**Scheme ID: SE/90067/559**

# M9 Chartershall Overbridge

Feasibility Report



Prepared for BEAR Scotland by JACOBS™

26 November 2008

**Transport Scotland**
**M9 Chartershall Overbridge Feasibility Report**

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# Appendices

# 1 Executive Summary

**1.1.1** Chartershall Overbridge is located southwest of Stirling and carries Chartershall Road over the M9 Edinburgh to Stirling trunk road motorway. The bridge is currently closed to vehicular traffic due to the 17th recorded collision since it was constructed in 1976.

**1.1.2** This report investigates the two proposals below to address the current bridge closure.

1. Construct a new road bridge and re-open Chartershall Road to vehicular access.

2. Construct a new footbridge for pedestrian/cyclist/equestrian access along Chartershall Road whilst upgrading Pirnhall Road as a permanent diversion.

**1.1.3** Two bridge options have been investigated for Proposal 1 above and a single span bridge with half height abutments was selected as the preferred option. This was based on its advantages in terms of health and safety, cost and construction duration when compared to a four span bridge option.

**1.1.4** This option was then used as a comparison against Proposal 2 above and Proposal 1 was still found to be the preferred option. Proposal 1 scored better than Proposal 2 on all of the main items that were considered to be relevant i.e. cost, timescale, land, utility diversions and environmental impact.

**1.1.5** The report also provides the results of a public consultation exercise which was carried out with the local residents based on the options in this report. 71% of the local residents who took part in the public consultation voted for Proposal 1 as the preferred option and this was also the view that was provided by the MSP Bruce Crawford and Stirling Council.

**1.1.6** It is therefore recommended that the existing Chartershall Road Overbridge should be replaced with a new road bridge and it is recommended that the form of this structure should be a single span bridge with half height abutments.

## 2 Introduction

**2.1.1** Chartershall Overbridge is located southwest of Stirling and carries Chartershall Road over the M9 Edinburgh to Stirling trunk road motorway. The bridge is currently closed to vehicular traffic due to the 17th recorded collision since it was constructed in 1976. Previous damage has been repaired under four separate repair contracts and has included: cutting out and welding replacement sections of the damaged beams; heat strengthening and jacking; cutting out and splicing 9m beam sections and bearing replacement.

**2.1.2** The most recent vehicle impact, which resulted in the bridge closure, took place on 21st May 2006, which caused damage to all 5 beams on the southbound carriageway. An investigation was carried out by Atkins in 2007 to determine the condition of the bridge. The report concluded that the bridge in its damaged state could not be assessed using conventional techniques due to the extent of the deformations to the damaged girders.

**2.1.3** Jacobs have subsequently been commissioned by BEAR Scotland Ltd on behalf of Transport Scotland to carry out this feasibility report covering options to replace the damaged structure. This report covers the structure options considered to replace the existing bridge on the M9 at Chartershall along with cost estimates for all options considered. The work also includes a public consultation exercise covering the options.

# 3 Existing Conditions

## 3.1 Existing Bridge

**3.1.1** Chartershall Overbridge lies to the southwest of Stirling and carries Chartershall Road over the M9 Edinburgh to Stirling trunk road motorway (see location plan in Appendix A). The existing bridge is located at NS 789 901 (O.S National Grid Reference).

**3.1.2** The bridge is a four span structure with a skew angle of 3.5 degrees and spans of 9.5m, 14.9m, 14.9m and 8.8m (see general arrangement drawing B0657100/B0802/ST001 in Appendix B and photographs in Appendix C). The superstructure is a continuous steel concrete composite deck comprising 5 No steel universal beams and a concrete deck slab. The superstructure is supported on three intermediate piers and two bankpads. The piers are made up of four individual rectangular columns, monolithic at the top and are constructed of reinforced concrete with a reinforced concrete hinge at their base. The piers and the bankpads are supported on spread footings. The bridge was built circa 1976 and the original designer was Stirling Council.

## 3.2 Damage and Repair History

**3.2.1** There have been 17 reported vehicle collisions with the bridge since its construction in 1976 which have resulted in the northbound carriageway beams being struck 4 times and the southbound carriageway beams being struck 6 times between April 1976 and June 1993.

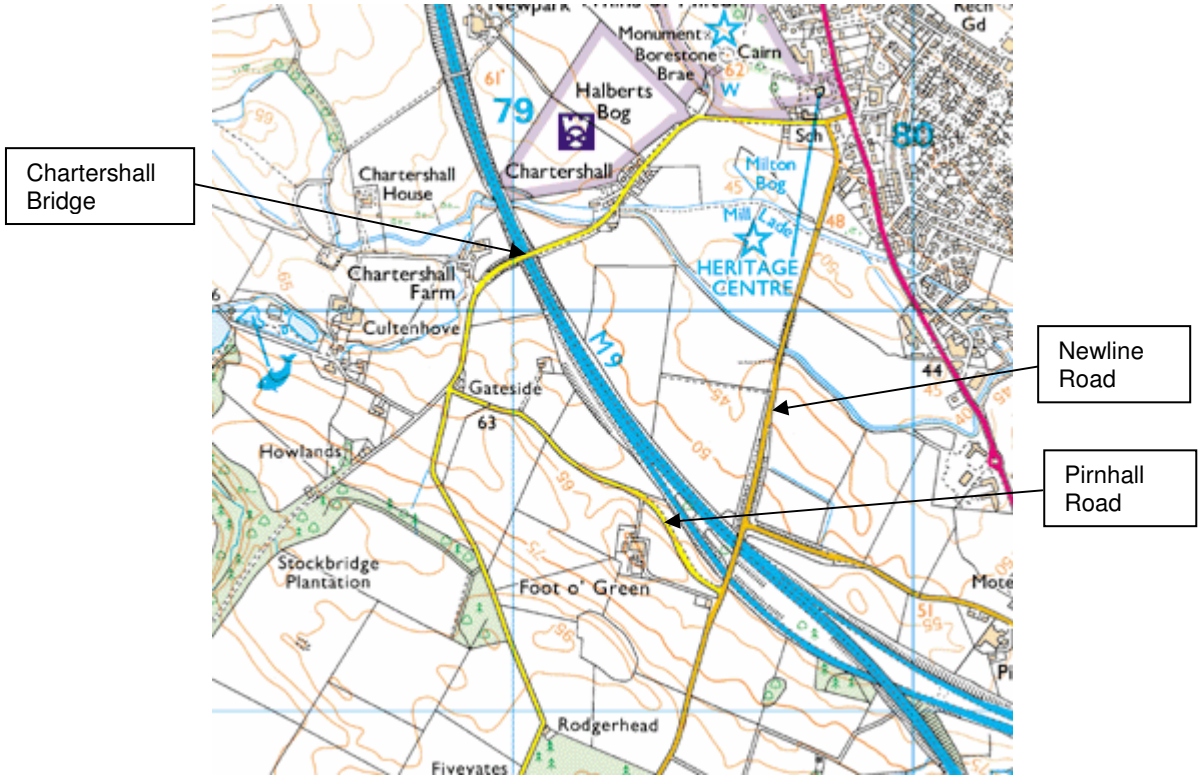
**3.2.2** Further impact damage to the beams occurred between June 1993 and October 2000. The beams over the northbound (span 2) were hit on 30th October by an over-height vehicle and all 5 beams in this span were badly damaged, with horizontal deflections of up to 630mm. In addition, the bearings at either side of this span deflected damaging the steel bolts installed through them and the reinforced concrete piers. The reinforced concrete deck was also cracked adjacent to the beams, placing doubt on the condition of the shear studs. The damage from this collision appeared to be more extensive than any of the previous collisions.

**3.2.3** All of the previous damage noted has been repaired under four separate repair contracts. This included: cutting out and welding replacement sections of the damaged beams; heat strengthening and jacking; cutting out and splicing 9m beam sections; and bearing replacement.

**3.2.4** Further to this, in 2003, on three occasions the steel beams above the M9 southbound carriageway were struck by high loads carried by vehicles passing below the bridge. The most recent vehicle impact damage took place on 21st May 2006 and this involved the beams of the southbound carriageway (span 3). Damage occurred to all of the five beams in this span and it was recommended that the road over the bridge be closed to vehicles greater than 7.5 tonnes. However, after consultation with stakeholders (Amey / Stirling Council / BEAR Scotland / Transport Scotland etc.), a completed closure of the bridge to vehicles was implemented.

