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B&NES Highway Safety Improvement Studies
Bathampton Canal Bridge

Design Report

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REVISION 1

Quality information

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1. Executive Summary

AECOM have been commissioned by Bath and North East Somerset (B&NES) Council to develop feasibility designs to identify options for pedestrian and cycling improvements along 6 urban highway routes in Bath. Additionally, B&NES are seeking limited ongoing support for traffic management. This report discusses the review undertaken for Bathampton Canal Bridge to inform the development of feasibility designs.

Bathampton Canal Bridge is Grade II listed. A pedestrian desire line exists between Bathampton Primary School and Dark Lane which requires students to walk along Bathampton canal bridge. However, no footway exists along the eastern side of the bridge where the desire line is. Therefore, students have to walk along the bridge mixed with traffic. The problem has been exacerbated by the mitigation work which is being carried out at Cleveland Bridge which might result in some traffic rerouting to Bathampton Canal Bridge.

AECOM project team visited the site twice on Wednesday 20th April 2022 and Wednesday 27th April 2022. The latter site visit occurred in the afternoon during school exit time to observe the existing issues faced by students. Several safety observations were made during the site visit which were noted and documented in this report. A traffic and speed survey conducted in November 2018 was analysed to establish peak hours within the study area, average speed and peak hour traffic volumes. Collisions data for the last 5 years within the study area was reviewed and analysed to identify any safety issues that can be addressed as part of this review.

Two options were developed: The first one involves single lane working along with give-way operation and the second one is a signalised option. Both options involve proposing footway eastern side of the bridge and narrowing down existing carriageway along the bridge to a single lane. Each option has its own advantages and limitations. Option 1 is relatively less expensive and therefore can be implemented as an experiment for a limited period of time to test its efficiency. Should the option proved not to be operationally successful, option 2 can be considered.

AECOM have completed an outline high-level construction cost estimate for the proposal, and this will be reviewed by B&NES officers in due course. Several elements need to be considered in the next design stage including updated traffic survey, topographical survey, pavement assessment, drainage review and lighting design. Approval is likely to be required from the Conservation Officer prior to any work on the bridge and advice should be sought from B&NES Council

2. Introduction

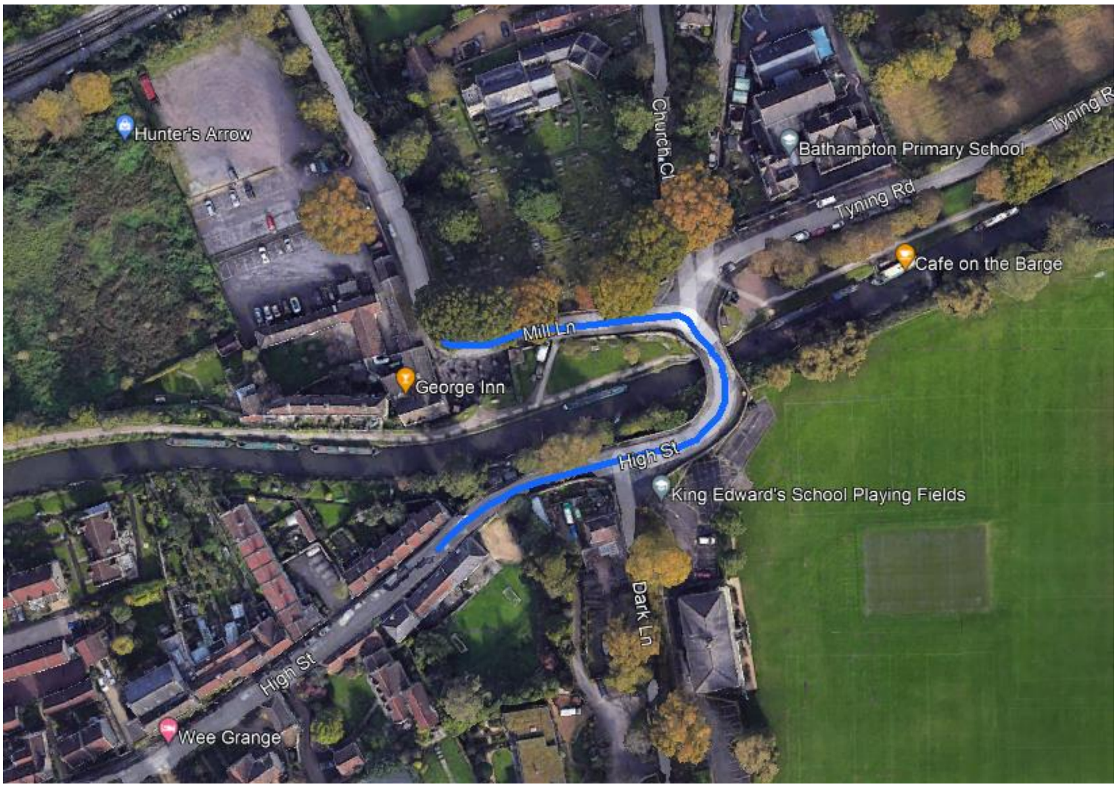
Overview

AECOM have been commissioned by Bath and North East Somerset (B&NES) Council to develop feasibility designs to identify options for pedestrian and cycling improvements along 6 urban highway routes in Bath. These include:

- Bloomfield Road;
- Newbridge Road /Upper Bristol Road;
- Weston Lane / Road;
- Lansdown Road;
- Access across the canal Bridge in Bathampton; and
- Widcombe Hill.

Additionally, B&NES are seeking limited ongoing support for traffic management. This report discusses the review undertaken for Bathampton Canal Bridge to inform the development of feasibility designs. Extent of work is indicated in Figure 1 below.

Figure 1: Location Plan of Bathampton Canal Bridge



Scheme Background

Bathampton Canal Bridge is Grade II listed. The site is located within the Bristol and Bath Green Belt and the Cotswolds AONB. The Kennet and Avon Canal is a designated SNCI and the tow path on the north bank is identified as a Public Right of Way (BA1/5) and a recreational cycle route. The site is located within the Bathampton Conservation Area and close to various heritage assets including the Grade II St Nicholas Church and its associated churchyard monuments of which 10 are individually listed, the Grade II.

A pedestrian desire line exists between Bathampton Primary School and Dark Lane which requires students to walk along Bathampton canal bridge. However, no footway exists along the eastern side of the bridge where the desire line is. Therefore, students have to walk along the bridge mixed with traffic. The problem has been exacerbated by the mitigation work which is being carried out at Cleveland Bridge which might result in some traffic rerouting to Bathampton Canal Bridge. The Council installed temporary signals that operate daily, once during the morning to aid the walk to school and again when children finish school. The lights are manually operated and reduce the traffic to a single lane. The bridge is a School Crossing Patrol (SCP) site. This position is currently filled and working at the George Inn crossing while the signals are in operation. The SCP will be moved to the bridge when the signals are removed. Unusually, the patrol helps people walk along the bridge rather than crossing the road.

Figure 2- Eastern side of Bathampton Canal Bridge where no footway exists

The community developed an alternative route which included a proposed footbridge over the canal. Planning permission was obtained, and the Council developed the proposals to a stage that enabled an accurate cost plan to be produced. The estimated cost was £2.0m at 2021 prices however no potential funding streams have been identified.

Scope of work

The scope of work for this commission includes:

- A site meeting with the Client representatives and Ward/Parish members to discuss problems, challenges and potentiation mitigation options;
- Review the last five years' injury accident records to identify any safety issues;
- Develop feasibility design options to address issues identified in the Brief;
- Provide improved pedestrian and cycle crossing facility on the approach and over the Bathampton Canal Bridge to Bathampton Schools;
- Engagement with Ward and Parish Members to discuss problems and proposals;
- Preparation of a Design Report with supported drawings that are of adequate detail to confirm the options are feasible; and
- Provide cost estimate for the delivery of the proposals.

The remaining of this report is structured as follow:
Chapter 3 reviews relevant policy background;
Chapter 4 investigates existing conditions within the extent of the study area;
Chapter 5 discusses design principles;
Chapter 6 summarises high level construction cost estimate for the proposed options; and
Chapter 7 includes conclusions and next steps.

3. Policy Context

3.1. National Policy

3.1.1. Gear Change (Department for Transport)

The Gear Change policy document set out its vision of doubling cycling journeys and making half of all journeys around towns and cities via walking and cycling.

To achieve this, Gear Change categorises policies into four themes all of them are aimed towards improving cycling facilities. Part of this theme is also promoting cycling to school via closing streets and enforcing parking restriction at pick-up and drop-off times. The theme also stresses the need to make routes direct, well connected, and free of obstacles.

3.2. Regional Policy

3.2.1. West of England Local Cycling and Walking Infrastructure Plan 2020-2036 (LCWIP).

The West of England LCWIP sets out the regional plan up until 2036. It aims to make cycling and walking the natural choice for shorter journeys, and to double national levels of cycling by 2025.

3.2.2. Joint Local Transport Plan 4 (JLTP4) 2020-2036

The JLTP4 aims to achieve carbon neutral by 2030 by promoting and improving facilities for public transport, cycling, and walking.

3.3. Local Policy

3.3.1. Getting Around Bath - a transport strategy for Bath

Getting Around Bath' sets out an agreed long term vision for transport which needs broad and enduring agreement. It covers the period up to 2029 to reflect the period for the Council's agreed Draft Core Strategy.

With an already high level of walking in the city, the plan aims to further promote walking by improving infrastructure like crossings, public seating, street lighting and much more so that it becomes the "UK's most walkable city". It also looks to make the streets more accessible especially for those with disabilities by the implementation of tactile paving, crossing arrangements, dropped kerbs, level surfacing and much more.

There is also a rise in the use of cycling in the city. To cater for this increase in demand and further promote cycling, the plan focuses on the need for desired and linked connected routes to form a coherent network. The plan also to mentions the need to implement several features to improve infrastructure for cycling such as specific junctions, designate routes, cycling parking, direction signing and much more.

3.3.2. Transport Delivery Action Plan for Bath 2020

The Transport Delivery Action Plan for Bath 2020 sets out Bath's vision for transport for the future and how it will achieve it. The plan set outs a number of key policies to achieve its objectives such as making walking and cycling the prioritised method of transport. The plan makes clear that this means removing the actual and perceived dominance of cars and improving walking and cycling facilities even at the expense of road space for motorists. The plan also mentions the need to improve connectivity of cycle routes and welcoming and facilitating the use of electric bikes.

3.3.3. Public Realm and Movement Strategy for Bath City Centre 2010

The Public Realm and Movement Strategy for Bath City Centre aims to restructure the hierarchy, putting pedestrians especially those with visual impairment at the top, followed by cyclists, followed by public transport users.

3.3.4. The City of Bath World Heritage Site Management Plan 2016 – 2022

This plan stresses the importance of the need to preserve the widespread historic buildings in Bath. It cites the need to reduce traffic flows in the city centre and promotes other methods of transport like walking and cycling. Furthermore, the plan also mentions the lack of quality and maintenance of footways. It makes clear the need of paving footways to fit in with the rest of the architecture of the city. The plan also notes the risk of flooding near the river. The plan sets out how the City of Bath World Heritage Site Steering Group will work with a range of stakeholders to ensure preservation of heritage sites.

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4. Existing Conditions Review

Introduction

Bathampton Canal Bridge is located north of Bathampton Village. The bridge sits on a sharp horizontal bend along High Street and passes over the Kennet and Avon Canal. The High Street runs in a north-easterly direction and connects to Bathampton Lane on the South-West and Mill Lane on the North-East. The two side roads in close proximity to the canal bridge are Dark Lane, Tyning Road and Church Close which connect to the High Street.

A narrow footway exists along the western side of the bridge. However, no footway exists on the eastern side of the bridge where there is a pedestrian desire line for school children walking from Bathampton Primary School to Dark Lane and vice versa. The Council installed temporary signals that operate twice daily, once during the morning to aid the walk to school and again when children finish school. Whilst the signals are operational, the carriageway is narrowed along the bridge to one lane using cones to provide a dedicated space for students along the bridge.

AECOM project team completed 2-days site visit on Tuesday 19th April and Wednesday 20th April 2022 with B&NES Council project team members to review the routes, challenges and discuss potential mitigation options. Additionally, another round of a site visits were completed the following week on Tuesday 26 April and Wednesday 27th April 2022 with attendance by AECOM PM, B&NES Council project team members, stakeholders and Ward/Parish members to get more insights into safety issues within the extent of the study area. The site visit on Wednesday 27th April 2022 occurred in the afternoon during school exit time to observe the existing issues faced by students. The following observations were made during the site visit:

- When the temporary signals are operational, occasional blocking back occurs from the eastbound temporary stopline onto High Street narrow section, framed by the high wall screening the garden of Bathampton Lodge, which can only accommodate one vehicle. This resulted in an occasional network standstill until eastbound traffic stream receives a green display.

Figure 3-Narrow section on High Street

- At its narrowest point, the existing carriageway width along the bridge is around 4.4m excluding the contrast surfacing on the eastern side of the bridge and around 5.3m including it. Considering the sharp horizontal curvature which requires wide swept path particularly for large vehicles, two-way operation at the bridge frequently fails with two vehicles unable to pass each other without reversing back and/or mounting the footway. This particularly occurs when a medium/large vehicle is present. Several near misses were reported by local residents due to vehicles mounting the footway to be able to pass each other.

- Traffic signals induce high speed particularly during peak hours when drivers' frustration to catch the green signal led to speeding up where vulnerable pedestrians might be walking along the bridge mixed with traffic.

