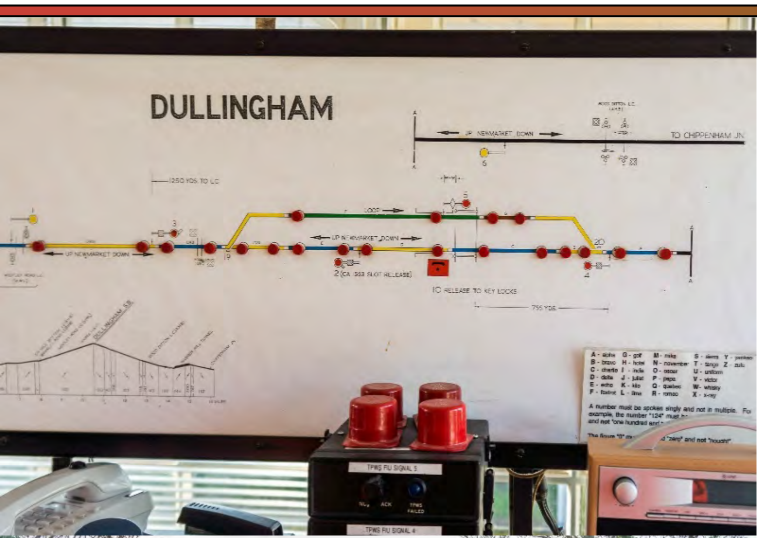

Risk Assessment for Dullingham MCB Level Crossing

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REVISIONS

Revision No	Prepared by	Checked by	Issue date	Comments
Issue 00	Chris Chapman	David Harris	-	Working draft
Issue 01	Chris Chapman	David Harris	03/05/19	Issued to Network Rail for review
Issue 02	Chris Chapman	David Harris	17/06/19	Issued to Network Rail

APPROVAL

Prepared by:	Name: Chris Chapman Job Title: Risk Specialist Date: 17th June 2019
Accepted By: (RLCM)	Name: John Prest Date: 29th July 2019
Accepted By: (RAM Signalling)	Name: CHARLES MURIU Date: 29/07/19

CONTENTS

ACRONYMS AND ABBREVIATIONS

Acronym	Description	Comments
ABCL	Automatic Barrier Level Crossing, Locally-monitored	
AHB	Automatic Half-Barrier (level crossing)	
ALARP	As Low As Reasonably Practicable	
ALCRM	The All Level Crossing Risk Model	A tool for assessing the risk at particular level crossings.
AOCL	Automatic Open Level Crossing, Locally-monitored	
AOCL+B	Automatic Open Level Crossing, Locally-monitored with retrofitted half barriers	
BAP	Biodiversity Action Plan	
BOAT	Byway Open to All Traffic	
BPM	Barrier Protection Management	A solution for auto-lower crossings that delays barrier lowering should there be a road vehicle underneath a barrier.
CBA	Cost Benefit Analysis	A numerical comparison of the monetised advantages and disadvantages of undertaking a particular course of action.
CCU / LCU	Crossing Control Unit	
COD	Complementary Obstacle Detector	
CCTV	Closed Circuit Television	
DIA	Diversity Impact Assessment	
EA	Equality Act 2010	
ELR	Engineering Line Reference	
ERTMS	European Rail Traffic Management System	A system of train control that allows for automatic train protection and cab based signalling.
ETCS	European Train Control System	
FWI	Fatalities and Weighted Injuries	A measure of safety performance where the predicted rate of fatalities and minor and minor injuries are combined into an overall measure of risk.
HGV	Heavy Goods Vehicle	
LCM	Level Crossing Manager	
LED	Light Emitting Diode	

Acronym	Description	Comments
MCB-CCTV	Manually-Controlled Barrier Level Crossing with CCTV	
MCB-OD	Controlled Barrier Level Crossing with Obstacle Detection	
MCG	Manually-Controlled Gate Level Crossing	
NPV	Net Present Value	
ORCC	Operations Risk Control Coordinator	
ORR	Office of Rail and Road	
PHI	Priority Habitat Inventory	
POD	Primary Obstacle Detector	
PROW	Public Right of Way	
PSB	Power Signal Box	
RAM	Route Asset Manager	
ROC	Regional Operations Centre	
RLSE	Red light static enforcement cameras	
RSSB	Rail Safety and Standards Board	
RTL	Road Traffic Light	
SAC	Special Area of Conservation	
S&SRA	Suitable and Sufficient Risk Assessment	
SEU	Signalling Equivalent Unit	A measure of signalling cost
SLL	Stop, Look and Listen sign	Signage normally used for footpath or user-worked crossings that require pedestrians to check whether a train is approaching before deciding whether it is safe to cross
SMIS	Safety Management Information System	The database used by the UK rail industry for reporting accidents and near misses
SPAD	Signal Passed at Danger	
SRM	Safety Risk Model	The rail risk model managed on behalf of the industry by RSSB
SSSI	Sites of Special Scientific Interest	
TMOB	Trainman Operated Barrier crossing	

Acronym	Description	Comments
TOC	Train Operating Company	
TPV	Train Pedestrian Value	A measure of used based on pedestrian usage and train frequency
TTRO	Temporary Traffic Regulation Order	
TWAO	Transport & Works Act Order	
VAS	Vehicle Activated Sign	A sign that illuminates in the event of blocking back ahead, reminding drivers to keep the crossing clear
VpF	Value of Preventing a Fatality	A value used to express safety risk in financial terms
YN, YO, ZN, ZO	Denotes the corner of the crossing.	Y is closest to the Up line; Z the Down line; N is the nearside (for traffic); O the offside.