### 3.3 Existing Bridge Closure and Temporary Diversion

**3.3.1** The existing M9 Chartershall overbridge is currently closed to vehicular traffic but is currently open to pedestrians, cyclists and equestrians. This closure means an alternative diversion route over the M9 motorway is currently in place utilising an alternative overbridge to the south at Whins of Milton.




**3.3.2** The diversion route uses Newline Road and Pirnhall Road to maintain vehicular access to Cultenhove, Howlands and Foot o' Green. The geometric standard of these local roads vary and neither have characteristics compliant with the current requirements set out in the Design Manual for Roads and Bridges (DMRB) TD27/05 'Cross Sections and Headrooms' and TD 9/93 'Highway Link Design'. The diversion route is narrow in places with insufficient width to accommodate larger vehicles travelling in opposing directions. Newline Road accommodates this constraint as the road is generally straight and forward visibility is adequate, however Pirnhall Road is tortuous with tight bends and poor forward visibility. The provision of passing places on Pirnhall Road shortly after the diversion was implemented has helped mitigate safety concerns arising as a result of the increased flow of traffic, however it is not considered suitable for long term use without improvements.

### 3.4 Road Layout

**3.4.1** The existing cross section of Pirnhall road consists of a 5.5 metre wide carriageway with narrow verges of approximately 1.0 metre width. There is no positive drainage however there are lengths of open ditch along the route.

### 3.5 Existing Traffic Data

**3.5.1** Stirling Council undertook an automated traffic count during the week 23rd August 2007 to 29th August 2007 and a further automated count over a twelve week period between 14th February 2008 and 30th April 2008 at the west end of Pirnhall Road. This data was supplemented with pedestrian and cyclist counts over a six week period between 20th March 2008 and 30th April 2008. The results are detail in the Table 1 below.

**Table 1 –Traffic Flows on Pirnhall Road**

| | | | | |
|---|---|---|---|---|
| Average Daily Flow | Eastbound | 181 | Pedestrians & Cyclists | Thu 23 Aug – Wed 29 Aug 2007 |
| | Westbound | 142 | | |
| | TOTAL | 323 | No Data | |
| Average Daily Flow | Eastbound | 120 | Pedestrians & Cyclists | Thu 14 Feb – Wed 20 Feb 2008 |
| | Westbound | 156 | | |
| | TOTAL | 276 | No Data | |
| Average Daily Flow | Eastbound | 111 | Pedestrians & Cyclists | Thu 21 – Wed 27 Feb 2008 |
| | Westbound | 134 | | |
| | TOTAL | 245 | No Data | |
| Average Daily Flow | Eastbound | 118 | Pedestrians & Cyclists | Thu 28 Feb – Wed 5 Mar 2008 |
| | Westbound | 177 | | |
| | TOTAL | 295 | No Data | |
| Average Daily Flow | Eastbound | 99 | Pedestrians & Cyclists | Thu 6 Mar – Wed 12 Mar 2008 |
| | Westbound | 155 | | |
| | TOTAL | 254 | No Data | |
| Average Daily Flow | Eastbound | 114 | Pedestrians & Cyclists | Thu 13 Mar – Wed 19 Mar 2008 |
| | Westbound | 132 | | |
| | TOTAL | 246 | No Data | |
| Average Daily Flow | Eastbound | 124 | Pedestrians & | Thu 20 Mar – Wed 26 Mar 2008 |

| | | | | |
|---|---|---|---|---|
| | Westbound | 156 | Cyclists | |
| | TOTAL | 280 | 121 | |
| Average Daily Flow | Eastbound | 123 | Pedestrians & | Thu 27 Mar – Wed 2 Apr 2008 |
| | Westbound | 156 | Cyclists | |
| | TOTAL | 279 | 114 | |
| Average Daily Flow | Eastbound | 115 | Pedestrians & | Thu 3 Apr – Wed 9 Apr 2008 |
| | Westbound | 137 | Cyclists | |
| | TOTAL | 252 | 134 | |
| Average Daily Flow | Eastbound | 126 | Pedestrians & | Thu 10 Apr – Wed 16 Apr 2008 |
| | Westbound | 144 | Cyclists | |
| | TOTAL | 270 | 144 | |
| Average Daily Flow | Eastbound | 127 | Pedestrians & | Thu 17 Apr – Wed 23 Apr 2008 |
| | Westbound | 149 | Cyclists | |
| | TOTAL | 276 | 141 | |
| Average Daily Flow | Eastbound | 123 | Pedestrians & | Thu 24 Apr – Wed 30 Apr 2008 |
| | Westbound | 154 | Cyclists | |
| | TOTAL | 277 | 130 | |
| | AVERAGE | 273 | 131 | |

### 3.6 Geometry

**3.6.1** The existing diversion routes of Pirnhall Road and Newline Road have characteristics below the current standards set out in DMRB. However it should be borne in mind that whilst traffic flows on these roads have increased as a result of the need to divert traffic away from Chartershall bridge, traffic volumes remain low on both roads.

**3.6.2** The current geometric characteristics of Newline Road have not been assessed as there is no aspiration to undertake any improvement work to this route.

**3.6.3** A plan and profile of the existing Pirnhall Road is shown on drawing B0657100/H0802/R01-07 in Appendix B.

**3.6.4** The existing horizontal and vertical geometry for Pirnhall Road is detailed in Tables 2 and 3 respectively. These geometric characteristics have been assessed using TD9/93 Highway Link

Design against an 85kph design speed and it can be seen there are a number of significant relaxations and departures.

**3.6.5** There are four multiple step relaxations and four departures from standards in the horizontal geometry, the most significant being the very tight curves between chainage 1+69 and 2+00 which coincides with the access to the private property Nae-Roo.

**3.6.6** There are three multiple step relaxations and six departures from standards in the vertical geometry, the most significant being the combination of crest and sag curves between chainage 1+30 and 2+13 which again coincides with the access to the private property Nae-Roo.

**3.6.7** Pirnhall road is very narrow for its full length and it is particularly difficult for larger vehicles to navigate especially when they meet another vehicle. There is limited visibility for most of the route due to the overgrown verges and tight corners.

**3.6.8** The current geometry of Pirnhall Road does not comply with the standards set out in DMRB TD 9/93 for an 85 kph design speed and in some areas is up to 5 steps below desirable minimum in horizontal and vertical curvature.

**Table 2 – Horizontal Geometry**

| Element No. | Start Chainage | End Chainage | Length (m) | Hand | Radius (m) | Relaxations/Departures (TD 9/93 clause 3.4) |
|---|---|---|---|---|---|---|
| 1 | 0+00 | 0+07 | 7 | Straight | - | |
| 2 | 0+07 | 0+18 | 11 | R | 175 | 1 step departure |
| 3 | 0+18 | 0+92 | 74 | Straight | - | |
| 4 | 0+92 | 1+41 | 49 | L | 250 | 3 step relaxation |
| 5 | 1+41 | 1+69 | 28 | Straight | - | |
| 6 | 1+69 | 1+76 | 7 | R | 7 | 3 step departure |
| 7 | 1+76 | 2+00 | 25 | R | 75 | 3 step departure |
| 8 | 2+00 | 2+49 | 49 | R | 255 | 2 step relaxation |
| 9 | 2+49 | 2+63 | 14 | Straight | - | |
| 10 | 2+63 | 3+11 | 48 | R | 2040 | |
| 11 | 3+11 | 3+64 | 53 | L | 275 | 2 step relaxation |
| 12 | 3+64 | 4+66 | 102 | L | 360 | 1 step relaxation |
| 13 | 4+66 | 5+28 | 62 | Straight | - | |
| 14 | 5+28 | 6+38 | 110 | R | 170 | 1 step departure |

| | | | | | | |
|---|---|---|---|---|---|---|
| Transition | 6+38 | 6+58 | 20 | Transition | - | |
| 15 | 6+58 | 7+87 | 129 | Straight | - | |