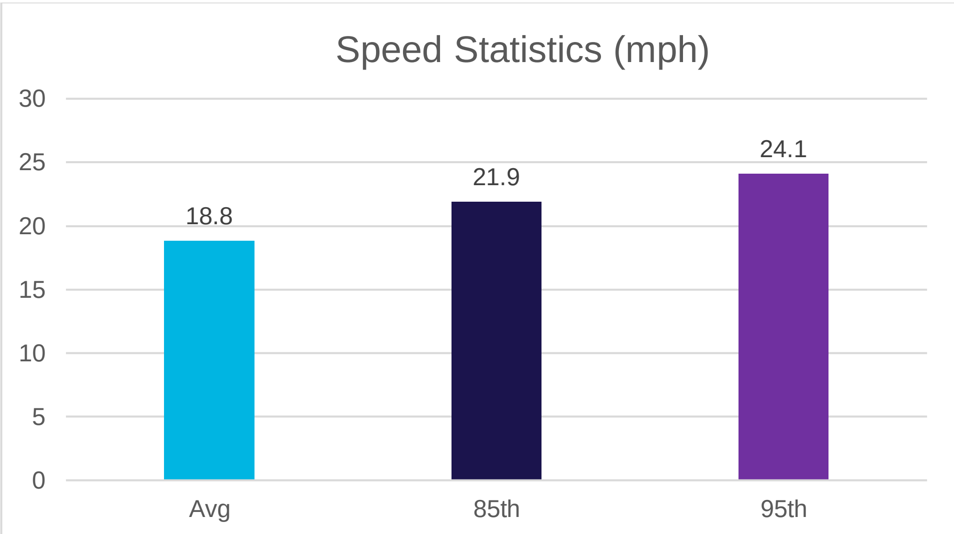
Traffic Flow and Speed Survey

B&NES Council provided Automatic Traffic Count (ATC) / Speed Survey data which was conducted in High Street for 7 consecutive days starting on Saturday 10 November 2018. The survey location was around 150 metres south west from the bridge as shown in Figure 4 below.

Figure 4-ATC / Speed Survey data conducted in High Street in November 2018

Interrogating speed survey data revealed a 7-day average 85 percentile speed of 22.3mph for eastbound traffic and 22.7mph for westbound traffic. Speed statistics is shown in Figure 5 below.

Figure 5-High Street Speed Survey Summary

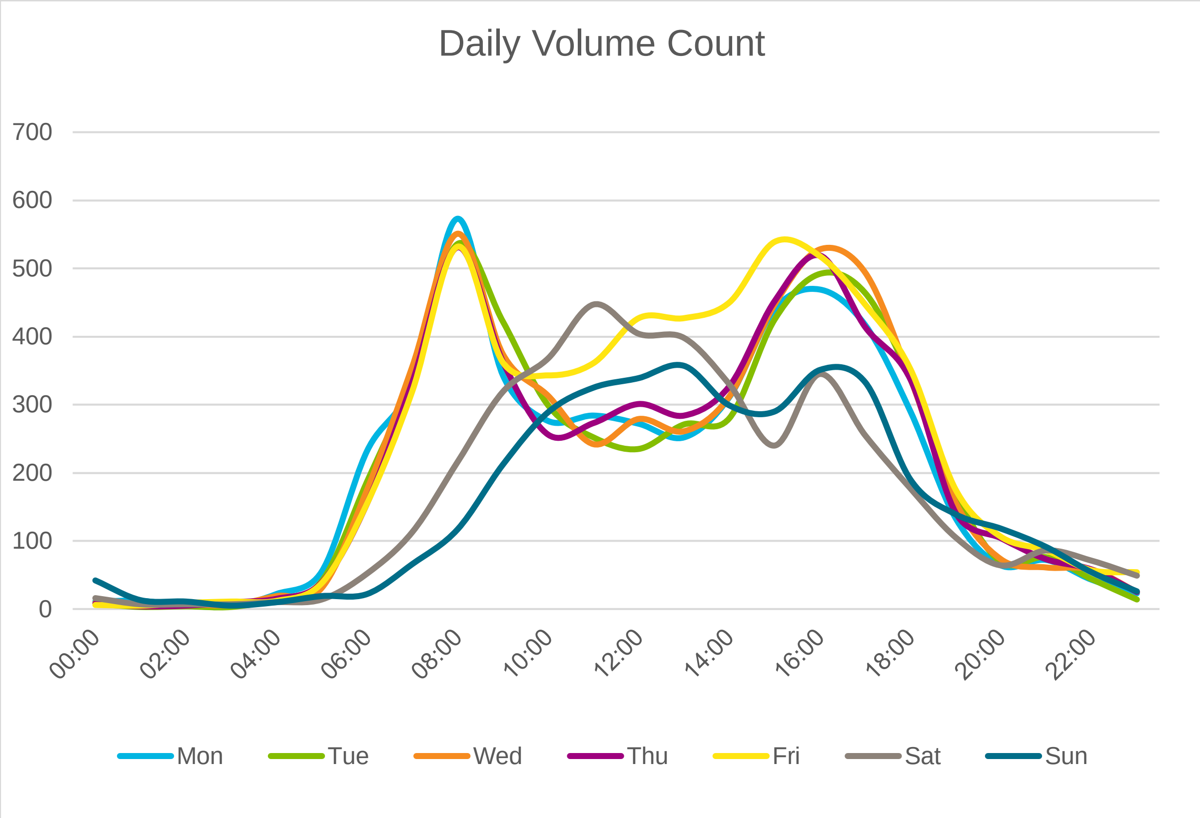


Weekday average two-way peak hour traffic volume was 559 vehicles per hour in the AM peak and 528 vehicles per hour in the PM peak. Analysing growth and decay of traffic flow revealed the following peak hours within the study area:

- 07:30 to 08:30 for the AM peak period; and
- 15:15 to 16:15 for the PM peak period.

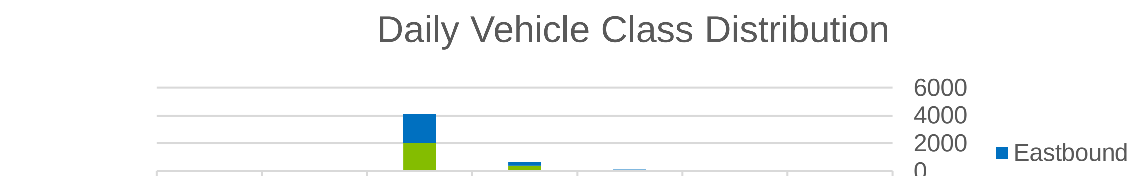
Traffic flow distribution throughout the survey period is shown in Figure 6 below.

Figure 6-High Street Two-way Traffic Flow Summary



Traffic composition consists mainly from private cars with considerable Light Goods Vehicles (LGVs) which constitute 13% of total traffic. Traffic composition summary is shown in Figure 7 below.

Figure 7- High Street Traffic Composition Summary



	PC	MC	CAR	LGV	OGV1	OGV2	PSV
Eastbound	15	10	2051	247	44	9	3
Westbound	12	12	2056	413	51	8	3

The following limitations should be noted regarding the traffic/speed survey:

- Mitigation work is currently undergoing in Cleveland Bridge which is likely resulting in some traffic rerouting to Bathampton Canal Bridge. Therefore, traffic volumes in 2022 might be higher than 2018. However, this is considered to be a temporary situation and does not represent the long-term traffic condition. Therefore, 2018 traffic volumes were deemed appropriate to be used for the purpose of this assessment;
- The surveyed 85 percentile speed of 22.5mph was measured around 150 metres away from the bridge where the combination of steep horizontal and vertical curvatures result in a reduced vehicles' speed. Therefore, actual speed on the approach to and along the bridge are likely to be considerably lower than the surveyed speed;
- The survey location is located in High Street around 150 metres away from the bridge. Traffic heading from Dark Lane to/from the bridge won't be counted as part of this survey since the access is located in closer proximity to the bridge. However, Dark Lane is considered a minor residential access and therefore is not assumed to have a significant effect on the traffic flow along the bridge.

Collisions Review

Only one traffic accident was reported between 2017 to 2021 within the study area. This occurred on the approach to the constrained section in high street before the constriction framed by the high wall screening the garden of Bathampton lodge. A vehicle was heading eastbound towards the constrained section and then stopped to allow oncoming traffic to pass through the narrow section when a follower cyclist locked their brakes to stop, causing the rider to go over the handle bars and dismount the cycle bike. This indicates that an intervention may be needed at this location to coordinate traffic and improve highway safety.

Figure 8- Collision reported in High Street in April 1019 in close proximity to Bathampton Bridge

5. Design Principles

Introduction

Table 1 below summaries options considered. All options include 1.5m proposed footway along the eastern side of the bridge and narrowing of carriageway along the bridge.

Table 1- Potential mitigation Options for Bathampton Canal Bridge

Option Description	Pros	Cons	Status
Give way marking both sides of the bridge	-Drivers will proceed with caution from both sides and give-way to each other.	-Drivers' frustration and aggression due to uncertainty over who has the right of way. -Not legally authorised by Traffic Signs Regulations and General Directions (TSRGD) 2016.	Dismissed
Option 1- Yellow box marking across the bridge	-Conveys the prohibition that a person must not cause a vehicle to enter the box junction so that the vehicle has to stop within the box junction due to the presence of oncoming vehicles or other stationary vehicles beyond the box junction. -Drivers need to proceed with caution from both sides and give-way to each other. -Relatively cheaper compared to the signalised option. -Less delay during off-peak hours. -Compliant with TSRGD 2016	-Potential drivers' non-compliance and/or confusion over the legal meaning of the yellow box marking. -Drivers are not able to see oncoming vehicles beyond the limit of the yellow box marking due to the restricted horizontal visibility which might lead to uncertainty over right of way. -The system is designed to accommodate two LGVs, to pass each other at the boundary of the yellow box marking. Should larger vehicles are passing each other, vehicles might need to mount the footway to pass each other. However, vehicles larger than LGVs represent a minimal amount of traffic as presented in earlier in Figure 7. -Less aesthetically appealing to paint the bridge carriageway with a yellow box due to the historical nature of the bridge. -Entry lane from Tyning Road might be temporarily blocked whilst vehicles are waiting behind the proposed yellow box across the bridge. -Need for proposed overrun area and/or full depth carriageway construction to accommodate two LGVs to pass each other where visibility is achieved.	Presented in Appendix A Drawing 6068179-ACM-GEN-BN-DR-TR-0001
Option 2- shuttle working: signalised operation over the bridge	-Clarity over right of way. -Pedestrians can benefit from the proposed uncontrolled crossing by walking during intergreen period , i.e. when traffic both sides will have a red signal display. -No need to provide overrun area and existing kerblines can largely be maintained.	-The system is designed to accommodate two LGVs, to pass each other at the boundary of the yellow box marking. Should larger vehicles are passing each other, vehicles might need to mount the footway to pass each other. However, vehicles larger than LGVs represent a minimal amount of traffic as presented in earlier in Figure 7. -Relatively more construction/maintenance cost compared to other options. -More delay during off-peak periods	Presented in Appendix A Drawing 6068179-ACM-GEN-BN-DR-TR-0001

Option 1 - Yellow box Marking

Within this option, traffic from both sides should be giving way to each other to avoid blocking the narrow carriageway along the bridge. Local Transport Note (LTN) 1/07 recommends a maximum peak hour of 400 vehicles per hour in each direction for single lane working. Since this figure is not exceeded as per the analysis of existing traffic flow presented in Figure 6, this option is deemed feasible.

Assessing the capacity of such operation is intricate and might require microsimulation modelling to replicate closely drivers' behaviour. However, first principles were used to assess the operational performance of the proposal.

Typically, the capacity of a give-way arm is calculated using empirical formals developed by Kimber et al (1980)[1]. A simplified version of the formula is utilised in LinSig 3 software and presented in the software User Guide. The formula states that:

F = F0 – A1 * Q1

Where:

F: Capacity of a give-way arm

F0: Maximum flow when there is no opposing traffic

A1: Slope Coefficient relates to the effect of the opposing flow on the capacity of the give way Lane and depends on visibility, lane width, etc.

Q1: Opposing traffic flow

The worst case in LinSig user guide where the capacity of the give-way traffic stream is minimal is for give-way left turning lanes. For this situation, F0 can be considered to be 715 and slope can be 0.22. Recalling the traffic survey conducted in High Street presented in Figure 6, the eastbound peak hour traffic flow is 284 Passenger Car Equivalent (PCU) whilst the westbound peak hour traffic flow 395 PCU. Therefore, the capacity of the eastbound traffic stream when giving way can be calculated as follow:

F= 715 – 0.22*395= 628 PCU/hr

And the capacity of the westbound traffic stream when giving can be calculated as follow:

F= 715 – 0.22*284= 652 PCU/hr

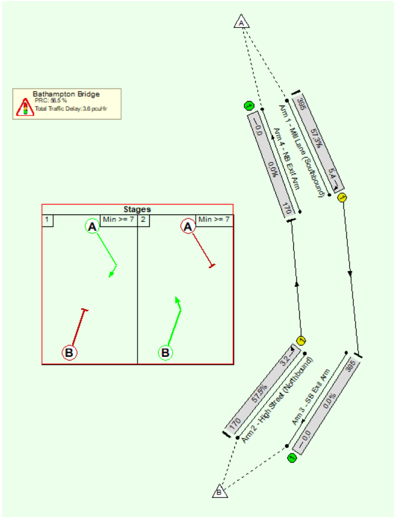
Typically, Ratio of Flow to Capacity (RFC) of 0.85 or less means that minimal queues and delays are expected. For Eastbound traffic stream, RFC = 284/628=0.45. For westbound traffic stream, RFC = 395 /652=0.6. Since both RFC are well below the 0.85 threshold, the proposal should not have capacity problems in theory. However, the complex nature of the operation might affect the results and close monitoring of the operation will be required post implementation to ensure satisfactory operational performance.