REFERENCE DOCUMENTS

The following documents have been used to support the production of this report:

Ref	Document Name	Number
1.	Level Crossings: A guide for managers, designers and operators (ORR)	Railway Safety Publication 7 December 2011
2.	Internal Guidance On Cost Benefit Analysis (CBA) IN Support Of Safety-related Investment Decisions	ORR, April 2015
3.	Network Rail Authority Paper (for LXEU and SEU costs)	V6.15 – 1st July 2015
4.	Census Report for Dullingham Level Crossing	Sky High-Count on Us 8801 Task 4 Site 28 – May 2013
5.	Level Crossing Guidance Document: Applying Risk Reduction Bednefits in ALCRM When Modelling Safety Enhancements	LCG 14 March 2016
6.	Transforming Level Crossings: A vision-led long-term strategy to improve safety and level crossings on Great Britain's railways	NR17
7.	Manually Controlled Barriers Obstacle Detection: MCB-OD Selection and Risk Mitigation Guidance	Signalling Design Group NR/IP/SDG York/MCB-OD/02 August 2014 Version 3.1
8.	MCB-OD Pedestrian Risk Tool	AD Little V1
9.	East Cambridgeshire Local Plan	Adopted April 2015
10.	Cambridge Local Plan	Adopted October 2018

1 INTRODUCTION

1.1 Background

The renewal of level crossings on the UK network must be supported by appropriate and robust risk assessment. This level crossing risk assessment was originally produced in support of the Cambridge Area Interlocking Renewals (CAIR) project in 2013. The Cambridge – Dullingham – Bury Re-Signalling (CBD) Project started out being called Cambridge Inner Re-Signalling (CIRS) with a smaller geographical scope. A further scope of works Cambridge Outer Re-Control and Life Extension (CORCLE) was added to the CIRS scope partway through GRIP 1 in order to gain efficiencies. An update to this level crossing risk assessment is required in order to take into account the latest project information. As part of this process, Network Rail has tasked Sotera Risk Solutions to update the suitable and sufficient risk assessment of the closure and renewal options for Dullingham AHB level crossing.

1.2 Approach to risk assessment

In order to carry out the risk assessments, Sotera has:

- Reviewed available information pertinent to the level crossing (including, SMIS event data, and input data to the All Level Crossings Risk Model (ALCRM)).

- Analysed national level crossing risk information to compare the main level crossing type options.

- Undertaken a site visit to the crossing to assess its current operation, to determine the existing controls, identify local hazards, to measure distances key to the risk assessment and make a photographic record of any issues. If there was no census since 2013, the site visit included a half hour census, which could be used to assess the suitability of the old census.

- Specified and carried assessments of the crossing type options using the ALCRM, where available based upon an up-to-date traffic census otherwise making use of the Department of Transport's TEMPro v7.2 software, which allows users to view the National Trip End Model (NTEM) dataset and can be used to factor up '*old*' censuses to current levels of usage.

- Carried out an initial options assessment which considered the available crossing type options from a safety, cost and feasibility perspective

- Facilitated an options assessment workshop, which reviewed the initial options assessment, supplementing it with additional information and ideas as appropriate.

2 DESCRIPTION OF THE SITE AND THE EXISTING LEVEL CROSSINGS

2.1 Current level crossing detail

Dullingham is a manned gate (MGH) crossing with two gates which are closed to the railway in normal use, and opened when required to allow a train to pass. It is controlled from Dullingham signal box, located adjacent to the crossing at the end of Platform 2 of the station.

The maximum line speed is 60 mph over this line. The line is not electrified.

Figure 1 shows the configuration of the crossing, viewed from the south. *Figure 2* provides the relevant extract from the sectional appendix covering the crossing. *Table 1* presents details of the location and operation of the crossing.

Figure 1 Current crossing equipment

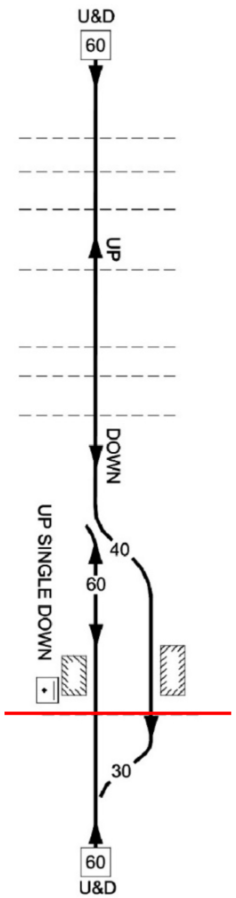
Table 1 Current Level Crossing Details

Level crossing name	Dullingham
Level crossing type	MGH
ELR and mileage	CCH 10m 56ch
Status	Public Road
Number of running lines	2
Permissible speed over crossing (Up)	60mph
Permissible speed over crossing (Down)	60mph
OS grid reference	TL618585
Postcode	CB8 8UP
Road name and type	Station Road (undesignated)
Local Authority	Cambridgeshire County Council
Supervising signal box	Dullingham SB
Electrification and type	None