**Table 3 – Vertical Geometry**

| Element No. | Start Chainage | End Chainage | Length (m) | Hand | Gradient | K Value | Relaxations/Departures (TD 9/93 clause 3.4) |
|---|---|---|---|---|---|---|---|
| 1 | 0+00 | 0+01 | 1 | Grade | 2% | - | |
| 2 | 0+01 | 0+02 | 1 | Sag | - | 0.21 | 2 step departure |
| 3 | 0+02 | 0+05 | 3 | Grade | 2.8% | - | |
| 4 | 0+05 | 0+06 | 1 | Hog | - | 0.53 | 3 step departure |
| 5 | 0+06 | 0+20 | 14 | Grade | 1% | - | |
| 6 | 0+20 | 0+67 | 47 | Hog | - | 50 | 1 step relaxation |
| 7 | 0+67 | 0+93 | 42 | Sag | - | 30 | |
| 8 | 0+93 | 1+30 | 37 | Hog | - | 20 | 2 step relaxation |
| 9 | 1+30 | 1+60 | 31 | Hog | - | 5 | 3 step departure |
| 10 | 1+60 | 2+13 | 52 | Sag | - | 7.5 | 2 step departure |
| 11 | 2+13 | 5+02 | 289 | Hog | - | 200 | |
| 12 | 5+02 | 5+43 | 42 | Sag | - | 7.5 | 2 step departure |
| 13 | 5+43 | 7+32 | 189 | Grade | 3.8% | - | |
| 14 | 7+32 | 8+62 | 131 | Hog | - | 25 | 2 step relaxation |
| 15 | 8+62 | 8+75 | 12 | Sag | - | 10 | 1 step departure |
| 16 | 8+75 | 8+77 | 2 | Grade | 0.1% | - | |

### 3.7 Stopping Sight Distance

**3.7.1** The visibility on Newline Road is very good as the road is very straight with virtually no trees or hedges to obscure oncoming traffic. There are open fields to either side of the road giving good visibility over the course of this section of the diversion.

**3.7.2** The stopping sight distance on Pirnhall road is particularly poor as a direct result of the geometry of the road. The road cuts through the fields so there is a high verge on one side of the road for its length. The narrow verge has overgrown vegetation, trees and hedges exacerbating poor visibility making the road feel very enclosed. There are a number of

accesses to fields and properties and entry or exit visibility from these are restricted. The accesses are positioned for ease of access into fields as opposed to being positioned to provide the best location to maximise potential visibility.

**3.7.3** The junction at Chartershall Road, Pirnhall Road and the unmarked road to Sauchieburn has poor visibility as a result of the dwelling on the corner obscuring the visibility for traffic travelling south on Chartershall Road towards Pirnhall Road.

### 3.8 Signage

**3.8.1** The existing signage is shown on drawing B0657100/H0802/R01-09 in Appendix B and this permanent signage has been supplemented with temporary diversion signs in appropriate locations to direct the traffic as a result of the bridge closure.

### 3.9 Street lighting

**3.9.1** Neither Pirnhall Road nor Chartershall Road has any street lighting. To the north of the M9 motorway Chartershall village and the beginning of the north side of Newline Road have street lighting.

### 3.10 Road Maintenance

**3.10.1** Sections of Pirnhall Road have been edge strengthened as a result of traffic overrunning the verges and leading to the edge of the pavement breaking up. Whilst edge strengthening is present on the inside edge of most of the corners visual inspection of the overall condition of the pavement suggests its structural integrity is sound. Two passing places have been installed since Pirnhall Road was formalised as the temporary diversion to enhance road safety on a narrow route with limited forward visibility.

**3.10.2** The section of Chartershall Road on the south side of the M9 motorway is in poor condition and appears to have had little maintenance recently. The surface condition is dilapidated with a previously applied surface dressing treatment now stripping. The junction where Chartershall Road meets Pirnhall Road also has a surface dressing failure with the resulting loose aggregate scattered across the junction. Road markings at this location are virtually non existent and also in need of replacement.

### 3.11 Culverts

**3.11.1** There is a stone culvert located at the western end of Pirnhall Road, approximately midway between its junction with Chartershall Road and the access to Nae-Roo. The culvert runs from the south to the north side of Pirnhall Road. The low height stone parapet is located circa 0.5 metres from the edge of the road.

### 3.12 Accesses

**3.12.1** The existing diversion route provides access over the M9 motorway from the north and south side.

**3.12.2** The existing route provides access from Chartershall Farm, Sauchieburn, Swanswater Fishery and a number of residential properties on the south side of the M9 to reach Chartershall village and Stirling to the north of the M9.

**3.12.3** Pirnhall Road provides access to surrounding agricultural land and has six field accesses and three property accesses. There are also an additional two field access located within the unorthodox junction layout between Pirnhall Road and Chartershall Road. The access points are in locations of poor visibility due to narrow verges being overgrown and the poor overall geometry standard of the road. The access into the residential property Nae-Roo is positioned on a tight bend of 75 metres radius in the road, however conspicuity has been highlighted by the use of reflective bollards to alert traffic.

## 4 Scope of Works

**4.1.1** The scope of work for this report was provided by BEAR Scotland Ltd which was defined by the two proposals below.

1. Construct a new road bridge and re-open Chartershall Road to vehicular access.

2. Construct a new footbridge for pedestrian/cyclist/equestrian access along Chartershall Road whilst upgrading Pirnhall Road as a permanent diversion.

### 4.2 Proposal 1

**4.2.1** Proposal 1 is required to consider the removal of the existing superstructure and the construction of a new, more robust deck at a higher level. The existing substructure is also to be assessed to ascertain whether upgrading or replacement of the substructure is required in accordance with current design standards. This was to ensure that the existing substructure could accommodate any proposed loading regime, including pier impact loads.

### 4.3 Proposal 2

**4.3.1** Proposal 2 is required to consider the remedial works required to the existing bridge deck to allow the safe passage of pedestrians, cyclists and equestrians. This proposal is to consider the feasibility of retaining the existing structure, raising the deck to increase the headroom underneath the bridge, or replacement of the entire bridge with a new footbridge.

**4.3.2** This proposal is also required to consider improvements to the surrounding road network which would be required. This would comprise upgrading to Pirnhall Road to provide adequate space for two-way traffic in accordance with Stirling Council's Road Development guidelines. This would also include amendments to traffic signing on New Line Road, Chartershall Road and Pirnhall Road.

### 4.4 General

**4.4.1** The scope also includes programme timescales for the detailed design and procurement phases as well as an envisaged outline of the proposed construction sequence including traffic management phasing for both proposals. The construction sequence is to allow for a minimum of two lanes of the M9 to remain open in each direction throughout the majority of the construction phase. Traffic delay costs for all options are to be calculated utilising QUADRO specialist techniques.

**4.4.2** Detailed cost estimates for each option are also to be compiled highlighting the expected costs and risks associated with the adoption of the different proposals as well as the impact these works would have on the adjacent structures.

**4.4.3** The scope of works also covers a public consultation exercise. This involves preparation of outline scheme plans, setting up and attending the public consultation and collecting, analysing and reporting on the consultation responses.

## 5 Collision Loading Assessment Results

**5.1.1** In order to determine the suitability of the substructure the piers were firstly assessed for collision loading in accordance with BD 48/93 Assessment and Strengthening of Highway Bridge Supports from the Design Manual for Roads and Bridges (DMRB). As part of this assessment the columns were checked for the worst case bending and shear and also for shear at the concrete hinge at the base of the column.

**5.1.2** The results of collision loading assessment are summarised in the table below:

| | Load Effect | Capacity | Pass/Fail |
|---|---|---|---|
| **Bending in the Column** | 2476.7kNm | 46.3kNm | Fail |
| **Shear in the Column** | 1534.5kN | 95.6kN | Fail |
| **Shear in the Concrete Hinge** | 1534.5kN | 34.5kN | Fail |

**5.1.3** In addition to the failure of the concrete hinge from the analysis it should also be noted that BE 5/75 Rules for the Design and Use of Freyssinet Concrete Hinges in Highway Structures in the DMRB states that this type of hinge should not be used where there is a risk of collision with the structure causing damage or displacement to the hinge and therefore it is not suitable.

**5.1.4** As the existing piers are well below standard significant works would be required to strengthen them. Furthermore a new, more robust superstructure is likely to increase the bearing pressure on the foundations, which would also require modification. It is therefore considered more practical to demolish and rebuild the substructure for all the proposals considered in this report.

## 6 Proposal 1

**6.1.1** On the basis that the existing substructure cannot practically be incorporated as part of Proposal 1 the options that are considered for Proposal 1 are complete bridge replacement options.

**6.1.2** Proposal 1 considers two different types of road bridge to replace Chartershall Overbridge.

Option 1A - Four Span Concrete Overbridge.

Option 1B - Single Span Steel Overbridge.

**6.1.3** Other forms of bridges could have been considered e.g. two span and three span. However, the four span concrete and single span steel options are considered to represent the full range of issues associated with the reconstruction of the bridge.