Option 2 – Shuttle Working

Within this option, traffic signals will be installed both sides of the bridge and each direction will have green signal display in sequence and/or according to demand. LinSig 3 was used to assess the operational performance of the proposed signalised option. Traffic volume was converted to PCUs using factors provided in Traffic Signs Manual Chapter 6. Due to the limitation discussed in Section 5.1.1, 2018 traffic flow was utilised in the analysis and no traffic growth was considered. Peak hour was considered to be 07:30 to 08:30 is the AM peak period and 15:15 to 16:15 in the PM peak period as per the analysis presented in Figure 6. Saturation flows were calculated using empirical formulas in LinSig 3 considering 3m lane width, 12m turning radius and 6% gradient. Proposed two stage sequence was considered.

[1] Kimber R M and Coombe R D (1980) The Traffic Capacity of Major/Minor Priority Junctions, SR582, TRRL, Crowthorne

Figure 9- Bathampton Canal Bridge proposed signalised option



The key performance indicators of the operational performance at signalised junctions are:

➢ Degree of Saturation (DoS):
DoS is calculated by dividing the arm demand (traffic flow) by the arm capacity and is measured in percentage. DoS of 100% means that the demand is equal to the capacity. DoS>100% means that the demand exceeds capacity. 90% is typically the threshold for triggering mitigation at a specific arm since queues and delays increase rapidly afterwards

➢ Junction Practical Reserve Capacity (PRC):
PRC is a measure of how much additional traffic, in percentage, could pass through a junction whilst maintaining a maximum Degree of Saturation9 (DoS) of 90% on all Lanes. Positive PRC means that a junction has a spare capacity while negative PRC indicates that the junction is close to capacity or overloaded.

➢ Queue Lengths:
The Mean Maximum Queue Length (MMQ) during the modelled time period at each arm. It is measured in passenger car equivalent (PCU) which is the average of all vehicles' types in the network.

The model run showed minimum queues and delays and ample spare capacity, i.e. PRC, of +56.5% in the AM peak and +63.9% in the PM peak. The below figures summarise the proposal operational performance.

Figure 10- Option 2 Degree of Saturation at Entry Lanes

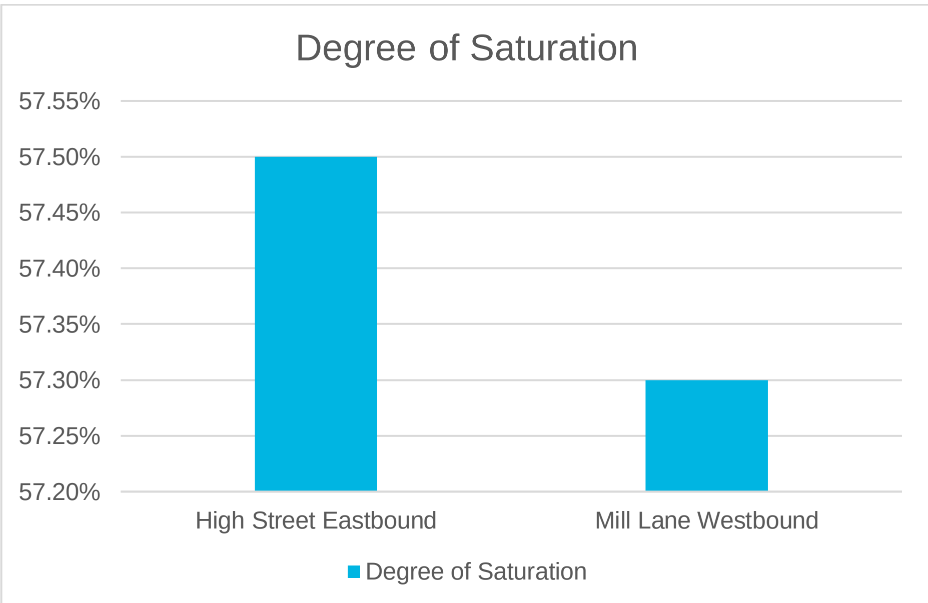
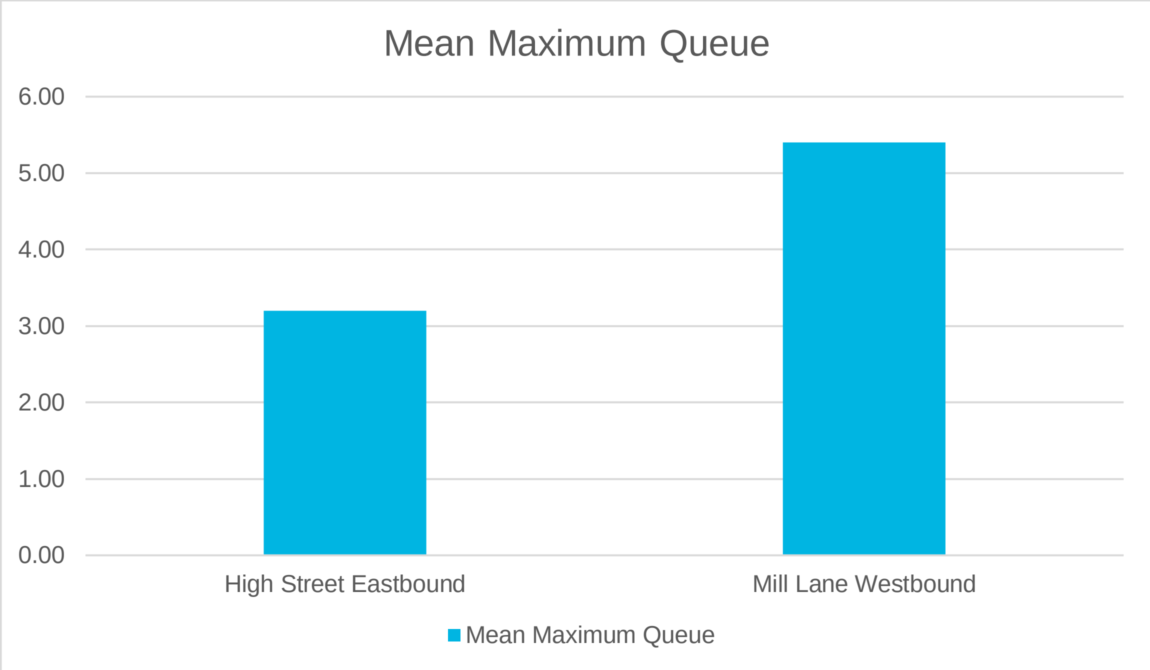


Figure 11-Option 2 MMQ at Entry Lanes



The results indicate an ample spare capacity which should accommodate existing traffic flow. Full LinSig inputs/outputs are included in Appendix B.

Other considerations

5.1.1 Traffic Flow

Mitigation work is currently undergoing in Cleveland Bridge which might result in some traffic rerouting to Bathampton Canal Bridge. Therefore, traffic volumes in 2022 might be higher than 2018. This is considered to be a temporary situation and does not represent the long term traffic condition therefore 2018 traffic volumes were deemed appropriate to be used for the purpose of this assessment. However, should traffic pattern in 2022 considered to be the long term traffic pattern, a traffic survey should be undertaken and proposed options reviewed accordingly to ensure they will still operate satisfactorily under the current traffic volumes.

5.1.2 Construction work on the bridge

Care needs to be taken when proposing design elements over the bridge deck due to the historical nature of the bridge and the likely shallow depth between existing carriageway and the apex of the bridge. Since the bridge is Listed, approval from conservation Officer will need to be sought prior to any site work and B&NES Council should be consulted for advice.

Options for proposed kerbline segregation between existing carriageway and proposed footway could include extruded asphalt which does not require any foundation and/or bolt down light segregation such as bollards. Segregation options will be considered in more detail in the next design stage.

For footway construction, level segregation might not be ideal since it will reduce parapet height. Options could include maintain existing carriageway level and rely on the physical segregation achieved using proposed kerbs achieved as described above.

Figure 12- Segregation between footway and carriageway over an existing bridge with footway and carriageway being at the same level (Source: DfT Traffic Control System Design for All Purpose Roads Compendium of Examples)

5.1.3 Proposed overrun area

Overrun area surfacing material will be detailed in the next design stage. Generally, overrun areas should not resemble footways or refuges in order to discourage pedestrians using it. Pavement assessment might be needed in the next design stage to confirm the suitability of the existing footway construction to be used for occasional overrun. Structural assessment might be needed in the next design stage to ensure the stability of the adjacent retaining walls. To ensure the constructability of overrun area construction, proposed overrun area is located away from bridge abutment in Option 1.

5.1.4 Constricted section in High Street to the West of Dark Lane

A narrow section exists on High Street before the constriction framed by the high wall screening the garden of Bathampton Lodge. Whilst the Invitation to Proposal for this commission suggested for this section to be signalised, the design team have concluded that a give-way to oncoming traffic operation using TSRGD 2016 Diagram 615 could be a more effective option since the horizontal visibility is achieved at both ends of the constrained section. Therefore, this section has been included as a give-way operation in both options.

In Option 2, care needs to be taken to ensure vehicles heading eastbound and waiting at the proposed give-way line before the constriction framed by the high wall screening the garden of Bathampton Lodge, will comply with the give-way operation whilst observing a green signal for their movement. Options could include smart detectors to extend signal timing and/or traffic signal Louver to limit the visibility of the signal head for those waiting behind the give-way line.

Figure 13- Narrow section in High Street highlighted in red

5.1.5 Tyning Road Entry Lane

In both options, Tyning Road entry lane will be temporarily blocked when vehicles are waiting behind the proposed yellow box across the bridge in Option 1 and proposed stopline in Option 2. Widening Tyning Road entry lane to avoid this situation will compromise the visibility from Tyning Road towards incoming traffic in Mill Lane. In Option 1, it is not possible to extend the proposed yellow box across the bridge further back in front of Tyning Road as this will compromise the visibility between traffic waiting at both ends of the bridge. In Option 2, other options exist as summarised below:

Table 2- Tyning Road Entry Lane Potential Treatment in Option 2

Description	Pros	Cons
Stopline located immediately before the canal bridge as currently presented in Option 2	-Tyning Road is controlled by signals -Visibility splay from Tyning Road towards incoming traffic in Mill Lane is achieved	-Entry lane from Tyning Road might be temporarily blocked when traffic is stationary behind the stopline. Traffic can informally utilise the wide exit lane in Tyning Road and its associated yellow box to complete the turning if needed -Need a small section of full depth carriageway construction/overrun area to accommodate two LGVs to pass each other at the stopline location
Maintain proposed stopline in front of Tyning Road as presented in Option 2 but widen entry lane from Tyning Road	-Traffic can exit Tyning Road without being blocked by stationary traffic utilising the yellow box located in front of Tyning Road	-Visibility splay from Tyning Road towards incoming traffic in Mill Lane will be compromised -Need a small section of full depth carriageway construction/overrun area to accommodate two LGVs to pass each other at the stopline location
Stopline shifted backwards in Mill Lane before Tyning Road	-Entry lane in Tyning Road won't be blocked by stationary traffic behind the stopline -No need for full depth carriageway construction/overrun area	-Traffic from/to Tyning Road will not be controlled by signals which could cause confusion -Larger intergreen time due to the increased distance between stoplines either sides of the canal bridge

5.1.6 Visibility towards uncontrolled crossing

Proposed uncontrolled crossing in both options is located next to Dark Lane where existing footway terminates. This is also the location where maximum visibility can be achieved between vehicles and pedestrians. However, the visibility doesn't meet the Stopping Sigh Distance (SSD) for 20mph design speed. In Option 1, SSD of 19m is achievable which corresponds to 17mph design speed whilst in Option SSD of 23m is achievable which corresponds to 19mph design speed. Whilst both design speeds are below the posted speed limit, i.e.20mph, the combination of the existing sharp horizontal and vertical curvature at the bridge encourages low speed. Therefore, whilst the reduced visibility towards the crossing point constitutes a Departure from Standards, it is not considered to be a major safety risk due to the reduced vehicles' speed at this section.

5.1.7 Visibility between vehicles both sides of the bridge in Option 1

Vertical visibility assessment has been undertaken between vehicles waiting at both sides of the proposed yellow box marking across the bridge. The analysis is presented in Appendix A Drawing 6068179-ACM-GEN-BN-DR-TR-0001. The analysis has been undertaken between a typical driver eye height of 1.05m as per MfS recommendations. MfS recommends measuring vertical stopping sight distance (SSD) towards an object located

0.6m above ground level, i.e. the height which represents a child. SSD is not achieved towards an object 0.6m above ground level due to the existing sharp vertical curvature. However, for the purpose of establishing priority both ends of the bridge, visibility is needed towards an object located 1.05m above ground level which represents the eye height of oncoming vehicles at the other end of the yellow box. The latter visibility is achieved and therefore the yellow box operation is deemed to be feasible. However, drivers are not able to see oncoming vehicles beyond the limit of the yellow box marking due to the restricted horizontal visibility.

6. Cost Estimate

AECOM have completed an outline high-level construction cost estimate for the proposal, and this will be reviewed by B&NES officers in due course.