Figure 2 Extract from the sectional appendix

LOR	Seq.	Line of Route Description	ELR	Route	Last Updated
EA1530	002	Coldham Lane Jn to Haughley Jn	CCH	Anglia	19/11/2016

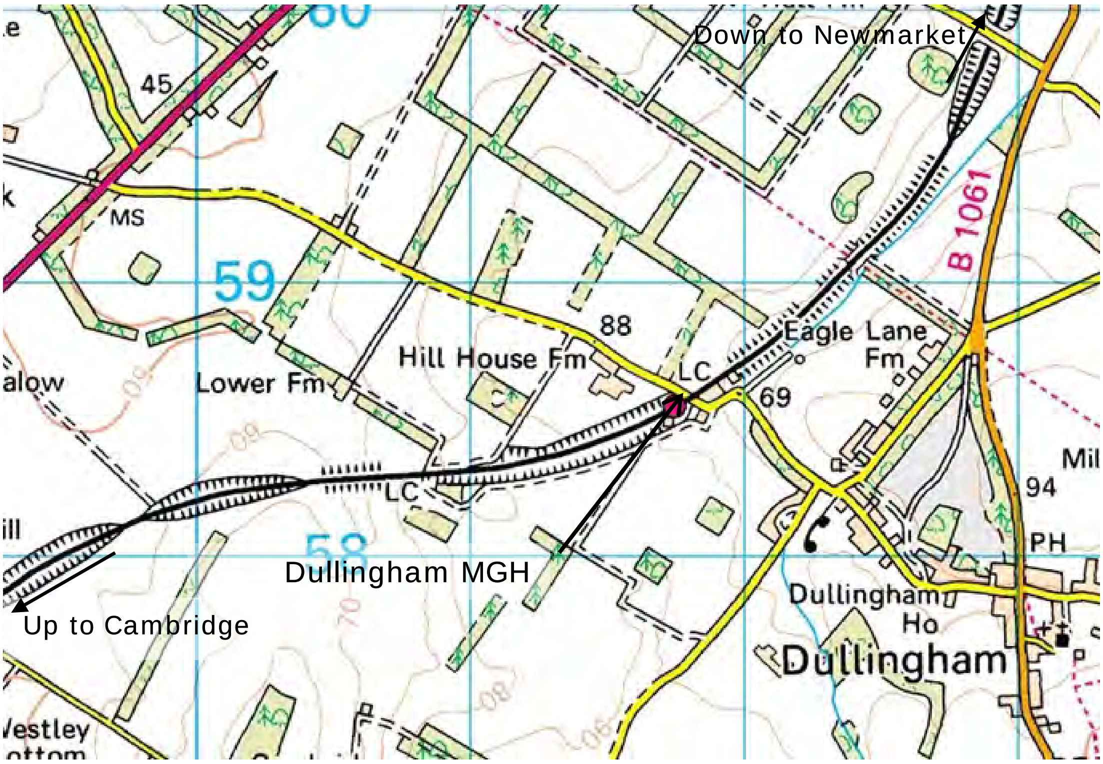
Location	Mileage M	Mileage Ch	Running lines & speed restrictions	Signalling & Remarks
				GSM-R TCB RA8 Cambridge SB (CA)
Fulbourn LC (AHBC)	4	36		
Home Farm LC FPS)	5	31		
Hicks LC (UWC)	5	38		
Six Mile Bottom LC (AHBC)	7	65		
Brinkley Road LC (AHBC)	7	78		
Cassells LC (FPG)	8	05		
Westley Road LC (R/G) (UWC)	8	74	T	
Single line	10	07		Up platform - 94m (102 yds) Down platform - 103m (111 yds)
DULLINGHAM	10	54		
Dullingham (DH) SB	10	54		TB Dullingham SB (DH)
Dullingham LC (MCG)	10	56		
Single line	11	09		



2.2 Environment

The crossing is located near Dullingham village, on Station Road, next to Dullingham Station. The crossing provides step free access between platforms. The road is rural, giving access to the A1304 from Dullingham village as well as access to the station as shown in *Figure 3*.

Figure 3 Map showing an overview of the location of the crossing



A satellite view of the location is shown in *Figure 4*.

Environmentally significant sites are shown in *Figure 5*. There are several Deciduous Woodland PHIs near to the crossing and there are several Grade II Listed buildings in the village of Dullingham.