### 6.2 Option 1A

**6.2.1** This option replaces the existing bridge with a new four span structure consisting of spans of 8.8m, 14.9m, 14.9m and 9.5m with an overall width of 10.4m (see general arrangement drawing B0657100/B802/ST/002 in Appendix B). The superstructure comprises pre- stressed inverted T beams with an insitu concrete infill deck and is integral with the three intermediate piers and bankseat abutments.

**6.2.2** To reduce the risk of further bridge strikes, the deck soffit level would be raised by approximately 230mm to increase the headroom from 5.07m to 5.3m in accordance with TD 27/05 Part 2 Cross Sections and Headrooms. Due to this increase the road level over the bridge would also be raised by approximately 230mm. In addition to this increase the structure would be designed to resist collision loading as defined in BD 60/04 Design of Highway Bridges for Vehicle Collision Loads.

### 6.3 Construction

**6.3.1** The first stage of construction for this structure would be the demolition of the existing bridge. This would be undertaken using conventional demolition plant during a full closure of the M9 for one weekend. (If this duration of closure is not permitted then a staged demolition would be required which can be investigated further as the design develops). The method of construction utilises traffic management operations with two lanes of the M9 remaining open in each direction during peak periods. In order to achieve this significant traffic management would be required. The abutments and piers would be

constructed using conventional insitu concrete construction methods and would be built individually with the adjacent lane/ hard shoulder closed to traffic.

**6.3.2** The beams would be lifted into position with a full carriageway closure operated by a contraflow system. The beams would be temporarily supported until the deck and diaphragms are cast. This would reduce the available lanes to the point where tidal flow would be required for a period. The remaining operation would be the construction of the deck cantilever and parapet edge beam which would require further contraflow operations for the installation and removal of the associated temporary works. Following the bridge deck waterproofing, surfacing, verge construction and other finishes the construction would be complete. The total duration for these works is estimated as 8 months.

### 6.4 Road Alignment

**6.4.1** The implications of the increased road alignment are more onerous for Option 1B and are therefore discussed in more detail under that option. Similar issues would arise for option 1A but to a lesser extent.

### 6.5 QUADRO

**6.5.1** A QUADRO (QUeues And Delays at ROadworks) assessment was carried out, to assess road user costs during construction. These are estimated as £790,000 for the four span option. It should be noted that the construction durations used in the QUADRO assessment are based on previous schemes and advice should be sought from Contractors to confirm these durations. The QUADRO report is included in Appendix E.

### 6.6 Environmental Issues

**6.6.1** A Preliminary Environmental Report was carried out to provide a preliminary review of the environmental implications of this option. For this option there were no impacts or limited impacts recorded against eight of the nine environmental parameters. The only item noted was a potential for construction impacts on watercourses. The report is included in Appendix F.

### 6.7 Utilities

**6.7.1** It has been noted from the record drawings there are two British Telecom (BT) ducts and one private water supply pipe in the north verge of the bridge. A C3 Notice was issued to BT on 24 September 2008 however, no response has been received. It is considered that during the bridge works BT would provide either a temporary overhead line over the M9 or a permanent diversion to reroute the line from the opposite side of the M9.

**6.7.2** During the public consultation exercise the residents of Chartershall Farm indicated that the private water supply was never installed through the bridge. However, should this supply still be live a temporary water supply could be provided whilst the bridge is undergoing construction.

**6.8 Option 1B**

**6.8.1** This option replaces the existing bridge with a single span bridge with half height abutments. The structure has a span of approximately 43m with an overall width of 10.5m (see general arrangement drawing B0657100/B0802/ST/003 in Appendix B). The superstructure comprises a steel concrete composite deck with four steel girders and a composite concrete deck slab. The superstructure would be integral with the abutments which would be insitu reinforced concrete cantilever walls.

**6.8.2** To reduce the risk of further bridge strikes the deck soffit level would be raised by 230mm to increase the headroom from 5.07m to 5.3m in accordance with TD 27/05 Part 2 Cross Sections and Headrooms. Due to this increase and the increased structural depth of the superstructure the road level over the bridge would be raised up to 1.2m. In addition to this increase in headroom the structure would be designed to resist collision loading as defined in BD 60/04 Design of Highway Bridges for Vehicle Collision Loads.

**6.9 Bridge Construction**

**6.9.1** The first stage of the bridge construction for this structure would be the demolition of the existing bridge. This would be undertaken using conventional demolition plant during a full closure of the M9 for one weekend. (If this duration of closure is not permitted then a staged demolition would be required which can be investigated further as the design develops). The method of construction utilises traffic management operations with two lanes of the M9 remaining open during peak periods. The abutments would be constructed using conventional insitu concrete construction and would be built individually with the adjacent lane/ hard shoulder closed to traffic.

**6.9.2** The steel girders would then be erected during a full closure of the M9 for one weekend. Once the girders are in place the permanent formwork would be placed in stages across the M9 whilst operating a contraflow on the M9 below. The concrete deck would be poured by adopting a similar method. The remaining operation would be the construction of the deck cantilever and parapet edge beam which would require further contraflow operations during the installation and removal of the associated temporary works. Following the bridge deck waterproofing, surfacing, verge construction and other finishes

the construction would be complete. The total duration for these works is estimated as 6 months.

**6.10 Road Alignment**

**6.10.1** The new road construction would involve raising the finished road level of Chartershall Road 1.2 metres on approach to the bridge in order to provide sufficient headroom for traffic on the M9 beneath. A plan and profile of the reprofiled Chartershall Road is shown in drawing number B0657100/H0802/R01-05 in Appendix B.

**6.11 Engineering Standards**

**6.11.1** A consultation meeting with Stirling Council held on 8th August 2008 established the geometric criteria for an improved road. Stirling Council advised that an 85kph design speed should be adopted. The reprofiled route has been designed in accordance with current vertical geometric standards utilising the technical guidance provided by the Design Manual for Roads and Bridges (DMRB) TD9/93 Highway Link Design.

**6.11.2** The proposed horizontal and vertical geometry for a reprofiled Chartershall Road approaching the over bridge is detailed in Tables 4 and 5 respectively.

**Table 4 – Horizontal Geometry**

| Element No. | Start Chainage | End Chainage | Length (m) | Hand | Radius (m) | Relaxations/Departures (TD 9/93 clause 3.4 |
|---|---|---|---|---|---|---|
| 1 | 0+00 | 0+14 | 14 | Straight | - | |
| Transition | 0+14 | 0+82 | 68 | Transition | - | |
| 2 | 0+82 | 2+48 | 166 | R | 190 | 3 step relaxation |
| 3 | 2+48 | 3+93 | 145 | Straight | - | |
| Transition | 3+93 | 4+59 | 66 | Transition | - | |
| 4 | 4+59 | 5+12 | 53 | L | 180 | 3 step relaxation |

**6.11.3** The horizontal geometry for the Chartershall Road reprofiling replicates the existing conditions and it can be seen from Table 4 that there is a 190 metre radius curve which is a three step relaxation for an 85 kph design speed between chainage 0+82 and 2+48 approaching the bridge from the south. There is also a three step relaxation between chainage 4+59 and 5+12 at the northern tie in of the proposed reprofiling.

**Table 5 – Vertical Geometry**

| Element No. | Start Chainage | End Chainage | Length (m) | Hand | Gradient | K Value | Relaxations/Departures (TD 9/93 clause 3.4 |
|---|---|---|---|---|---|---|---|
| 1 | 0+00 | 0+00.43 | 0.43 | Grade | 2% | | |
| 2 | 0+00.43 | 0+60 | 60 | Sag | - | 15.5 | 2 step relaxation |
| 3 | 0+60 | 4+46 | 386 | Hog | - | 55 | |
| 4 | 4+46 | 5+11 | 65 | Sag | - | 13 | 2 step relaxation |
| 5 | 5+11 | 5+11 | 0.6 | Grade | 0.5% | | |

**6.11.4** The vertical geometry for the Chartershall Road reprofiling incorporates a crest curve with a desirable minimum K value of 55. There are relaxations in the sag curves, elements two and four, which tie into the vertical profile of the existing road geometry however it is anticipated that development of the detailed design would facilitate the investigation and elimination of such relaxations.