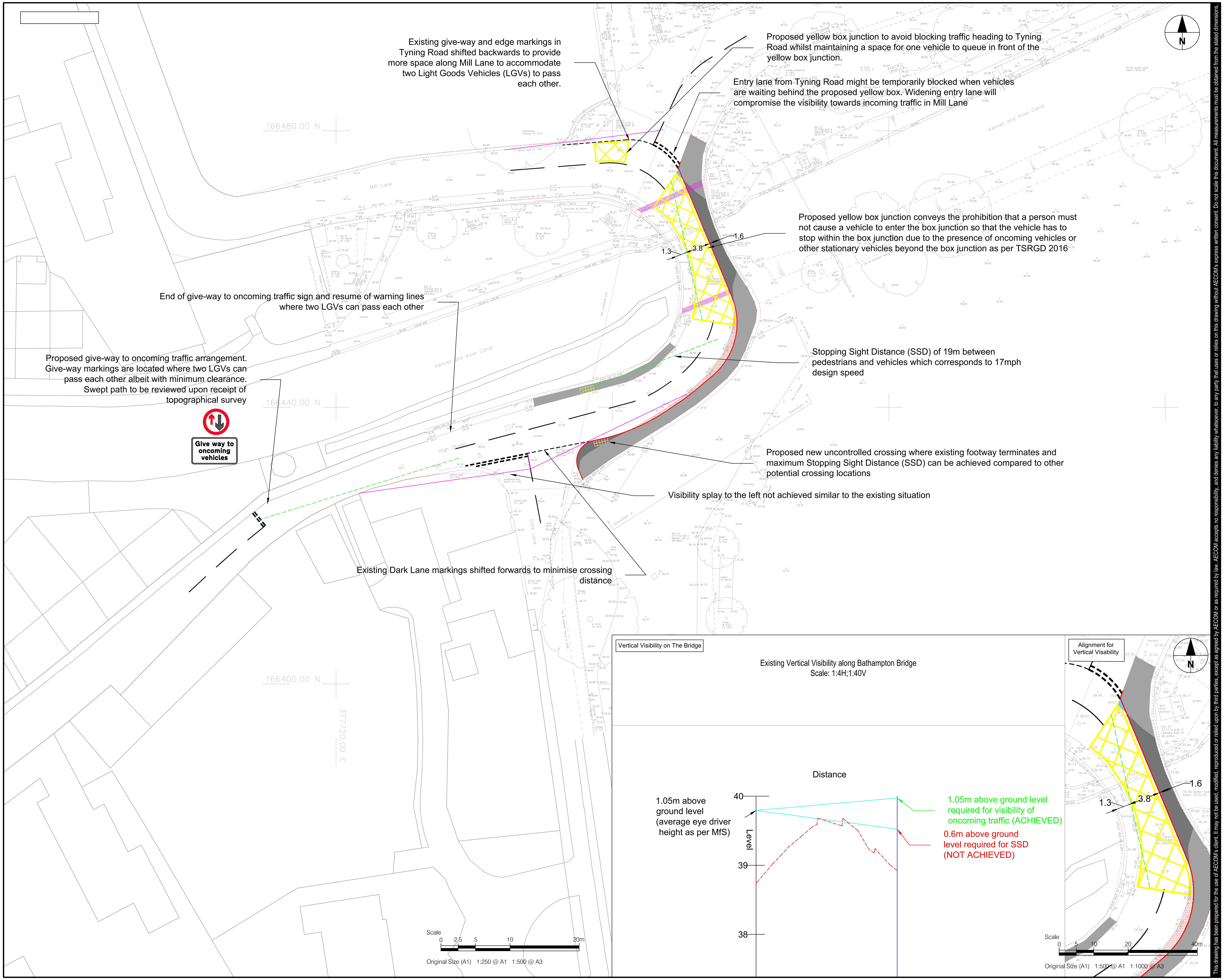
7. Conclusion and Next Steps

Two options were developed: The first one involves single lane working along with give-way operation and the second one is a signalised option. Both options involve proposing footway eastern side of the bridge and narrowing down existing carriageway along the bridge to a single lane. Each option has its own advantages and limitations. Option 1 is relatively less expensive and therefore can be implemented as an experiment for a limited period of time to test its efficiency. Should the option proved not to be operationally successful, option 2 can be considered.

The following should be considered in the next design stages:

- Should rerouting from Cleveland Bridge towards Bathampton Bridge is expected to constitute the long term traffic pattern, traffic survey should be completed to replicate 2022 conditions and proposed options to be reviewed accordingly;
- Updated topographical survey might be needed for the study area. Whilst topographical survey was provided, it was only available in PDF format and therefore approximate scaling was undertaken to complete the design work. This might result in slight displacement of proposed design coordinates, i.e. setting out information. Additionally, existing topographical survey doesn't cover the full extent of the study area particularly the narrow section in High Street to the west of Dark Lane;
- Structural /pavement assessment might need to be undertaken in the next design stage to confirm the suitability of the existing footway construction to be used for occasional overrun by large vehicles as well as to ensure the stability of existing retaining walls;
- Drainage review might need to be undertaken in the next design stage to ensure adequate drainage components are provided;
- Street lighting might need to be reviewed in the next design stage to ensure adequate lighting is available particularly at the proposed uncontrolled crossing point;
- Approval is likely to be required from the Conservation Officer prior to any work on the bridge and advice should be sought from B&NES Council; and
- Care needs to be taken when designing elements above the bridge deck to ensure its constructability.

Appendix A Drawings



ISO A1 594mm x 841mm

Drawn: --- Approved: SG Checked: AF Designer: UK Project Management Initials:

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Filename: C:\PWWORKING\AECOM_DS09_UK_2020\D0261514\60681793-ACM-GEN-BN-DR-TR-000001

AECOM

PROJECT

Bath & NES HIGHWAY SAFETY IMPROVEMENT STUDIES

CLIENT

WEST OF ENGLAND Combined Authority

CONSULTANT

AECOM
Royal Court
Colmore Circus Queensway
Birmingham
+44 (0) 1212621900

REGISTRATION

NOTES

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- PROPOSED OVERRUN AREA
- BRIDGE ABUTMENT
- PROPOSED ROAD MARKINGS
- PROPOSED YELLOW BOX JUNCTION
- PROPOSED KERB
- HIGHWAY BOUNDARY
- HORIZONTAL VISIBILITY
- PROPOSED UNCONTROLLED CROSSING
- VERTICAL VISIBILITY
- EXISTING GROUND LEVEL
- EXISTING OS MAP/TOPO SURVEY
- PROPOSED FULL DEPTH CARRIAGEWAY CONSTRUCTION
- JUNCTION VISIBILITY SPLAY

REVISION / APPROVAL DATE

P00.0 ---

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P00.0	17/06/2022	First issue

ISSUE PURPOSE / SUITABILITY

INITIAL STATUS OR WIP

PROJECT NUMBER

60681793

SHEET TITLE

BATHAMPTON BRIDGE PROPOSAL - OPTION 1 SHEET 1/2

SHEET NUMBER

Project Number	Originator	Volume
60681793	ACM	GEN

Location	Type	Role	Number
BN	DR	TR	0001

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Checked: AF
Designer: UK
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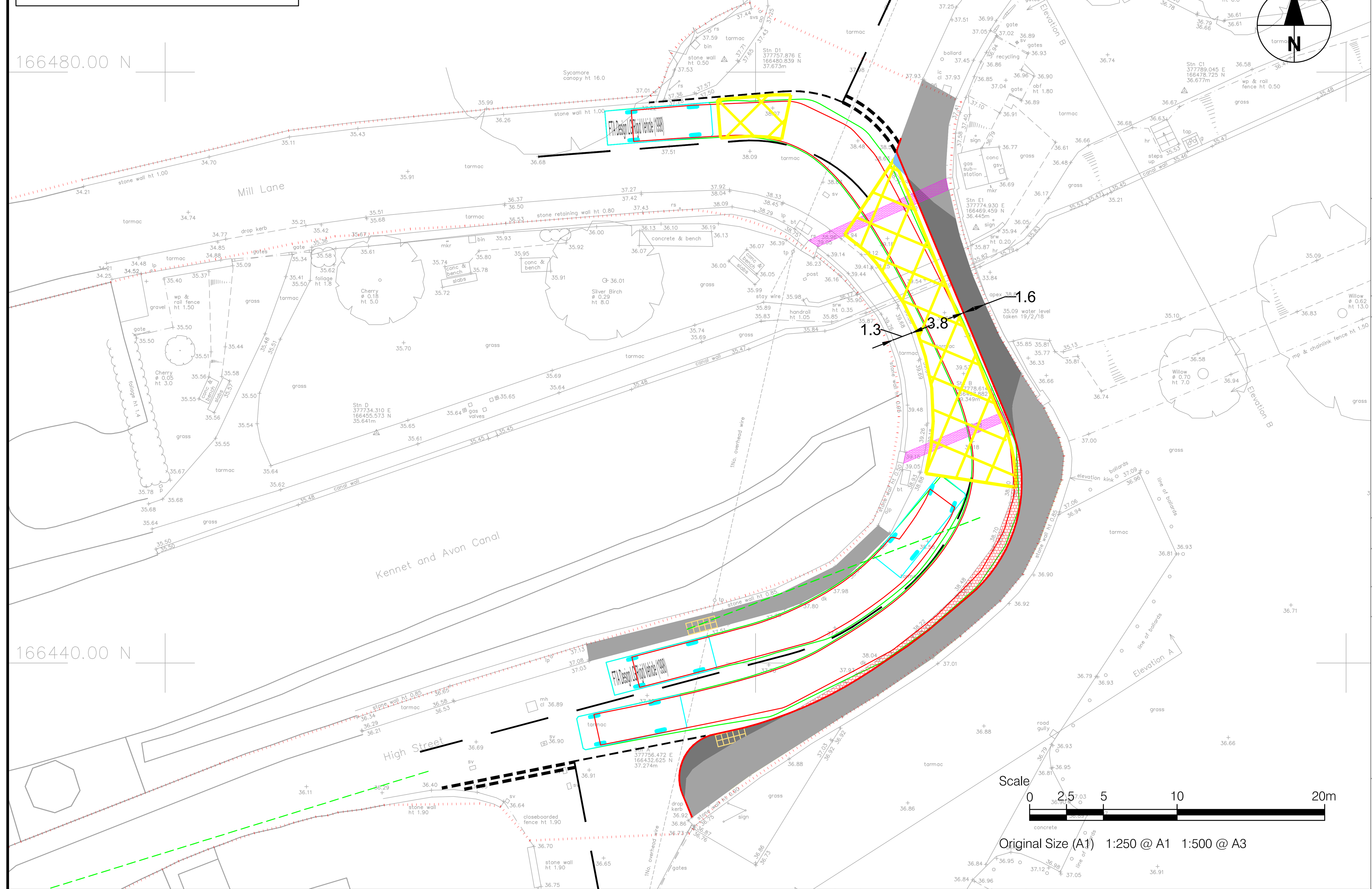
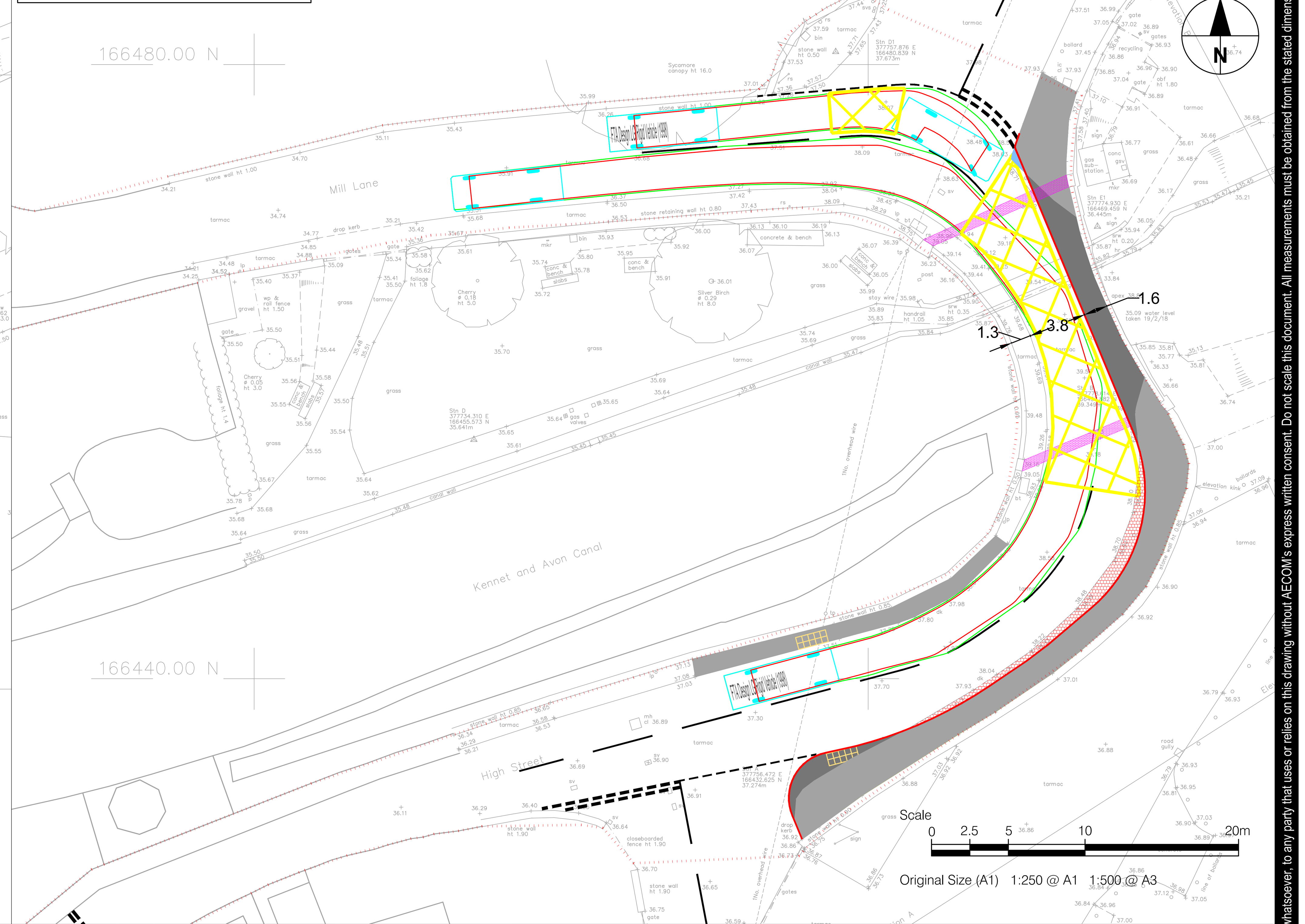
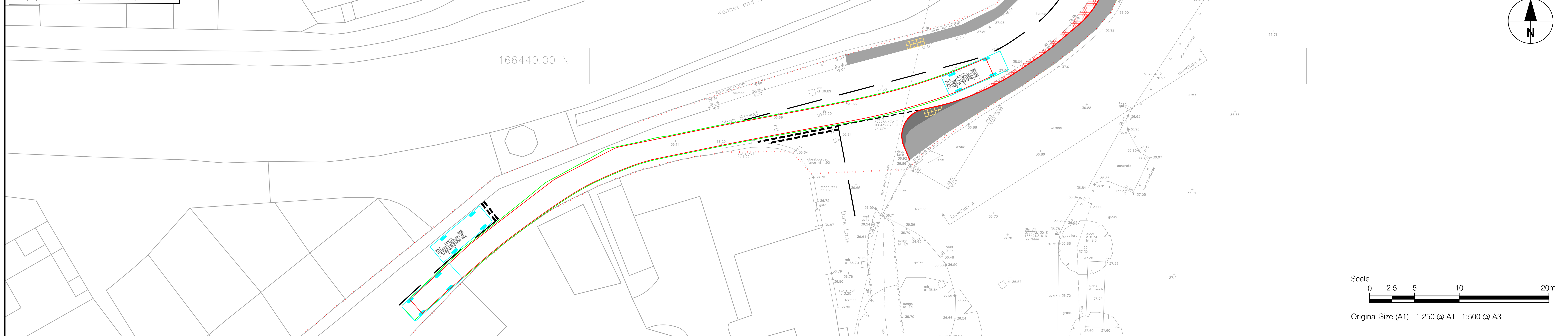
Swept path of Design Vehicle (LGV) Scenario 1