Figure 4 Satellite view showing the location of the crossing

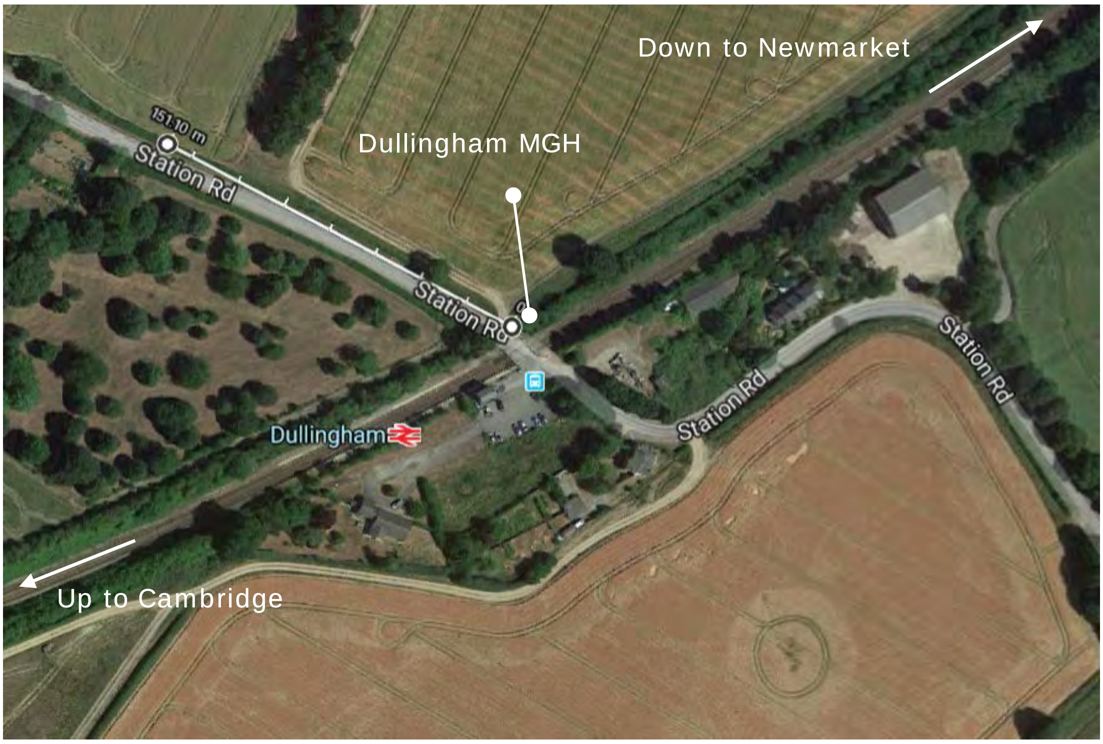
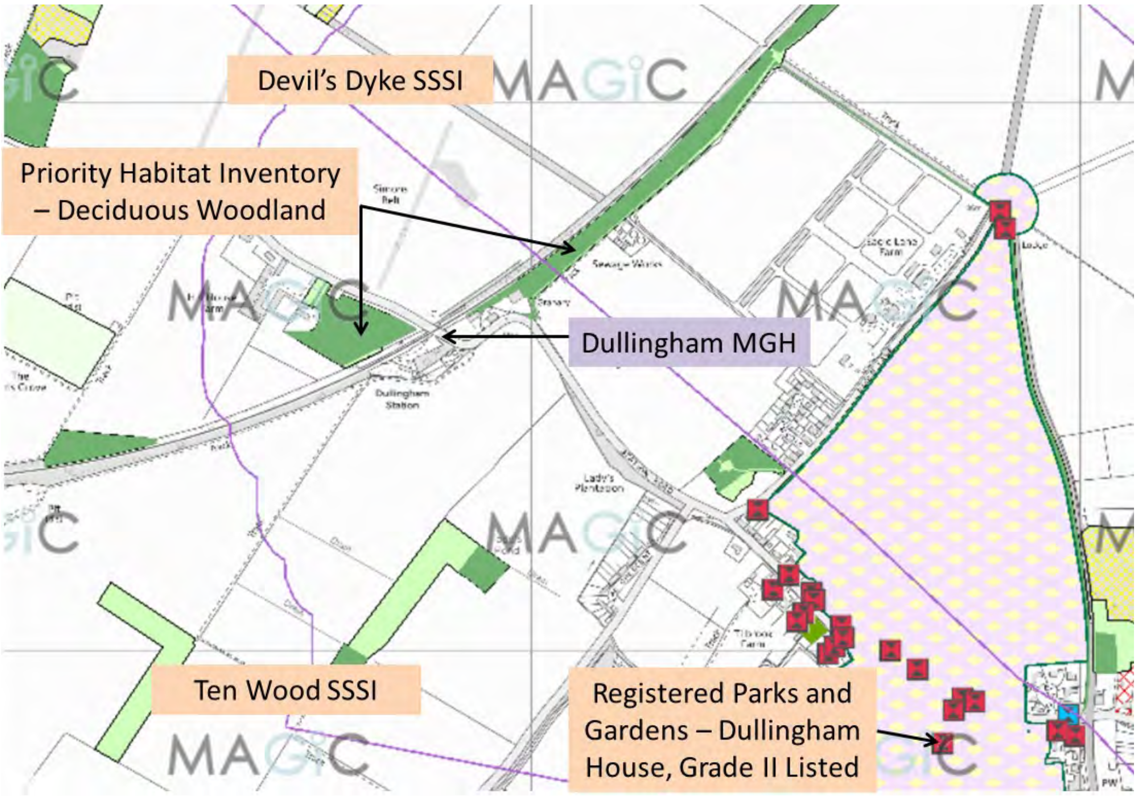


Figure 5 Environmentally significant sites



2.3 Footpath approaches

There are no footways on either sides of the crossing as seen in *Figure 1*, *Figure 6* and *Figure 7*. The barrier to barrier distance is currently 8.3m.