**6.12 Earthworks**

**6.12.1** Earthworks for the reprofiled Chartershall Road consist of 6044m3 of fill with only 215m3 of excavation. The imported fill will be used to raise the existing road level from 0.0 metres to 1.2 metres north and south of the M9 to tie in with the new bridge deck level. Benching of the existing embankment will be required prior to increasing the embankment height and in order to eliminate land acquisition the earthworks will be engineered and steepened to remain within the existing boundary fence.

**6.12.2** The existing slope on the embankment is generally 1 in 2 however as the scheme must remain within the existing road boundary the new slope will be 1 in 1.5. Alternatively small retaining walls could be provided to maintain the existing 1 in 2 slope.

**6.13 Drainage**

**6.13.1** The carriageway drainage for this option will remain as over the edge drainage, the same as the existing system. The water from the carriageway on the approach to the bridge will run off to the verges and down the embankment.

**6.13.2** The new road level will tie with the existing road level towards the junction with Pirnhall road. There is an existing drainage system in place on Chartershall Road that services

the junction with Pirnhall Road. The drainage system should not be affected by the increased level however a drainage survey should be undertaken to confirm this.

**6.14 Land**

**6.14.1** The option to reprofile Chartershall Road will require no land take in order to complete the scheme. The existing embankment surface level is to be increased however slope gradients will be engineered to ensure the toe of the heightened embankment will remain within the limits of the existing boundary fence in order to avoid any land acquisition.

**6.15 Road Orders**

**6.15.1** This proposal envisages no changes to the footprint of the existing road. The Road (Scotland) Act 1984, Part 1, Public Roads – General powers and duties of roads authorities, Clause 1(1) states '*a local roads authority shall manage and maintain all such roads in their area … they shall, subject to provisions of this Act, have power to reconstruct, alter, widen, improve or renew any such road* …' and it is not considered that there will be a need to promote statutory orders for this proposed option. However, during the bridge reconstruction there will be no provision for pedestrian access and this may require a Temporary Order or temporary footbridge, which is not currently included in any of the cost estimates.

**6.16 Road Construction**

**6.16.1** The construction activities associated with this scheme will have minimal impact on local traffic and the community as the main area of works will be on the approaches to the bridge where there is currently no through route for vehicles.

**6.16.2** The residents and business activities at Chartershall farm will be affected to some degree by the earthworks involved in the scheme as they will encroach on the entrance into the farm. The farm access will need to be re-profiled in order for it to tie into the increased road level. A temporary farm access may need to be established in order to allow the business to continue with minimal impact during the work.

**6.17 QUADRO**

**6.17.1** A QUADRO (QUeues And Delays at ROadworks) assessment was carried out, to assess road user costs during construction. These are estimated as £320,000 for the four span option. It should be noted that the construction durations used in the QUADRO assessment are based on previous schemes and advice should be sought from Contractors to confirm these durations. The QUADRO report is included in Appendix E.

### 6.18 Environmental Issues

**6.18.1** A Preliminary Environmental Report was carried out to provide a preliminary review of the environmental implications of the options. For this option there were no impacts or limited impacts recorded against eight of the nine environmental parameters. The only item noted was a potential for construction impacts on watercourses. The report is included Appendix F.

### 6.19 Utilities

**6.19.1** It has been noted from the record drawings there are two British Telecom (BT) ducts and one private water supply pipe in the north verge of the bridge. A C3 Notice was issued to BT on 24 September however, no response has been received. It is considered that during the bridge works BT would provide either a temporary overhead line over the M9 or a permanent diversion to reroute the line from the opposite side of the M9.

**6.19.2** During the public consultation exercise the residents of Chartershall Farm indicated that the private water supply was never installed through the bridge. However, should this supply still be live a temporary water supply could be provided whilst the bridge is undergoing construction.

## 7 Proposal 2

**7.1.1** Part of the scope for Proposal 2 was to consider if any of the existing structure could be retained for safe passage of pedestrians, cyclists and equestrians. A number of options were briefly considered to strengthen the existing superstructure e.g. to encase the existing beams in reinforced concrete deck slab or to provide robust steel sections below the existing deck slab. However, these options were not progressed for a number of reasons. Firstly, the practicality of implementing these options was complex and was considered to require extensive traffic management. Furthermore, these measures would not increase the existing headroom and significant work would also be required to strengthen the existing piers for collision loading. Therefore, only a full replacement option was developed further as this was considered to be the only practicable option.

**7.1.2** A number of alternative forms of footbridge are available for this location. However, a vierendeel girder truss has been selected for this report as it is considered to offer the optimum solution in terms of cost and visual appearance. This location is not deemed to be appropriate for a landmark structure.

### 7.2 Option 2

**7.2.1** Option 2 replaces the existing bridge with a single span footbridge allowing pedestrian, equestrian and cyclist access. The new footbridge is proposed as a vierendeel girder steel truss of approximately 41.5m span and a width of 3.5m. The steel truss would be simply supported on half-height abutments which would be reinforced concrete cantilever walls. To reduce the risk of further bridge strikes the soffit level would be raised by 630mm to increase the headroom from 5.07 to 5.7m in accordance with TD 27/05 (see general arrangement drawing B0657100/B0802/ST/004 in Appendix B).

**7.2.2** Pirnhall Road will also be upgraded which serves part of the current diversion route. Pirnhall Road will be upgraded to a 6m carriageway with 2m verges either side to accommodate the traffic in this area.

### 7.3 Bridge Construction

**7.3.1** The first stage of the bridge construction would be the demolition of the existing bridge. This would be undertaken using conventional demolition plant during a full closure of the M9 for one weekend. (If this duration of closure is not permitted then a staged demolition would be required which can be investigated further as the design develops). The method of construction utilises traffic management operations with two lanes of the M9 remaining open during peak periods. The abutments would be constructed using conventional insitu

concrete construction and would be built individually with the adjacent hard shoulder closed to traffic.

**7.3.2** The truss would then be erected during a full closure of the M9 for one weekend. Once the truss is in place the bridge would essentially be complete.

**7.4 Road Alignment**

**7.4.1** Option 2 consists of improving the local network as the bridge will remain closed to vehicular traffic. The improvements would be to Pirnhall Road, its junction with Chartershall Road and turning heads on Chartershall Road adjacent to a closed bridge. A plan and profile of the realigned Pirnhall Road is shown in drawing number B0657100/H0802/R01-06 in Appendix B. The location of turning heads and proposed signage alterations are also shown on drawing number B0657100/H0802/R01-09 in Appendix B.

**7.4.2** A Pirnhall Road realignment will improve geometric standards whilst relocating the route to the north of the existing road.

**7.4.3** The junction layout at Chartershall Road and Pirnhall Road is to be repositioned in order to standardise the layout and improve approach and egress visibility.

**7.5 Engineering Standards**

**7.5.1** A consultation meeting with Stirling Council held on 8th August 2008 established the geometric criteria for an improved Pirnhall Road. Stirling Council advised that an 85kph design speed should be adopted, and a 6.0 metre carriageway width with 2.0 metre wide verges accommodated. Turning head geometry should be in accordance with Stirling Councils Development Roads Guidelines and Specifications as amended October 1989.

**7.5.2** The proposed horizontal and vertical geometry for a realigned Pirnhall Road and junction with Chartershall Road is detailed in Tables 6 and 7 respectively.

**Table 6 – Horizontal Geometry**

| Element No. | Start Chainage | End Chainage | Length (m) | Hand | Radius (m) | Relaxations/Departures (TD 9/93 clause 3.4 |
|---|---|---|---|---|---|---|
| 1 | 0+00 | 0+21 | 21 | Straight | - | |
| 2 | 0+21 | 0+57 | 36 | R | 110 | 2 step departure |
| Transition | 0+57 | 1+23 | 66 | Transition | - | |
| 3 | 1+23 | 1+98 | 75 | Straight | - | |
| Transition | 1+98 | 2+84 | 86 | Transition | - | |
| 4 | 2+84 | 6+31 | 347 | L | 510 | |
| Transition | 6+31 | 7+17 | 86 | Transition | - | |
| 5 | 7+17 | 7+74 | 56 | Straight | - | |
| Transition | 7+74 | 8+40 | 66 | Transition | - | |
| 6 | 8+40 | 9+37 | 97 | L | 180 | 3 step relaxation |
| Transition | 9+37 | 10+03 | 66 | Transition | - | |
| 7 | 10+03 | 10+09 | 6 | Straight | - | |

**7.5.3** The horizontal geometry for the Pirnhall Road realignment proposal is primarily compliant with an 85 kph design speed over its length, with the exception of the 110 metre radius curve between chainage 0+21 and 1+23 inclusive of curve exit transition. It was however agreed at the meeting held on 8th August 2008 with Stirling Council that the retention of this geometry at the east end of Pirnhall Road would be acceptable as changes to the road alignment at this locus would potentially have significant detrimental effects on the Foot o' Green farm buildings. A relaxation in horizontal geometry is also proposed with a 180 metre radius curve between chainage 7+74 and 10+03 balancing achieving improved geometric standards with minimising land acquisition and field severance on a non through route primarily servicing dispersed rural housing where traffic volumes are low.