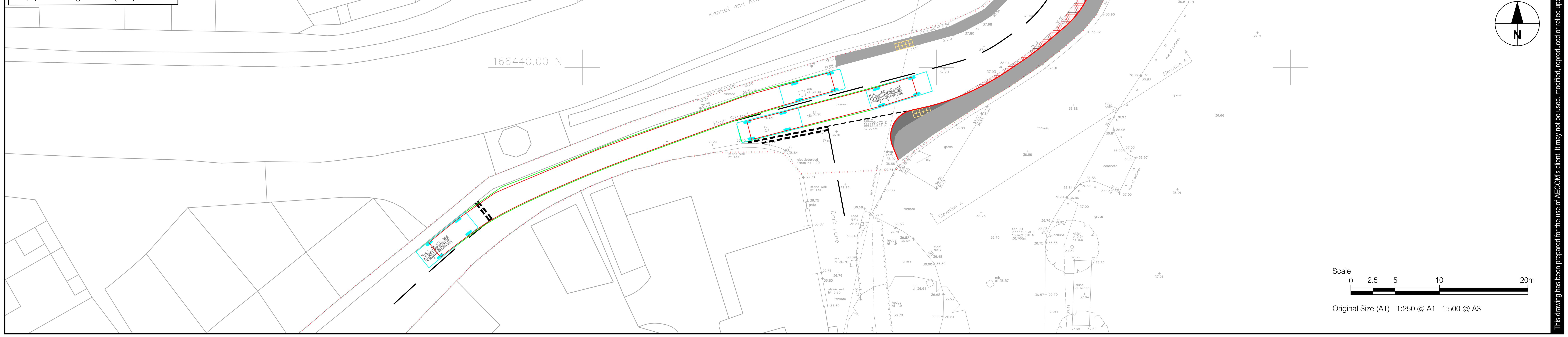
Swept path of Design Vehicle (LGV) Scenario 2



Swept path of Design Vehicle (LGV) Scenario 3



Swept path of Design Vehicle (LGV) Scenario 4



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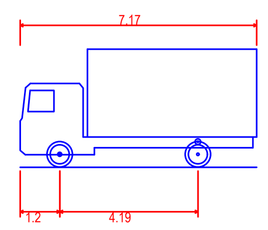

FTA Design LG Rigid Vehicle (1998)	
Overall Length	7.170m
Overall Width	2.300m
Overall Body Height	3.580m
Min Body Ground Clearance	0.375m
Track Width	2.120m
Lock to lock time	3.00s
Kerb to Kerb Turning Radius	7.000m

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ISSUE PURPOSE / SUITABILITY

INITIAL STATUS OR WIP

PROJECT NUMBER

60681793

SHEET TITLE

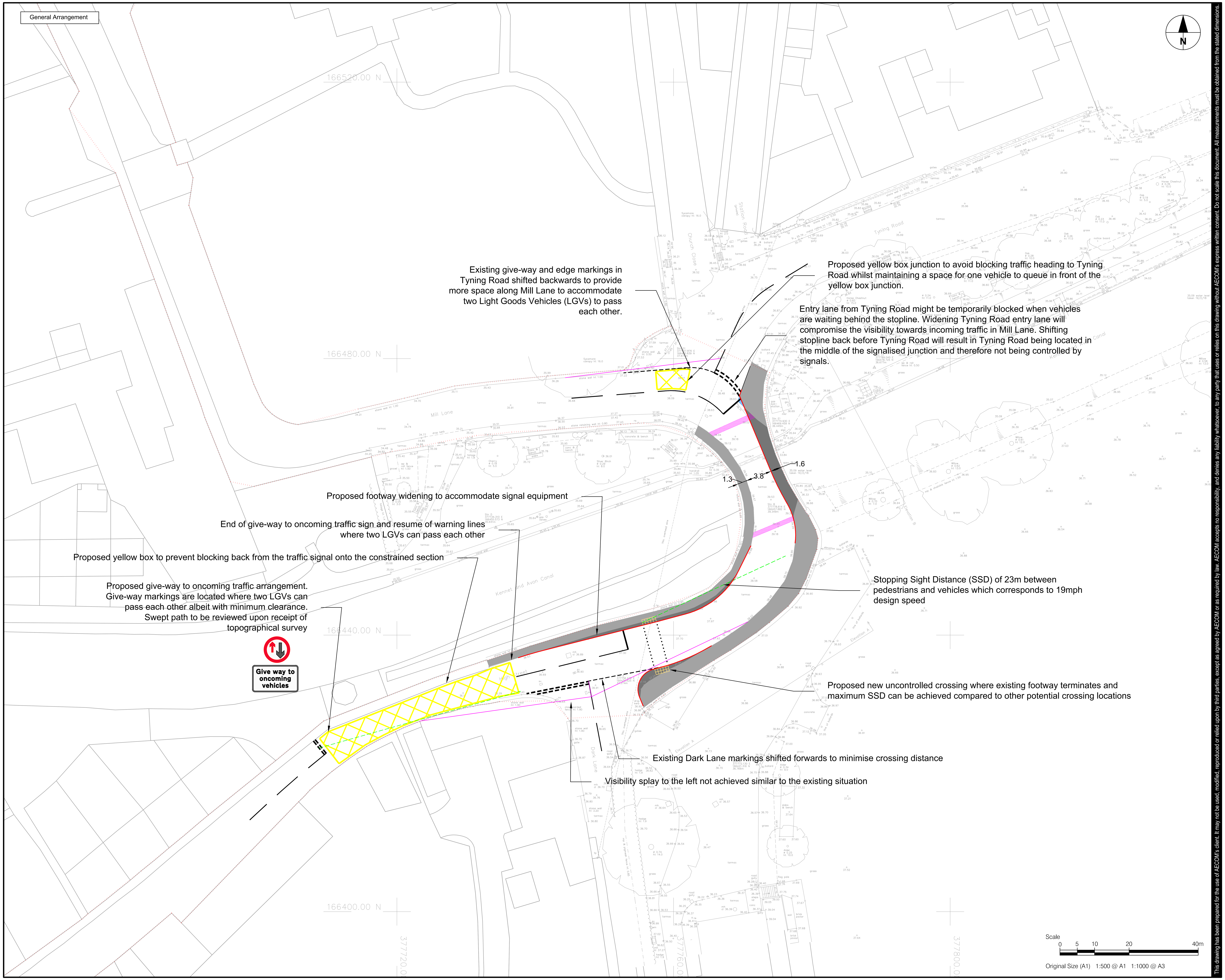
BATHAMPTON BRIDGE
PROPOSAL - OPTION 1
SHEET 2/2

SHEET NUMBER

Project Number	Originator	Volume
60681793	ACM	GEN

Location	Type	Role	Number
BN	DR	TR	0001

NOT FOR CONSTRUCTION



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HIGHWAY SAFETY
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REGISTRATION

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PROPOSAL - OPTION 2
SHEET 1/2