Based upon ORR guidance [1], pedestrian footpaths over crossings are categorised into three classes based upon usage by pedestrians and the frequency of rail traffic. From the guidance, the volume of pedestrian and train flow is determined by the train pedestrian value (TPV). The TPV is the product of the maximum number of pedestrians and the number of trains passing over the crossing within a period of 15 minutes. The TPV at Dullingham, based upon a 9-day census, is 69. This places the crossing in the lowest usage category – category 'C' (the criteria for class C being a TPV of up to 150). In this class, the ORR recommends that the footpaths are 1.5m wide. The ORR also indicates that the footpath width can be reduced to 1.0m where the daily number of pedestrians is less than 25. The census indicates a weekday average pedestrian frequency of 13 and a weekly average of 27, primarily due to the crossing being very busy on the first Saturday of the census.

It should be noted that the pedestrian usage from the train station is limited as normally the platform adjacent to the pedestrian car park is utilised. The platform (the loop line) opposite the station car park is only currently scheduled to be used once per day. If this were changed e.g. due to increased train frequency, the pedestrian usage of the level crossing would be expected to increase commensurately.

If the crossing was upgraded to a full barrier MCB-OD or MCB-CCTV type level crossing, a footway would be required of width 1.5m on the station side in order to comply with ORR guidance.

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1 ORR, Level Crossing: A guide for managers, designers and operators, Railway Safety Publication 7, December 2011.

Figure 6 No footway on west side

Figure 7 No footway on east side

2.4 Road approaches

Road approach to the crossing from the southeast

The key features of the approach are:

1. The road bends sharply 60m before the crossing as shown in *Figure 9* and the crossing is not visible from the distant signage.

2. The crossing comes into view about 65m from the crossing (see *Figure 10*). The road has a speed limit of 60mph, although due to the narrow road, hill and bends near the crossing, observed vehicles were travelling relatively slowly. The 85th percentile vehicle was measured travelling at 38.3mph at the distant signage

3. The entrance to the station car park is just before the crossing, as can be seen in *Figure 12.* This is a potential cause of blocking back as it is a right turn for vehicles that have traversed the crossing. The main car park is well used and is on the same side as the platform normally used, which limits the pedestrian usage of the level crossing. The platform (the loop line) opposite the station car park is only currently scheduled to be used once per day.

4. The crossing is visible from about 65m on the approach.

5. The level crossing signage had good conspicuity at the time of the site visit.

The distant, intermediate and close road approaches from the east are shown in *Figure 9* to *Figure 11*.

A plan of the key features is shown in *Figure 8;* the numbers in the figure refer to the above numbered list of features.

Figure 8 Key features on the southern approach to the crossing

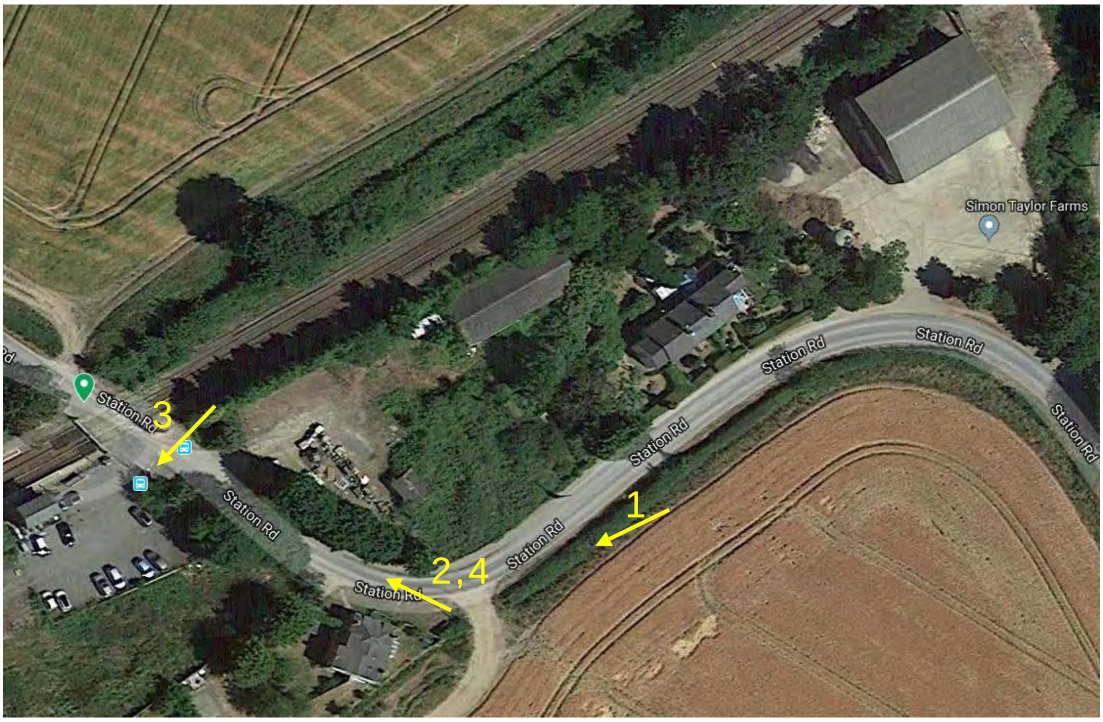


Figure 9 Road approach to crossing (east approach)

Figure 10 Intermediate View of Crossing (east approach)

Figure 11 Near view from Crossing of road approach (east approach)

Figure 12 Station car park entrance

Road approach to the crossing from the northwest

The key features of the approach are:

1. The approach curves gently to the right and runs downhill to the crossing as shown in *Figure 14*. The 85th percentile speed is 28.9mph and the crossing is visible about 160m from the crossing. There is a significant gradient down to the crossing. There is no anti-slip surface to stop cars sliding down hill into the gates on the Down side. This is currently a risk to the signaller operating the gates and will be a potential cause of barrier strikes if the crossing is upgraded.