**7.5.4** The junction with Chartershall Road falls within the extents of this curve at chainage 8+80 and a widened verge will be necessary on the south side of Pirnhall Road to ensure the desirable minimum stopping sight distance of 160 metres is achieved approaching the junction.

**Table 7 – Vertical Geometry**

| Element No. | Start Chainage | End Chainage | Length (m) | Hand | Gradient | K Value | Relaxations/Departures (TD 9/93 clause 3.4) |
|---|---|---|---|---|---|---|---|
| 1 | 0+00 | 0+06 | 6 | Grade | 1% | | |
| 2 | 0+06 | 1+70 | 163 | Hog | - | 30 | 1 step relaxation |
| 3 | 1+70 | 2+61 | 92 | Grade | 4% | | |
| 4 | 2+61 | 4+08 | 147 | Sag | | 20 | |
| 5 | 4+08 | 6+48 | 240 | Hog | | 55 | |
| 6 | 6+48 | 7+19 | 71 | Sag | | 20 | |
| 7 | 7+19 | 8+27 | 108 | Hog | | 55 | |
| 8 | 8+27 | 8+84 | 57 | Sag | | 20 | |
| 9 | 8+84 | 10+09 | 125 | Grade | 3% | | |

**7.5.5** The vertical geometry is primarily compliant with an 85kph design speed over its length, with the exception of the crest curve between change 0+06 and 1+70 where a relaxation is present. As with the horizontal geometry it was agreed at the meeting held on 8th August 2008 with Stirling Council that the retention of existing geometry at the east end of Pirnhall Road would be acceptable as reprofiling in this area would lead to significant earthworks in the southern verge with potential detrimental effects on the Foot o' Green farm buildings.

**7.6 Earthworks**

**7.6.1** Earthworks for the new Pirnhall Road alignment comprise of 5577 m3 of excavation and 2694 m3 of fill. It is envisaged that the material removed in the excavation process would be used as fill if deemed to be suitable following the appropriate ground investigation study. This would only leave 2883 m3 of excavation to be either removed from site or utilise as landscape material to reinstate the redundant sections of the existing Pirnhall Road as agricultural land.

**7.6.2** The main areas of earthworks on Pirnhall Road are two sections of cut into a knoll to the southeast of Gateside and into the sidelong ground northeast of Foot o' Green farm. There is minimal variation between existing and proposed road level at these locations,

circa 0.6 metres southeast of Gateside and a negligible level difference at Foot o' Green the earthworks arising primarily from an increased cross section width. One section of fill, circa 2.0 metres depth, is also present between chainage 3+00 and 4+00. The earthworks in the scheme are not significant and it is envisaged minimal geotechnical certification in accordance with Technical Memorandum SH4/89 Geotechnical Certification Procedures: Trunk Road Ground Investigations will be required.

**7.7 Drainage**

**7.7.1** The drainage for this scheme will consist of filter drains running along the verges of the realigned road. There are a couple of low points where the water will gather and a suitable drainage outfall will be established during the detailed design stage. The new system would have to be in compliance with SUDS.

**7.8 Land**

**7.8.1** The upgrading of Pirnhall Road to a standard acceptable to Stirling Council would involve an offline realignment. The realignment of Pirnhall Road will require acquisition of agricultural land from two owners and following discussions with these owners at a Public Exhibition held on 29th and 30th October 2008 they expressed dislike for this option. There is therefore significant potential that land acquisition would require a Compulsory Purchase Order (CPO) to be promoted.

**7.8.2** The two landowners affected by the land-take that would be involved in this option are Mr Wilson of Chartershall Farm and Mr Strathern of Foot o' Green farm. The two fields to the north of the existing road would be used in the new alignment.

**7.8.3** The field to the northwest of Foot o' Green farm is most affected by the new alignment as it severs the field in half. The area of the severed land is approximately 4000m2, however it is anticipated the existing road will be reinstated as farmland which consists of an area of approximately 4000m2. The size, shape and access to the fields will be affected and will possibly affect the land use.

**7.8.4** The junction of Chartershall Road and Pirnhall Road is to be realigned to locate it to the south of the existing junction with land take of approximately 2500m2. The short section of the existing road to Howlands will be reinstated to farmland to mitigate adverse affects from the new construction.

### 7.9 Road Orders

**7.9.1** Realignment of Pirnhall Road and a section of the Howlands Road would also require sections of the existing roads to be stopped up and returned to agricultural land necessitating the promotion of a Stopping Up Road Order. Furthermore a new Mainline Road Order would be required for the rerouted Pirnhall road.

### 7.10 Road Construction

**7.10.1** The construction of the roadworks for this proposal would require careful planning of works in order to keep the existing road open while the new carriageway is constructed. This would not be a problem for the majority of the realignment which is offline, however areas where the new alignment ties into the existing would require particular attention during detailed design paying due cognisance to available road width for passing traffic and construction activities.

**7.10.2** The total duration for these activities is estimated as 9 months.

### 7.11 QUADRO

**7.11.1** A QUADRO (QUeues And Delays at ROadworks) assessment was carried out, to assess road user costs during construction. These are estimated as £210,000 for the footbridge option. It should be noted that the construction durations used in the QUADRO assessment are based on previous schemes and advice should be sought from Contractors to confirm these durations. The QUADRO report is included in Appendix E.

### 7.12 Environmental Issues

**7.12.1** A Preliminary Environmental Report was carried out to provide a preliminary review of the environmental implications of the options. For this option several impacts were recorded against six of the nine environmental parameters. This included

- Impacts on agricultural land, including arable and rough grazing
- Impacts on drainage ditches. Potential for construction impacts on watercourses
- Loss of ecological habitats
- Impacts on the AGLV and local character of the area
- Potential for impacts on local residents
- Potential conflict with POL.E15 regarding AGLV (Local Plan)

**7.12.2** This option has also has a beneficial impact on pedestrians in this area. The report is included Appendix F.

### 7.13 Utilities

**7.13.1** It has been noted from the record drawings there are two British Telecom (BT) ducts and one private water supply pipe in the north verge of the bridge. A C3 Notice was issued to BT on 24 September however, no response has been received. It is considered that during the bridge works BT would provide either a temporary overhead line over the M9 or a permanent diversion to reroute the line from the opposite side of the M9.

**7.13.2** During the public consultation exercise the residents of Chartershall Farm indicated that the private water supply was never installed through the bridge. However, should this supply still be live a temporary water supply could be provided whilst the bridge is undergoing construction.

**7.13.3** For the utilities in Pirnhall Road preliminary inquiry C2 notices have been issued in accordance with the New Roads and Street Works Act (NRSWA) 1991. Scottish Water is the only utility to indicate any affects on their apparatus. There are two water mains running along the side of Pirnhall Road, one in each verge. They will have to be diverted if this realignment option is to be promoted. A draft scheme and budget estimate C3 notice has been issued to Scottish Water to establish a draft cost for the apparatus to be diverted however a response remains outstanding at the time of compiling this report

## 8 Cost Estimate

**8.1.1** A cost estimate has been prepared for all of the options based on the information available. The costs have been derived from publications on current market prices for the required construction elements. For specialist items e.g. the new footbridge budget estimates have been sought from key suppliers.