SHEET NUMBER

Project Number	Originator	Volume
60681793	ACM	GEN
LN	DR	TR 0001
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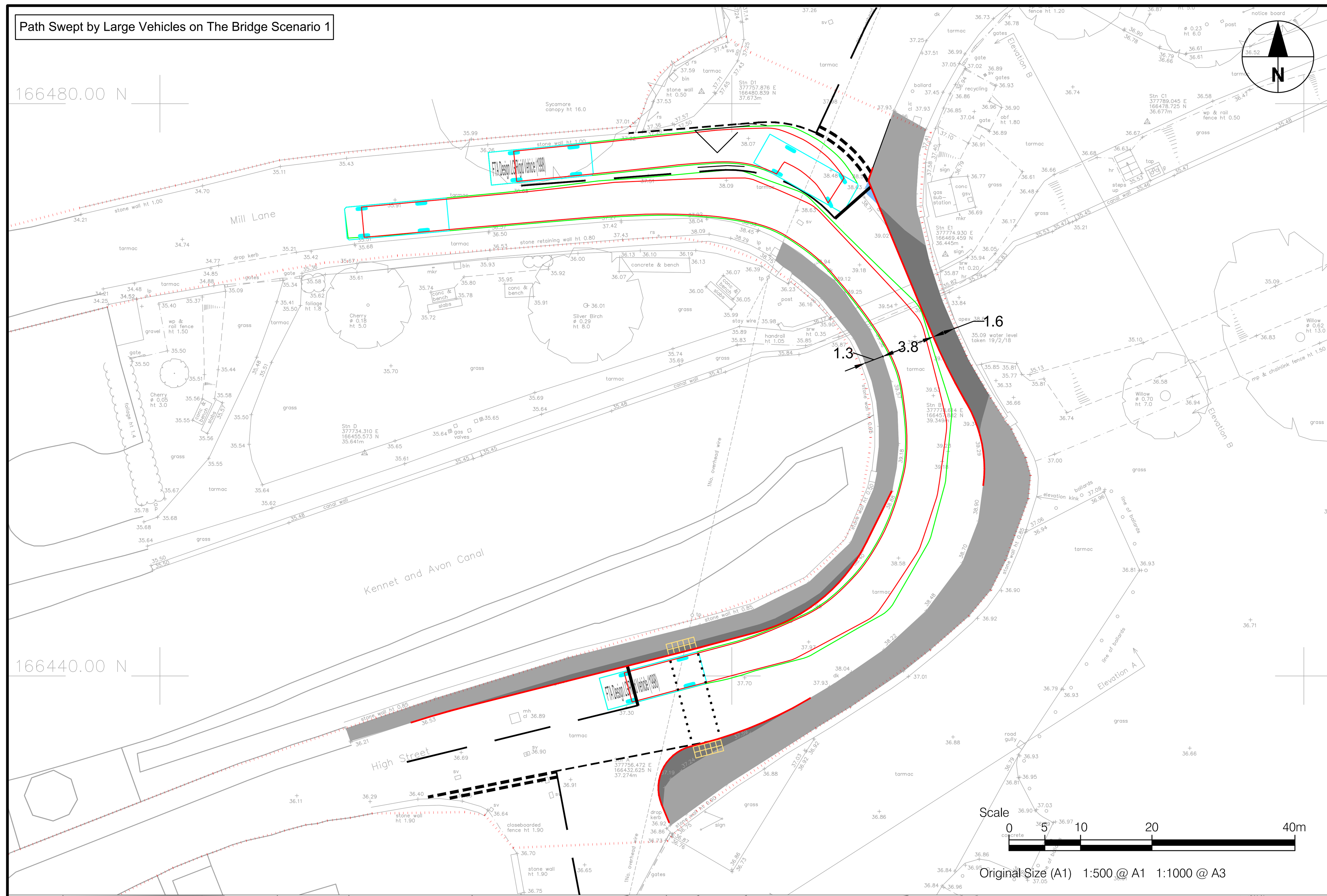
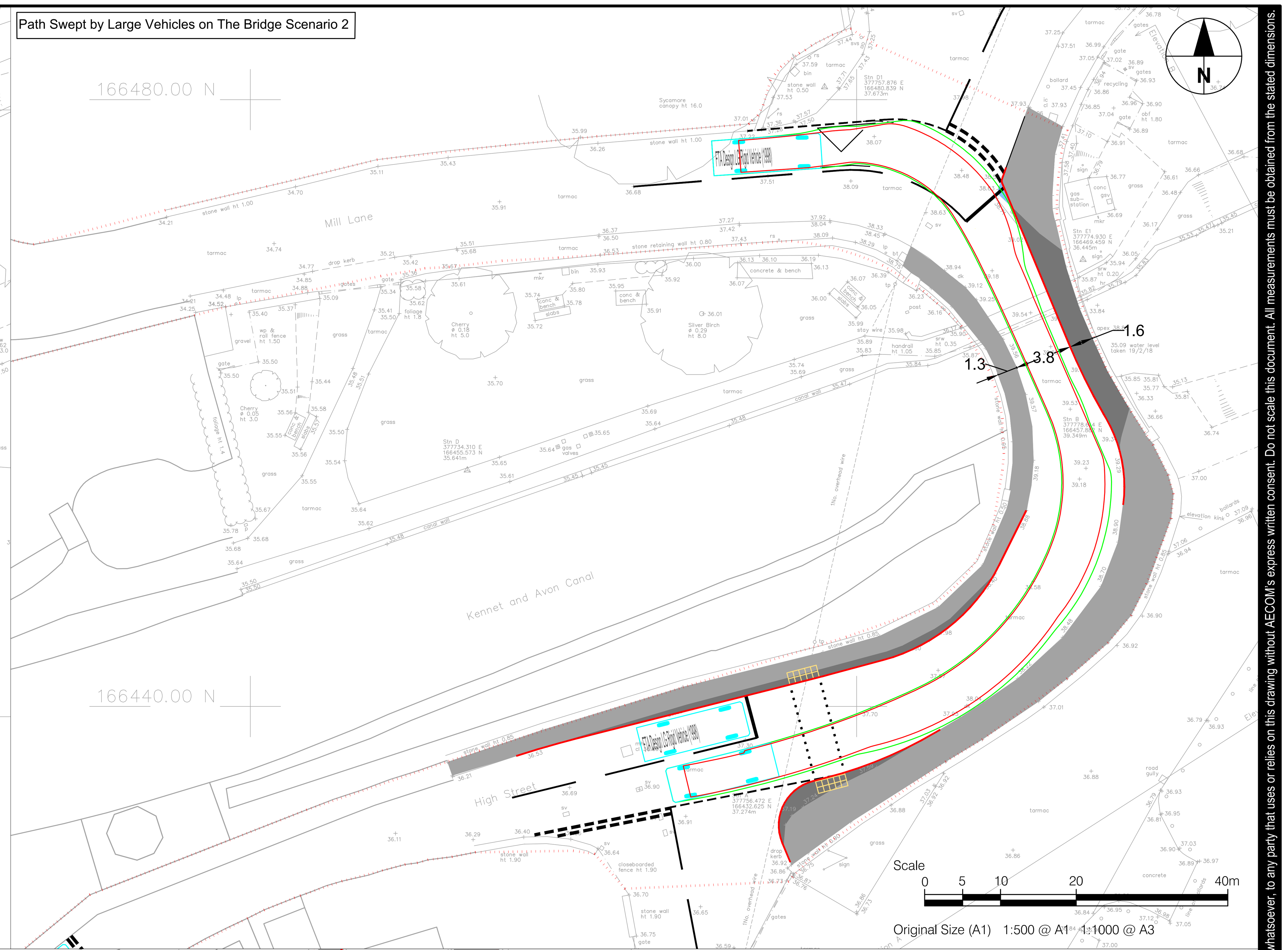
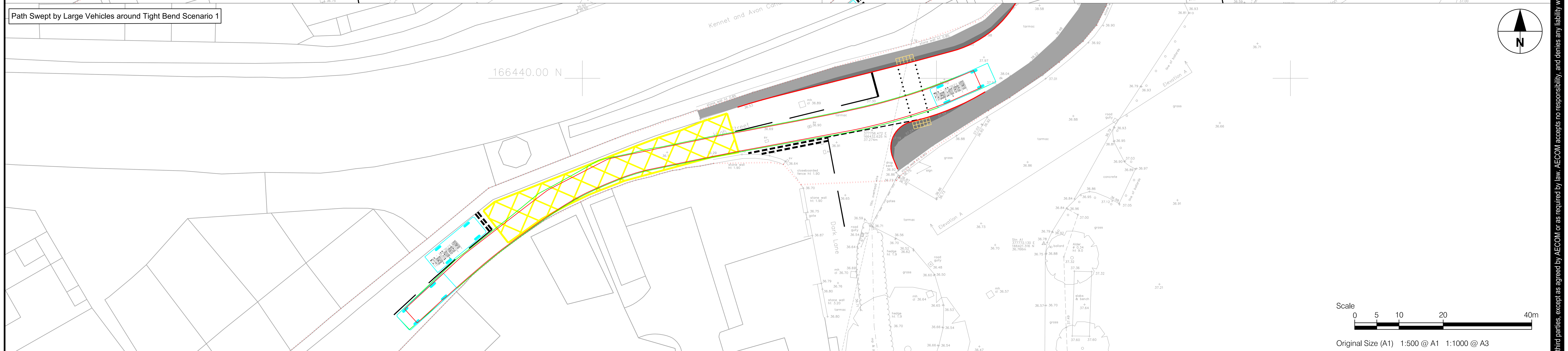


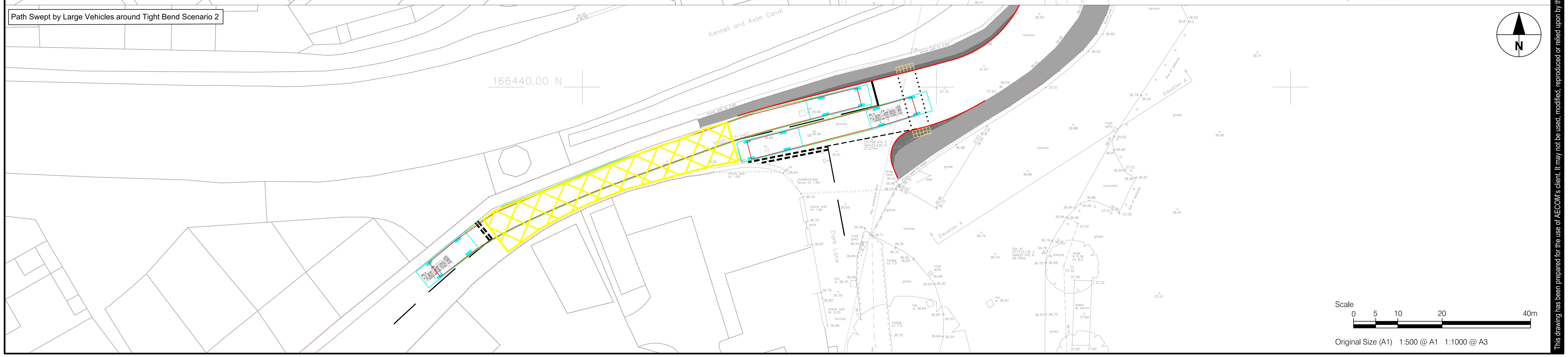
Path Swept by Large Vehicles on The Bridge Scenario 1



Path Swept by Large Vehicles on The Bridge Scenario 2



Path Swept by Large Vehicles around Tight Bend Scenario 1



Path Swept by Large Vehicles around Tight Bend Scenario 2

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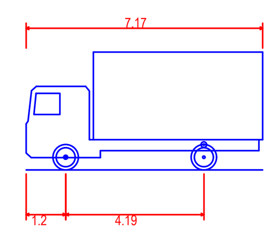

FTA Design LG Rigid Vehicle (1998)	
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Overall Width	2.300m
Overall Body Height	3.580m
Min Body Ground Clearance	0.375m
Track Width	2.120m
Lock to lock time	3.00s
Kerb to Kerb Turning Radius	7.000m

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P00.0	11/01/21	First issue

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PROJECT NUMBER

60681793

SHEET TITLE

BATHAMPTON BRIDGE
PROPOSAL - OPTION 2
SHEET 2/2

SHEET NUMBER

Project Number	Originator	Volume		
60681793	ACM	GEN		
BN		DR	TR	0001
Location		Type	Role	Number