2. There is a farm entrance with a gate 20m from the crossing as shown in *Figure 17*. A westbound agricultural vehicle stopped while the gate is unlocked could block back vehicles over the crossing although no blocking back was noted in the census.

3. There is a farm entrance 10m from the crossing as shown in *Figure 18*. A westbound agricultural vehicle seeking to turn right into the field could block back vehicles over the crossing although no blocking back was noted in the census.

4. The level crossing signage had good conspicuity at the time of the site visit.

The distant, intermediate and close road approaches from the northwest are shown in *Figure 14* to *Figure 16*.

A plan of the key features is shown in *Figure 13;* the numbers in the figure refer to the above numbered list of features.

Figure 13 Key features on the northern approach to the crossing

Figure 14 Distant View of Crossing (north approach)

Figure 15 Intermediate View of Crossing (north approach)

Figure 16 Near View of Crossing (north approach)

Figure 17 Field entrance 20m beyond crossing

Figure 18 Field entrance 10m beyond crossing

2.5 Impact of low sun on the crossing

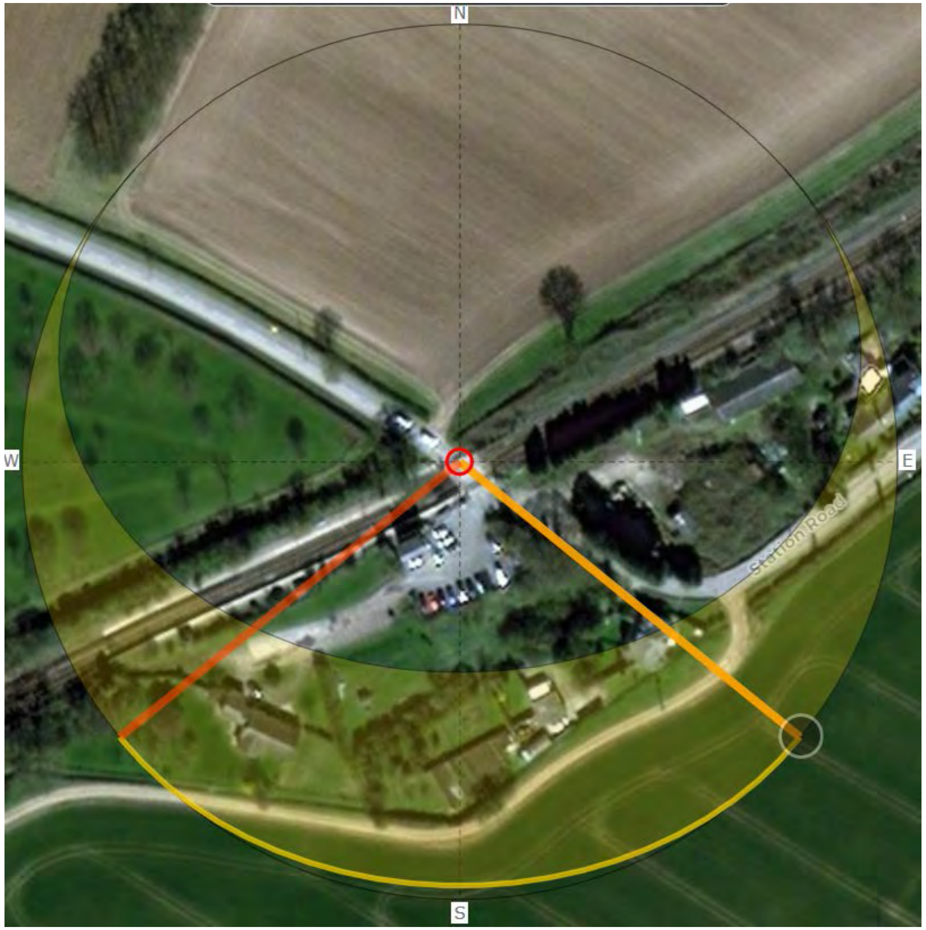
Dullingham level crossing is a northwest-southeast facing crossing (for the road), therefore road users are potentially affected by sun glare.

Below, is the output from the SunCalc application, which has been used to identify the line of the sun at sunrise and sunset at times of year when low sun would align with the road approaches. The shortest and longest day are shown in *Figure 19*.