**8.1.2** The approximate costs for the construction of the different options are estimated as,

- Option 1A £3,050,000
- Option 1B £2,560,000
- Option 2 £2,700,000

**8.1.3** A breakdown of the main items in the cost estimate for all three options can be seen in the Table below.

| Item | Options | | |
|---|---|---|---|
| | **1A – 4-Span** | **1B – Single Span** | **2 - Footbridge** |
| Design | £100,000 | £100,000 | £100,000 |
| Procurement | £100,000 | £100,000 | £100,000 |
| Construction | | | |
| Bridges | £600,000 | £850,000 | £470,000 |
| Road Alignment | £100,000 | £230,000 | £700,000 |
| Traffic Management | £500,000 | £120,000 | £20,000 |
| Preliminaries | £360,000 | £360,000 | £360,000 |
| Contingencies | £180,000 | £180,000 | £180,000 |
| Utilities | £100,000 | £100,000 | £350,000 |
| Land | - | - | £10,000 |
| Supervision | £100,000 | £100,000 | £100,000 |
| Sub-total | £1,940,000 | £1,940,000 | £2,190,000 |
| QUADRO | £790,000 | £320,000 | £210,000 |
| Inflation 4% | £120,000 | £90,000 | £100,000 |
| **Total** | **£3,050,000** | **£2,560,000** | **£2,700,000** |

## 9 Discussion of Options

**9.1.1** Options 1A and 1B (Proposal 1) are discussed below, appraising them on their advantages and disadvantages. The preferred vehicular bridge option from these two options will then be selected before comparing this to Option 2 (Proposal 2).

### 9.2 Options 1A and 1B

### 9.3 Health and Safety

**9.3.1** With respect to health and safety the single span bridge (Option 1B) is considered to be less hazardous during the construction phase than the four span bridge (Option 1A). Due to the intermediate supports required for Option 1A, operatives are required to work in close proximity to live traffic travelling at high speeds which is more hazardous than Option 1B, where supports are remote from the carriageway.

### 9.4 Cost

**9.4.1** Comparing the costs of Option 1A (£3.05m) and Option 1B (£2.56m), Option 1B offers the most economic solution by an estimated £490,000.

### 9.5 Construction

**9.5.1** Option 1B also compares more favourably to Option 1A with respect to the duration of construction. Option 1A has an estimated construction period of 8 months whereas Option 1B has an estimated construction period of 6 months.

### 9.6 Traffic Management

**9.6.1** With respect to traffic management operations one advantage with Option 1A compared to Option 1B is that only one full closure of the M9 is required (during the demolition of the existing bridge). Option 1B requires two full road closures of the M9 (during demolition of the existing bridge and during erection of the main girders). However, Option 1A requires substantially more other traffic management operations, which are mainly contraflow and tidal flow. This extensive use of lane and carriageway closures can be hazardous, disruptive and costly and this is reflected in the costs and construction durations where this option fairs poorly.

### 9.7 Central Pier

**9.7.1** A further disadvantage for Option 1A compared to Option 1B is the requirement for a central pier. At present, the central reserve at the existing bridge is narrower than the standard required. In order to provide a central pier that is suitably robust to resist

collision loading with the associated vehicle restraint system, set back and working width, the central reserve would require widening. Increasing the width of the central reserve at this location is unlikely, therefore a below standard barrier arrangement would be expected. However, as Option 1B has no intermediate supports there is no need for this non-standard arrangement.

### 9.8 Durability and Maintenance

**9.8.1** Comparing the long term durability and maintenance characteristics of the options the notable difference is the concrete beams of the four span bridge compared to the steel girders of the single span bridge. The concrete beams of Option 1A are considered to be advantageous to the steel beams of Option 1B due to the maintenance painting and associated traffic management etc. required.

### 9.9 Aesthetics

**9.9.1** Option 1A is also considered to hold an advantage over Option 1B with respect to one aspect of aesthetics. The existing overbridge is one of a “family of structures” crossing the M9 as there are seven, four span structures north of Chartershall and four to the south. Option 1A replaces the existing four span bridge with a similar 4 span structure. However although the single span of Option 1B would not match the span arrangement of the adjacent structures, the structure itself is not considered to be aesthetically displeasing. There are a variety of differing spans on the M9 including a three span pedestrian footbridge north of Chartershall and a two span to the south. There is also a single span structure located at Junction 9 and therefore it could be argued that it would not be completely out of context, although Option 1A would still be considered to offer an advantage in this respect.

### 9.10 Road Level

**9.10.1** The final item where Option 1A could be considered to offer an advantage over Option 1B the single span bridge is that it would not have as significant an impact on the road level over the bridge. The road level is expected to increase by approximately 230mm for Option 1A and up to 1.2m for Option 1B. However, it is considered both options can be accommodated within the available land and no significant penalty would apply if Option 1B was selected.

**9.10.2** From the discussion above the options and their associate advantages and disadvantages are summarised in the table below. Although it can be seen that there are advantages and disadvantages associated with both, the advantages associated with Option 1B (the single span bridge) outnumber those for Option 1A (the four span bridge).

This is perhaps even more conclusive as the items that Option 1B (the single span bridge) score better on, are believed to be items of a higher weighting.

| | Option 1A | Option 1B |
|---|---|---|
| Health and Safety | ✗ | ✓ |
| Cost | ✗ | ✓ |
| Construction Time | ✗ | ✓ |
| Traffic Management | - | - |
| Central Pier | ✗ | ✓ |
| Durability and Maintenance | ✓ | ✗ |
| Aesthetics | ✓ | ✗ |
| Change in Road Level | ✓ | ✗ |

**9.11** **Proposal 1 vs. Proposal 2**

**9.11.1** Since Option 1B (the single span bridge) has been selected as the preferred road bridge option from Proposal 1, this is now compared to Proposal 2 (Option 3) which replaces the existing bridge with a footbridge and upgrades Pirnhall Road as part of the permanent diversion.

**9.12** **Health and Safety**

**9.12.1** With respect to health and safety during construction there are not considered to be any significant advantages or disadvantages between Proposal 1 (new road bridge) and Proposal 2 (new footbridge and local road upgrade). However, during operation Proposal 2 is considered to offer both advantages and disadvantages. One advantage is that the provision of a footbridge would reduce the volume of traffic through Chartershall village, which has poor geometry, poor visibility and narrow or no verges. However, during the public consultation a number of local residents noted that the lack of traffic over the bridge had caused the bridge location to become an area for loitering and antisocial behaviour.

**9.13** **Cost**

**9.13.1** Comparing the costs of Proposal 1 (£2.56m) and Proposal 2 (£2.7m), Proposal 1 offers the most economic solution by an estimated £140,000.

**9.14** **Design, Procurement & Construction Timescales**

**9.14.1** Proposal 1 compares more favourably to Proposal 2 with respect to the overall duration of design, procurement and construction. Proposal 1 has an estimated timescale of 18 months (refer to public consultation material in Appendix G) whereas Proposal 2 has an estimated timescale of 27 months.

**9.15** **Traffic Management**

**9.15.1** With respect to traffic management operations one advantage with Proposal 2 is that it requires substantially less traffic management operations than Proposal 1 on the M9 motorway. However, Proposal 2 causes more disruption to the local road network than Proposal 1.

**9.16** **Land**

**9.16.1** There is no requirement for land acquisition or road orders for Proposal 1 which is considered to be a significant advantage. These would be required for Proposal 2 which involves severance of agricultural land.

**9.17** **Utilities**

**9.17.1** Proposal 1 is also considered to hold an advantage over Proposal 2 with respect to utilities. The bridge option for Proposal 1 is able to accommodate services over it whereas the bridge option for Proposal 2 is not. Additionally Proposal 2 requires a diversion of the two water mains in Pirnhall Road and this is not required with Proposal 1.

**9.18** **Environmental**

**9.18.1** From the Preliminary Environmental Report carried out for both proposals it is evident that there are likely to be more environmental issues to be addressed with Proposal 2 than Proposal 1 on a ratio of 6 to 1.

**9.18.2** From the discussion above the options and their associate advantages and disadvantages are summarised in the table below. Proposal 1 can be seen as the preferred bridge option with Proposal 2 having no notable advantages.

| | Proposal 1 | Proposal 2 |
|---|---|---|
| Health and Safety | - | - |
| Cost | ✓ | ✗ |
| Timescale | ✓ | ✗ |
| Traffic Management | - | - |
| Land | ✓ | ✗ |
| Utilities | ✓ | ✗ |
| Environmental | ✓ | ✗ |

## 10 Public Consultation

**10.1.1** A public exhibition was held in the King Robert Hotel, Glasgow Road, Whins of Milton, Stirling, FK7 0LJ on the 29th and 30th of September 2008 between the hours of twelve noon and seven in the evening to gauge local public opinion. Representatives of Transport Scotland, BEAR Scotland Ltd and Jacobs were present to furnish members of the public with information.

**10.1.2** Furthermore the proposed options were posted on the Transport Scotland's web site, www.transportscotland.gov.uk/road, encouraging interested parties to express their views.