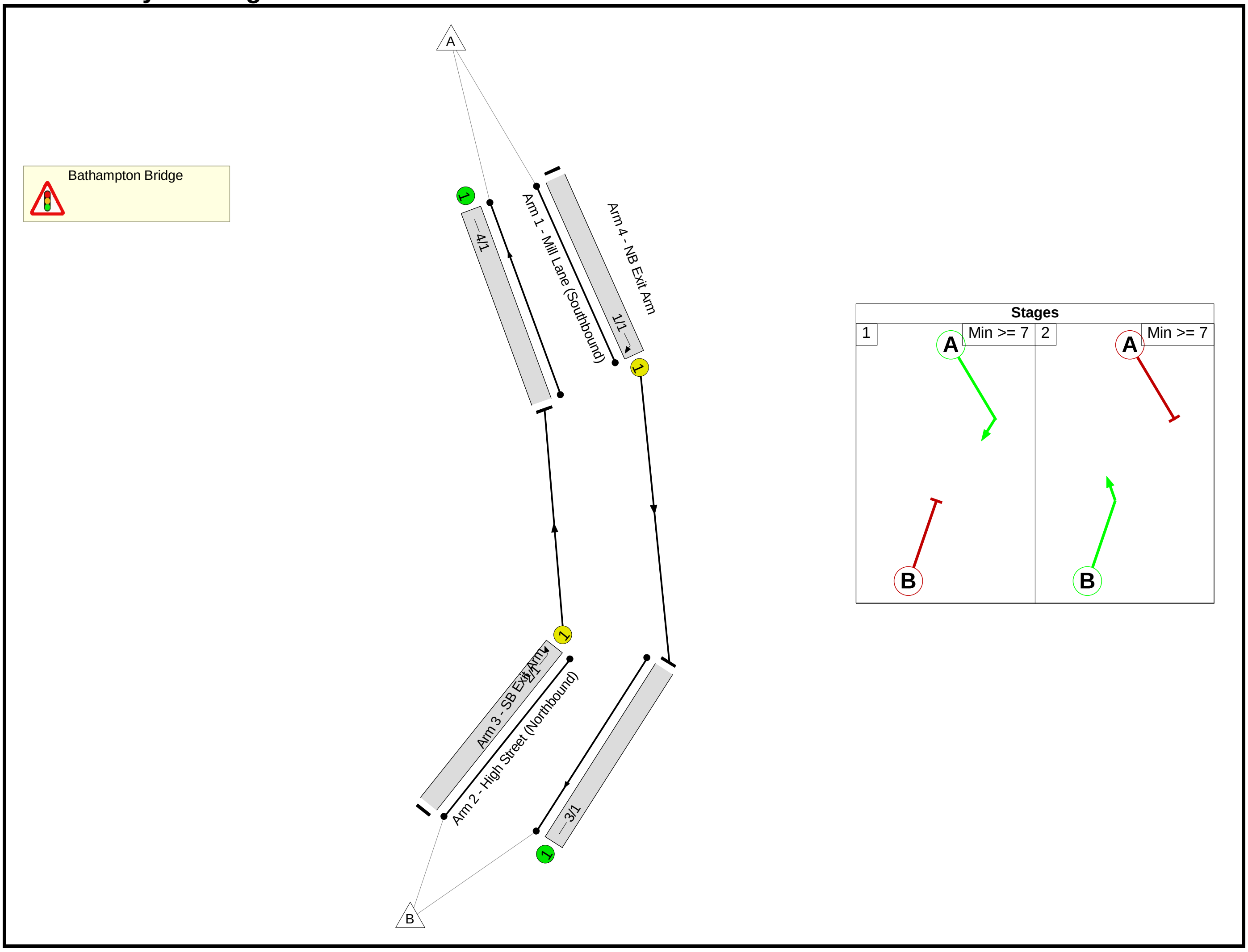
Appendix B LinSig inputs/outputs

Full Input Data And Results

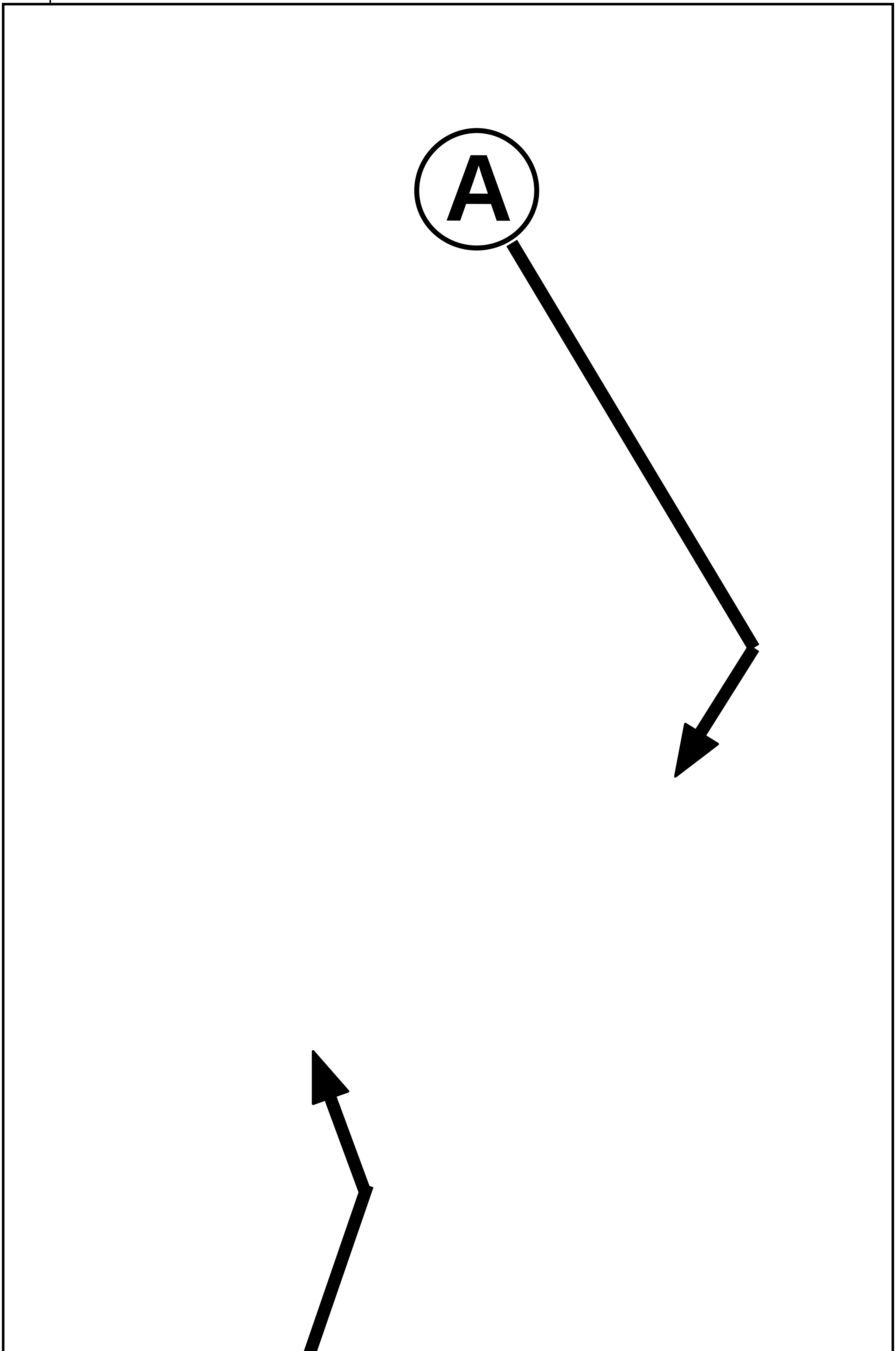
User and Project Details

Project:	**B&NES Highway Safety Improvement Studies**
Title:	**Bathampton Proposal - Option 3**
Location:	
Client:	B&NES
Site Ref(s):	Bathampton
Design Layout Ref:	Option 3
Additional detail:	
File name:	Bathampton Option 3 Traffic Model.lsg3x
Author:	Amr Fouda
Company:	AECOM
Address:	Colmore Building

Network Layout Diagram



Phase Diagram


A

Full Input Data And Results

Phase Input Data

Phase Name	Phase Type	Assoc. Phase	Street Min	Cont Min
A	Traffic		7	7
B	Traffic		7	7

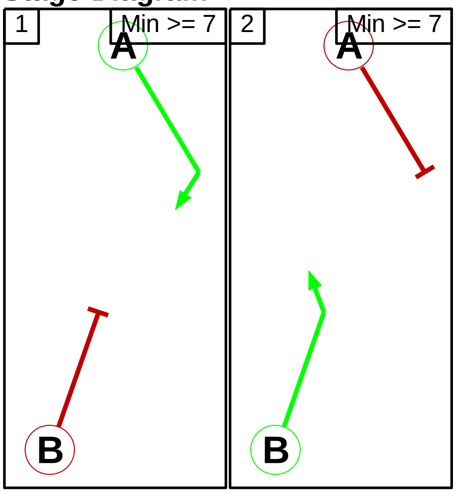
Phase Intergreens Matrix

	Starting Phase		
Terminating Phase		A	B
	A		11
	B	11	

Phases in Stage

Stage No.	Phases in Stage
1	A
2	B

Stage Diagram



Phase Delays

Term. Stage	Start Stage	Phase	Type	Value	Cont value
There are no Phase Delays defined					

Prohibited Stage Change

	To Stage		
From Stage		1	2
	1		11
	2	11	

Give-Way Lane Input Data

Junction: Bathampton Bridge
There are no Opposed Lanes in this Junction

Full Input Data And Results

Lane Input Data

Junction: Bathampton Bridge												
Lane	**Lane Type**	**Phases**	**Start Disp.**	**End Disp.**	**Physical Length (PCU)**	**Sat Flow Type**	**Def User Saturation Flow (PCU/Hr)**	**Lane Width (m)**	**Gradient**	**Nearside Lane**	**Turns**	**Turning Radius (m)**
1/1 (Mill Lane (Southbound))	U	A	2	3	60.0	Geom	-	3.00	6.00	Y	Arm 3 Right	12.00
2/1 (High Street (Northbound))	U	B	2	3	60.0	Geom	-	3.00	6.00	Y	Arm 4 Left	12.00
3/1 (SB Exit Arm)	U		2	3	60.0	Inf	-	-	-	-	-	-
4/1 (NB Exit Arm)	U		2	3	60.0	Inf	-	-	-	-	-	-

Traffic Flow Groups

Flow Group	Start Time	End Time	Duration	Formula
1: 'AM Peak '	07:45	08:45	01:00	
2: 'PM Peak '	15:30	16:30	01:00	

Scenario 1: 'AM Peak' (FG1: 'AM Peak ', Plan 1: 'Network Control Plan 1')

Traffic Flows, Desired

Desired Flow :

	Destination			
Origin		A	B	Tot.
	A	0	395	395
	B	170	0	170
	Tot.	170	395	565

Traffic Lane Flows

Lane	Scenario 1: AM Peak
Junction: Bathampton Bridge	
1/1	395
2/1	170
3/1	395
4/1	170

Lane Saturation Flows

Junction: Bathampton Bridge								
Lane	Lane Width (m)	Gradient	Nearside Lane	Allowed Turns	Turning Radius (m)	Turning Prop.	Sat Flow (PCU/Hr)	Flared Sat Flow (PCU/Hr)
1/1 (Mill Lane (Southbound))	3.00	6.00	Y	Arm 3 Right	12.00	100.0 %	1478	1478
2/1 (High Street (Northbound))	3.00	6.00	Y	Arm 4 Left	12.00	100.0 %	1478	1478
3/1 (SB Exit Arm Lane 1)	Infinite Saturation Flow						Inf	Inf
4/1 (NB Exit Arm Lane 1)	Infinite Saturation Flow						Inf	Inf

Scenario 2: 'PM peak' (FG2: 'PM Peak ', Plan 1: 'Network Control Plan 1')

Traffic Flows, Desired

Desired Flow :

	Destination			
Origin		A	B	Tot.
	A	0	250	250
	B	284	0	284
	Tot.	284	250	534

Traffic Lane Flows

Lane	Scenario 2: PM peak
Junction: Bathampton Bridge	
1/1	250
2/1	284
3/1	250
4/1	284

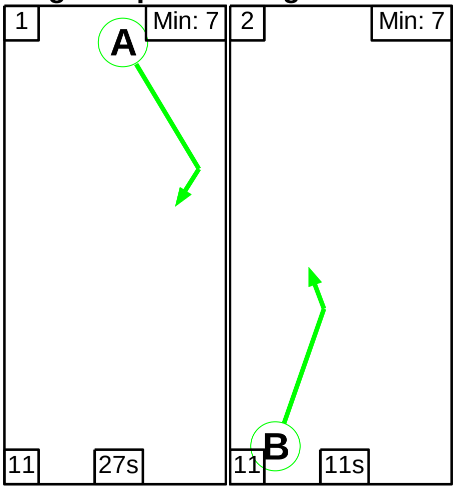
Lane Saturation Flows

Junction: Bathampton Bridge								
Lane	Lane Width (m)	Gradient	Nearside Lane	Allowed Turns	Turning Radius (m)	Turning Prop.	Sat Flow (PCU/Hr)	Flared Sat Flow (PCU/Hr)
1/1 (Mill Lane (Southbound))	3.00	6.00	Y	Arm 3 Right	12.00	100.0 %	1478	1478
2/1 (High Street (Northbound))	3.00	6.00	Y	Arm 4 Left	12.00	100.0 %	1478	1478
3/1 (SB Exit Arm Lane 1)	Infinite Saturation Flow						Inf	Inf
4/1 (NB Exit Arm Lane 1)	Infinite Saturation Flow						Inf	Inf

Full Input Data And Results

Scenario 1: 'AM Peak' (FG1: 'AM Peak ', Plan 1: 'Network Control Plan 1')