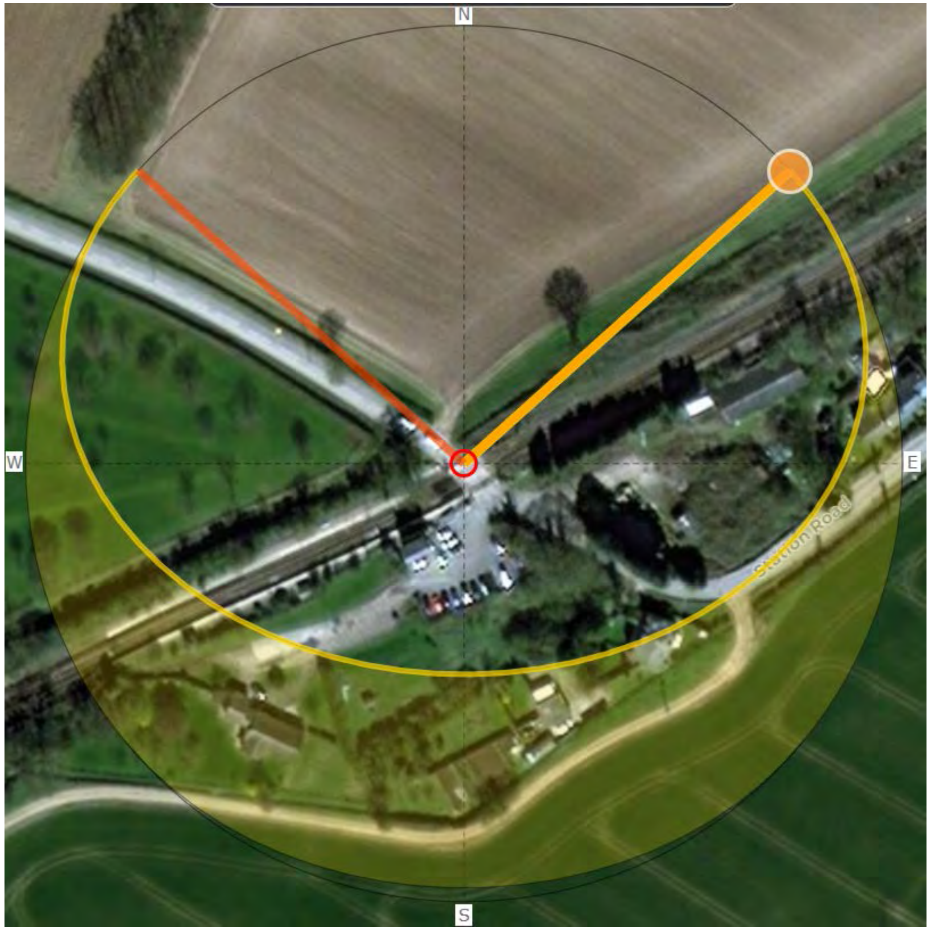
The thin orange curve is the current sun trajectory, and the yellow area around is the variation of sun trajectories during the year. The closer a point is to the centre, the higher is the sun above the horizon.

The yellow line shows the direction of sunrise; the dark orange line the direction of sunset.

Figure 19 Suncalc diagrams



Shortest Day



Longest Day

Northbound approach

There is one potential issue with low sun when approaching the crossing northbound:

1. In the summer, the evening sun would be straight behind the crossing, potentially causing glare. The vehicle approach speed is low as there is a sharp bend in the road in advance of the crossing. The view of the crossing is upwards which exacerbates the effect of low sun. The approach is well lined with trees, which would be in full leaf in summer and the approach is uphill, which facilitates braking.
2. In the winter, the morning sun would shine towards the potential RTLs, potentially washing them out. If upgraded the crossing would be fitted with LED RTLs which would mitigate this hazard.

Southbound approach

There is one potential issue with low sun when approaching the crossing southbound:

1. In the summer, the evening sun would shine towards the crossing and the potential RTLs, potentially washing them out. If upgraded the crossing would be fitted with LED RTLs which would mitigate this hazard.
2. In the winter, the morning sun would be straight behind the crossing, potentially causing glare. The approach is downhill which gives a good background to the crossing but does not facilitate braking.

3 CROSSING USAGE

This section of the risk assessment discusses the current usage of the crossing and its history of accidents and incidents. It then considers proposed and potential future changes to the usage and assesses the safety impact.

3.1 Traffic census

A nine-day, 18-hour traffic census by continuous recording was carried out at the crossing between 20th and 28th April 2013. The following provides a summary of the results obtained of this census.

Train frequency	**Weekday**	34
	Saturday	35
	Sunday	17
Road closure (min:secs)	**Average**	04:25
	Maximum	11:24
Road vehicle frequency	**Busiest day**	851
	Average weekday	713
Blocking Back Observations		None
85th percentile speed (free flowing cars only)	**Eastbound**	28.9
	Westbound	38.3
Pedestrian and cyclist frequency	**Busiest day**	715
	Average week day	33
Train Pedestrian Value (TPV)		69
Pedestrian Category		C

The observed train, vehicle and pedestrian usage is presented in *Table 2* and a comparison with a 30 minute census in 2019 is shown graphically for vehicles in *Figure 20,* and for pedestrians in *Figure 21*.

It is concluded from the 30-minute '*quick*' census that there has not been a major change in usage since 2013.

The notable observations recorded in the report were:

- No Blocking back was observed.