### 10.2 Exhibition Attendance

**10.2.1** The exhibition was well received and over the course of the two days 76 members of the public including a Member of the Scottish Parliament, Stirling Council elected members and community council representatives attended.

### 10.3 Exhibition Feedback

**10.3.1** Comments received during the exhibition were captured on feedback forms and the data has been collated. 72 feedback forms were received between the exhibition dates and 10 November 2008. 51 (71%) of these expressed a desire to see Chartershall Road bridge replaced and reopened to vehicular traffic. 21 (29%) local residents wished vehicular restrictions to remain on Chartershall Bridge with the associated upgrading to the local Pirnhall Road. Both the MSP Bruce Crawford and Stirling Council confirmed their preference was for Chartershall Road bridge to be replaced and reopened to vehicular traffic.

**10.3.2** The exhibition highlighted a pronounced difference in opinion within the local community. Those members of the public residing within Chartershall village, to the north side of the M9 motorway, were keen that vehicular restrictions remained on Chartershall Bridge as restrictions had reduced traffic through the village and a perception prevails that road safety has improved. Those members of the dispersed community of Sauchieburn, residing to the south side of the M9 motorway, were keen that vehicular access across Chartershall Bridge be reinstated as the closure results in a lengthier alternative route towards Stirling via Pirnhall Road and New Line Road.

**10.3.3** The different reasons given by the local residents for the preferred options are summarised in the tables below, together with the number of times those reasons were raised on the feedback forms.

| Reasons for selection of Option 1 | No of times raised | Percentage |
|---|---|---|
| Ease of access | 24 | 15% |
| Required for local business | 22 | 14% |
| Safer road | 17 | 11% |
| Removal of anti-social behaviour on the closed bridge | 14 | 9% |
| Required for local community | 11 | 7% |
| Common sense solution | 10 | 6% |
| Less impact on the environment | 10 | 6% |
| Reinstates existing | 10 | 6% |
| Traffic volumes require it | 7 | 4% |
| Shorter timescale to implement | 6 | 4% |
| Improved access for emergency vehicles | 5 | 3% |
| Dislike Option 2 | 5 | 3% |
| No disturbance to agricultural land | 5 | 3% |
| Reduces traffic on Pirnhall Road & New Line Road | 4 | 3% |
| Simpler due to no land acquisition required | 3 | 2% |
| Retains an alternative crossing for the M9 and doesn't rely solely on New Line Road bridge | 3 | 2% |
| Reduces mileage | 2 | 1% |
| Less disruption during construction | 2 | 1% |
| **Total** | 160 | 100% |

**10.3.4**

| Reasons for selection of Option 2 | No of times raised | Percentage |
|---|---|---|
| Improved safety in Chartershall | 16 | 37% |
| Improves environment | 8 | 19% |
| Reduced traffic speed through Chartershall | 6 | 14% |
| Safer for walkers | 5 | 12% |
| Reduction in HGV's in Chartershall | 5 | 12% |
| Improved junction at Pirnhall Road | 1 | 2% |
| Safer for equestrians | 1 | 2% |
| Better option | 1 | 2% |
| **Total** | 43 | 100% |

## 11 Procurement Methodology

**11.1.1** For the design and construction it is considered that there are three main forms of contract procurement. These are: -

- Method 1 – Traditional ICE 5th Contract procured through the South East term Maintenance contract.
- Method 2 – Traditional ICE 5th Contract procured through open tendering
- Method 3 – Design and Build Project

**11.1.2** A traditional ICE 5th Contract (Methods 1 & 2) would involve the design and check being carried out fully, prior to the letting of the contract through open tendering. A design and build style contract (Method 3) would include the preparation of an outline design prior to letting the contract to prepare detailed design and complete construction.

**11.1.3** Method 1 would be managed / let through the 3rd Generation South East Unit Term Maintenance Contract. This would utilise the existing framework that is already in place and allow the design and checking works to be carried out using agreed contract rates. The major benefit of this method is that a start can be made to the detailed design phase rapidly and allow the design to be completed and "put on the shelf" until suitable construction funds were available. It is envisaged that the detailed design would be carried out by Jacobs with the independent check carried out by BEAR Scotland Ltd.

**11.1.4** Method 2 is similar to Method 1 but with the main difference being that the detailed design and checking phase would also be let through an open tendering procedure. One benefit of this is that it would allow the comparison of various consultants' costs. The major drawback of this method is that the timescales for the design would be extended due to the additional tendering process and the requirement for a scope of works to be developed. This method would also have the disadvantage of not easily allowing for the alteration or additions to the scope of work without further financial negotiation.

**11.1.5** Method 3 would be let as a detailed design and build contract following the preparation of an outline design and appointment of an Engineer. Although there are normally benefits through value engineering, the scope of the works involved are considered straightforward enough that these benefits would be negligible. There are potentially major financial and programme implications with this method. As detailed design would not commence until the final contract is let, there would not be an available construction solution until full funding could be secured.

## 12 Implications of Increased Headroom below Chartershall Bridge

**12.1.1** Currently the existing headroom below Chartershall Bridge is greater than the legal minimum of 5.03m and the bridge being the lowest of the structures on the M9 Stirling Bypass acts as a buffer to other structures in the North bound direction. Both of the proposed road bridge options will look to provide a new minimum clearance of 5.3m below the structure (5.7m would be provided for the footbridge option). Surveys of the adjacent bridges have indicated that there are locations that may be affected by the proposed works. These structures may become liable to bridge strikes if vehicles of a similar height to those currently hitting Chartershall continue on this route. There are four proposed strategies that can be implemented to help prevent the bridge strike problems transferring to another structure: -

- A detailed signing strategy to all approach roads, reminding drivers to know the height of their vehicles. This option would require the least construction cost and disruption and would provide a good interim measure until it was evident that there was still a bridge strike problem.

- A series of over height detectors could be installed on approaches to the structures to highlight to drivers a potential bridge strike. Additional construction works would be required to provide a holding area and crossover to the centre reserve to allow the "release" of the vehicle concerned. This strategy is discussed in detail in Amey's report of 2005 titled "M9 Stirling Bypass – Overheight Study".

- Provision of collision protection beams or strengthening to the existing superstructures of the remaining bridges to accommodate collision loading. This provides a solution for protecting the structures but does not prevent collisions and is therefore still a residual risk for the M9 traffic.

- Raising of the affected structures could be undertaken to provide a minimum clearance of 5.3m. This would involve a major investment and lead to long term disruption of the route while works are carried out.

**12.1.2** Structures that have the potential to be affected are M9 9-10 35 Newpark farm in the northbound direction and M9 9-10 55 Torbrex Bridge in the southbound direction. Currently there is evidence of bridge strikes affecting Torbrex Bridge.

## 13 Conclusions and Recommendations

**13.1.1** It is recommended that the existing Chartershall Road Overbridge should be replaced with a new road bridge (Proposal 1). It is recommended that the form of this structure should be a single span bridge with half height abutments (Option 1B).

**13.1.2** It is considered that this option should be progressed due to the extensive damage that has occurred to the existing bridge and the susceptibility of the bridge to further damage. This is further reinforced by the fact that the existing bridge piers are not able to withstand the effects of collision loading.

**13.1.3** The bridge is proposed as a single span bridge with half height abutments due to the health & safety, cost and construction duration advantages it has over the other option considered.

**13.1.4** The proposal to replace the bridge with a new road bridge is considered to be the lower cost option and can be implemented in a shorter timescale than a footbridge with associated local road improvements. This also offers environmental advantages and requires less onerous public utility diversions.

**13.1.5** Additionally, this proposal was the preferred option from the public consultation carried out with the local community by a margin of 71% to 29%. It should also be noted that the MSP Bruce Crawford and Stirling Council expressed their support for this option.

**13.1.6** During the public consultation the majority of local residents that voted for Option 2 did so on the basis that it improved the safety of Chartershall Road through Chartershall. Therefore if Option 1B is selected as the preferred option then it may be appropriate that improvements to road safety in Chartershall be considered by Stirling Council.

**Transport Scotland**
**M9 Chartershall Overbridge Feasibility Report**

## Appendix A

Location Plan

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**Appendix B**

General Arrangement Drawings

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**Appendix C**

Photographs

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**Appendix D**

HE and RR Forms

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**Appendix E**

QUADRO Report

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**Appendix F**

Environmental Report

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**Appendix G**

Public Consultation Material