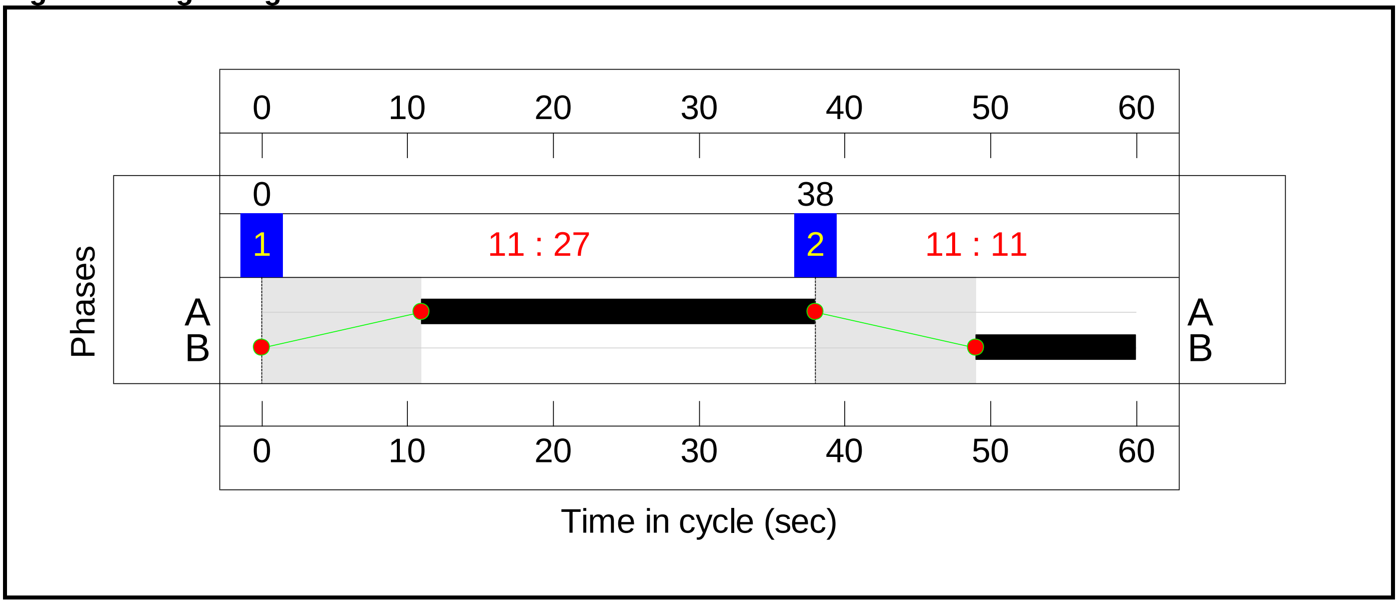
Stage Sequence Diagram



Stage Timings

Stage	1	2
Duration	27	11
Change Point	0	38

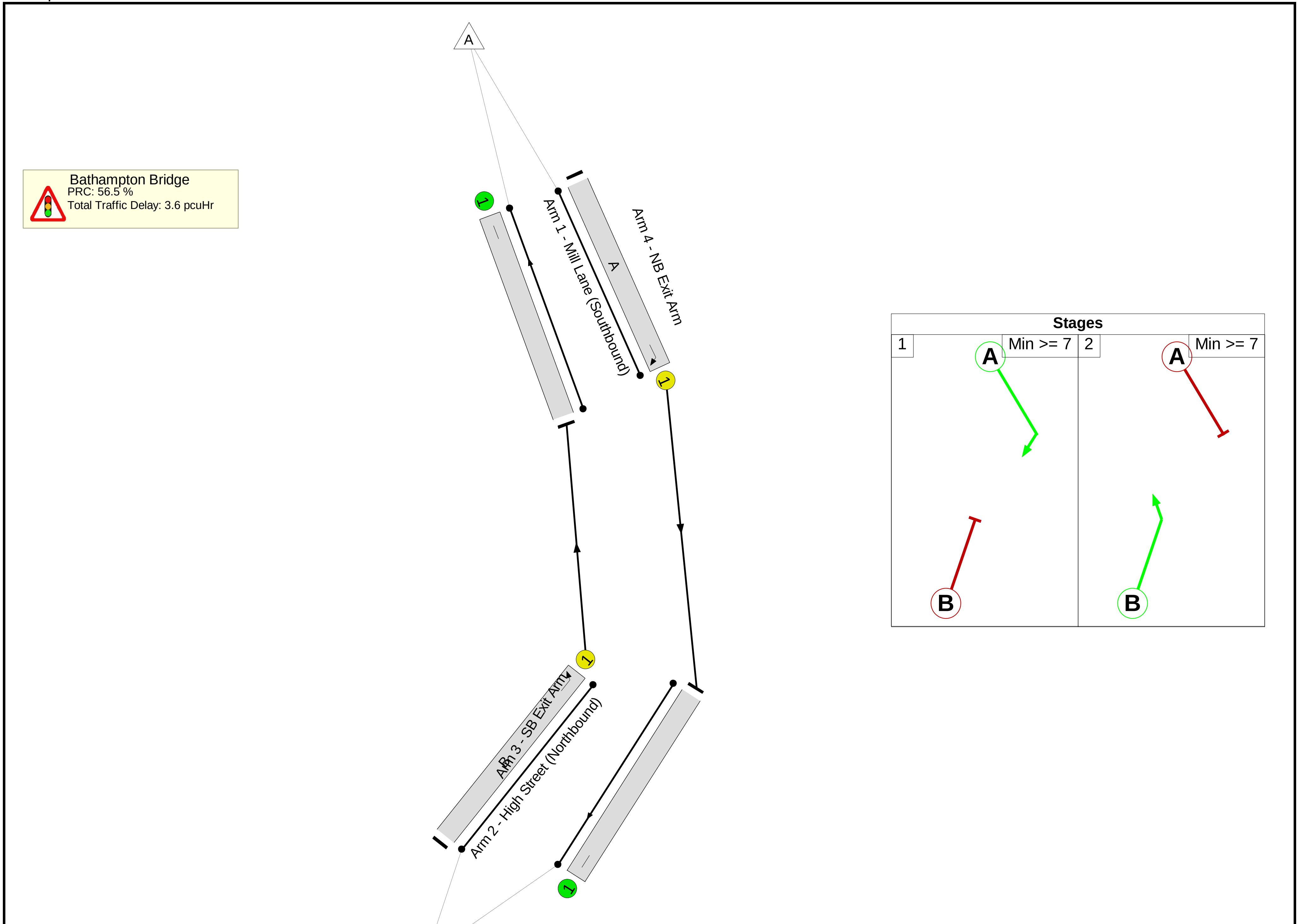
Signal Timings Diagram



Full Input Data And Results

Network Layout Diagram

Full Input Data And Results



Network Results

Item	Lane Description	Lane Type	Controller Stream	Position In Filtered Route	Full Phase	Arrow Phase	Num Greens	Total Green (s)	Arrow Green (s)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Capacity (pcu)	Deg Sat (%)
Network: Bathampton Proposal - Option 3	**-**	**-**	**N/A**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**57.5%**
Bathampton Bridge	**-**	**-**	**N/A**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**57.5%**
1/1	Mill Lane (Southbound) Right	U	N/A	N/A	A		1	27	-	395	1478	690	57.3%
2/1	High Street (Northbound) Left	U	N/A	N/A	B		1	11	-	170	1478	296	57.5%
3/1	SB Exit Arm	U	N/A	N/A	-		-	-	-	395	Inf	Inf	0.0%
4/1	NB Exit Arm	U	N/A	N/A	-		-	-	-	170	Inf	Inf	0.0%

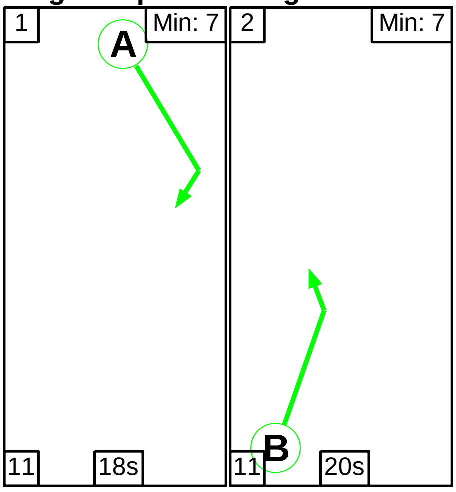
Item	Arriving (pcu)	Leaving (pcu)	Turners In Gaps (pcu)	Turners When Unopposed (pcu)	Turners In Intergreen (pcu)	Uniform Delay (pcuHr)	Rand + Oversat Delay (pcuHr)	Storage Area Uniform Delay (pcuHr)	Total Delay (pcuHr)	Av. Delay Per PCU (s/pcu)	Max. Back of Uniform Queue (pcu)	Rand + Oversat Queue (pcu)	Mean Max Queue (pcu)
Network: Bathampton Proposal - Option 3	**-**	**-**	**0**	**0**	**0**	**2.3**	**1.3**	**0.0**	**3.6**	**-**	**-**	**-**	**-**
Bathampton Bridge	**-**	**-**	**0**	**0**	**0**	**2.3**	**1.3**	**0.0**	**3.6**	**-**	**-**	**-**	**-**
1/1	395	395	-	-	-	1.3	0.7	-	1.9	17.7	4.7	0.7	5.4
2/1	170	170	-	-	-	1.0	0.7	-	1.7	35.9	2.5	0.7	3.2
3/1	395	395	-	-	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0
4/1	170	170	-	-	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0

C1 PRC for Signalled Lanes (%): 56.5 Total Delay for Signalled Lanes (pcuHr): 3.64 Cycle Time (s): 60
PRC Over All Lanes (%): 56.5 Total Delay Over All Lanes(pcuHr): 3.64

Full Input Data And Results

Scenario 2: 'PM peak' (FG2: 'PM Peak ', Plan 1: 'Network Control Plan 1')

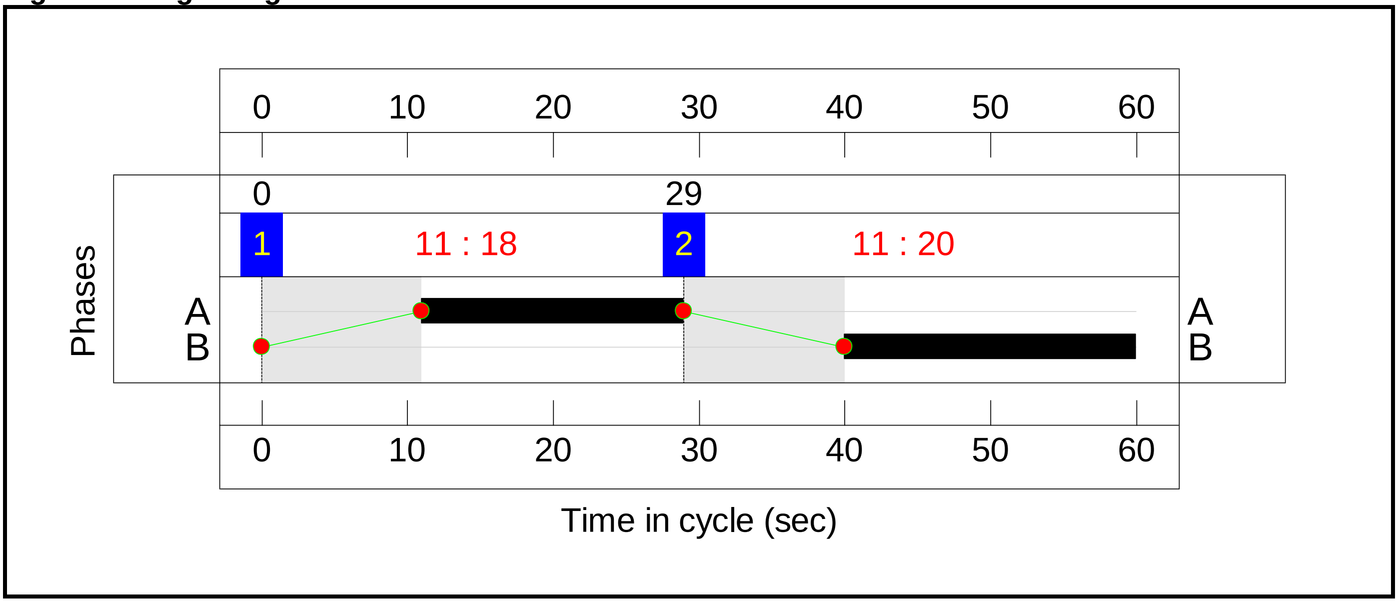
Stage Sequence Diagram



Stage Timings

Stage	1	2
Duration	18	20
Change Point	0	29

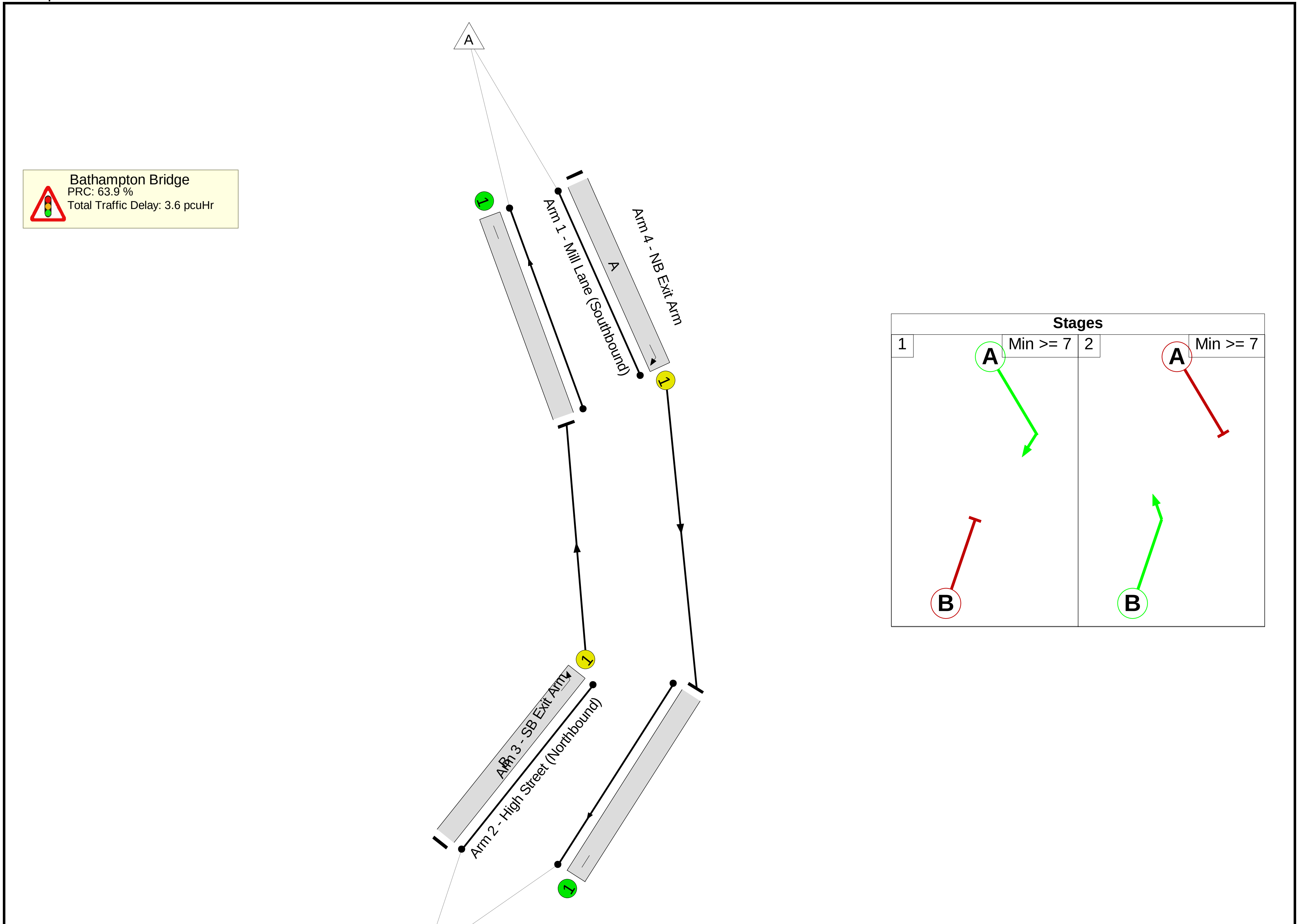
Signal Timings Diagram



Full Input Data And Results

Network Layout Diagram

Full Input Data And Results



Network Results

Item	Lane Description	Lane Type	Controller Stream	Position In Filtered Route	Full Phase	Arrow Phase	Num Greens	Total Green (s)	Arrow Green (s)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Capacity (pcu)	Deg Sat (%)
Network: Bathampton Proposal - Option 3	**-**	**-**	**N/A**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**54.9%**
Bathampton Bridge	**-**	**-**	**N/A**	**-**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**54.9%**
1/1	Mill Lane (Southbound) Right	U	N/A	N/A	A		1	18	-	250	1478	468	53.4%
2/1	High Street (Northbound) Left	U	N/A	N/A	B		1	20	-	284	1478	517	54.9%
3/1	SB Exit Arm	U	N/A	N/A	-		-	-	-	250	Inf	Inf	0.0%
4/1	NB Exit Arm	U	N/A	N/A	-		-	-	-	284	Inf	Inf	0.0%

Item	Arriving (pcu)	Leaving (pcu)	Turners In Gaps (pcu)	Turners When Unopposed (pcu)	Turners In Intergreen (pcu)	Uniform Delay (pcuHr)	Rand + Oversat Delay (pcuHr)	Storage Area Uniform Delay (pcuHr)	Total Delay (pcuHr)	Av. Delay Per PCU (s/pcu)	Max. Back of Uniform Queue (pcu)	Rand + Oversat Queue (pcu)	Mean Max Queue (pcu)
Network: Bathampton Proposal - Option 3	**-**	**-**	**0**	**0**	**0**	**2.4**	**1.2**	**0.0**	**3.6**	**-**	**-**	**-**	**-**
Bathampton Bridge	**-**	**-**	**0**	**0**	**0**	**2.4**	**1.2**	**0.0**	**3.6**	**-**	**-**	**-**	**-**
1/1	250	250	-	-	-	1.2	0.6	-	1.7	25.1	3.4	0.6	4.0
2/1	284	284	-	-	-	1.2	0.6	-	1.8	23.4	3.8	0.6	4.4
3/1	250	250	-	-	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0
4/1	284	284	-	-	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0

C1 PRC for Signalled Lanes (%): 63.9 Total Delay for Signalled Lanes (pcuHr): 3.59 Cycle Time (s): 60
PRC Over All Lanes (%): 63.9 Total Delay Over All Lanes(pcuHr): 3.59