,502
TRC	-	-	-	1,392	1,823
Sum	4,129	4,665	5,136 *	4,975	6,064
Flow Change		Increase from Base	Increase from DM 2023	Increase from DM 2023	Increase from DM 2038

Breydon Bridge	-	139	121 *	-98	127 *
Haven Bridge	-	397	350 *	-984	-1,022 *
TRC	-	-	-	1,392	1,823 *
Sum	-	537	471 *	310	928 *

*These values are unreliable due to the congestion problems in '*2038 Do Minimum*'.

Table 6-6 - River Screenline Traffic Relief (PM peak) – two way traffic flows

Road	2018	2023 DM	2038 DM	2023 DS	2038 DS
Breydon Bridge	2,711	2,890	2631*	2,908	2,959
Haven Bridge	2,300	2,174	1843 *	1,286	1,735
TRC	-	-	-	1,594	1,718
Sum	5,010	5,064	4,474 *	5,788	6,413
Flow Change		Increase from Base	Increase from DM 2023	Increase from DM 2023	Increase from DM 2038
Breydon Bridge	-	179	-259 *	18	328 *
Haven Bridge	-	-126	-331 *	-889	-108 *
TRC	-	-	-	1,594	1,718 *
Sum	-	54	-590 *	723	1,939 *

*These values are unreliable due to the congestion problems in '*2038 Do Minimum*'.

7 SUMMARY

7.1.1. This report has described the methods and assumptions used in preparing the future year traffic forecasts using the 2018 base year traffic model for Great Yarmouth, in line with the Department for Transport's guidance. A forecast from a 2018 present year has been conducted to the opening year, 2023 and design year, 2038.

7.1.2. A schedule of vessel movements was derived from a statistical analysis, and the correspondent need for the bridge to raise has been modelled, as same as its impact to the network operation.

7.1.3. Forecasting results, with variable demand, predict that the Scheme will help to reduce total travel distance, reduce total travel time and increase average network speed in the study area.

7.1.4. The results are considered appropriate to employ in a subsequent Transport Assessment of the Scheme.

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