Table 2 Traffic survey observed usage 2013

Census Site 29 - Dullingham Level Crossing			Totals per day											
			Vehicles							Non-vehicles				
Day		No. trains per day	Cars	Vans / small lorries	HGVs	Buses	Tractors	Motor cycles	Total	Pedal cycles	Herded animals and horses	Pedestrians	Total
Saturday	20-Apr-13	35	529	40	3	43	16	6	637	54	0	661	715
Sunday	21-Apr-13	0	467	38	5	16	5	37	568	43	3	10	56
Monday	22-Apr-13	34	614	71	39	4	2	2	732	12	0	15	27
Tuesday	23-Apr-13	34	669	91	42	4	4	6	816	31	0	6	37
Wednesday	24-Apr-13	34	718	94	24	5	2	8	851	19	2	6	27
Thursday	25-Apr-13	33	635	102	38	4	8	10	797	31	0	28	59
Friday	26-Apr-13	36	628	92	19	3	0	7	749	9	0	8	17
Saturday	27-Apr-13	35	478	56	6	3	2	4	549	44	0	6	50
Sunday	28-Apr-13	17	419	29	5	20	4	18	495	52	0	123	175
Highest		36	718	102	42	43	16	37	851	54	3	661	715
7 day average		29	594	76	25	6	3	8	713	28	0	27	56
Weekday average		34	653	90	32	4	3	7	789	20	0	13	33

Figure 20 Comparison to 2019 30 minute census - vehicles

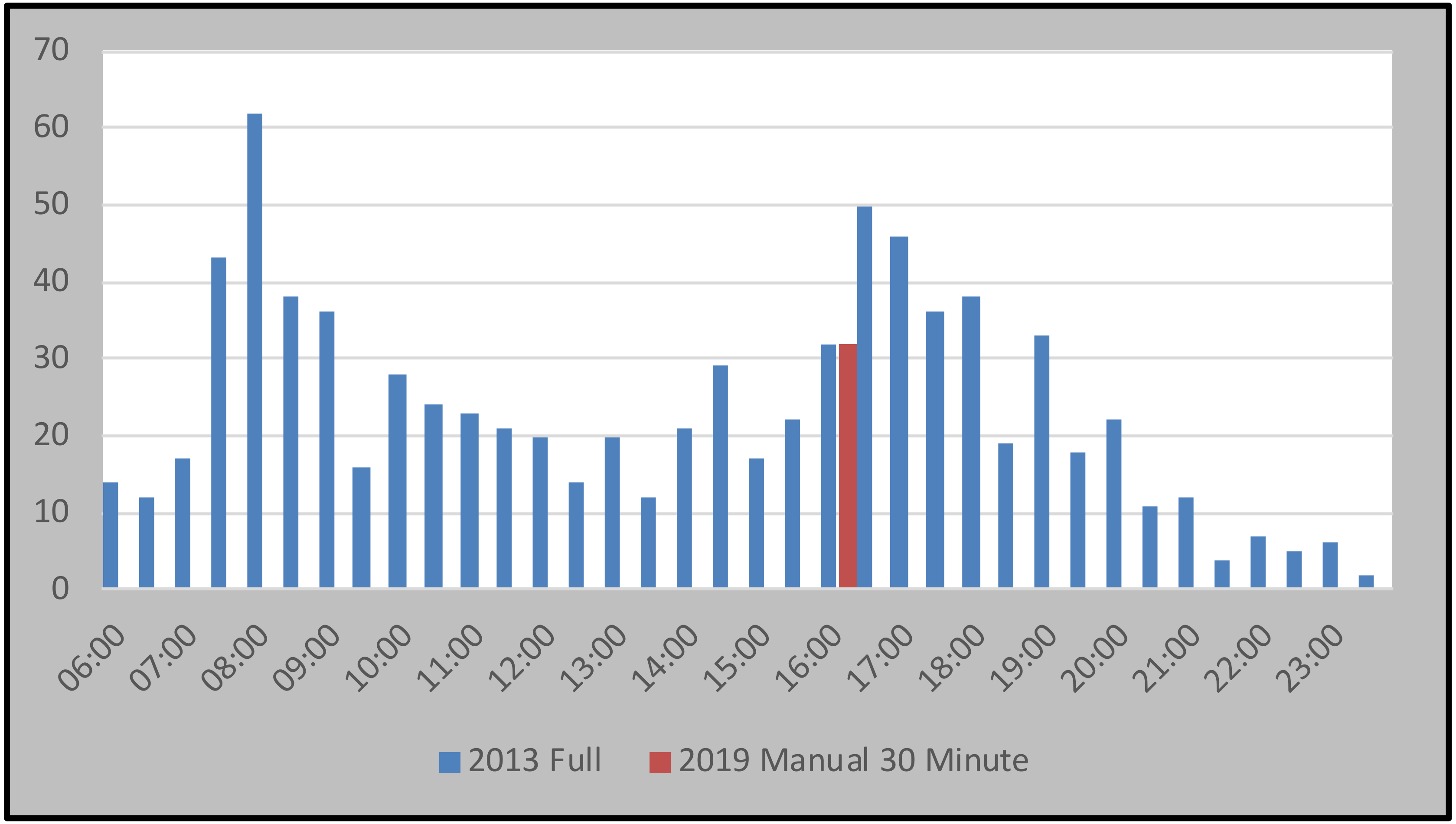
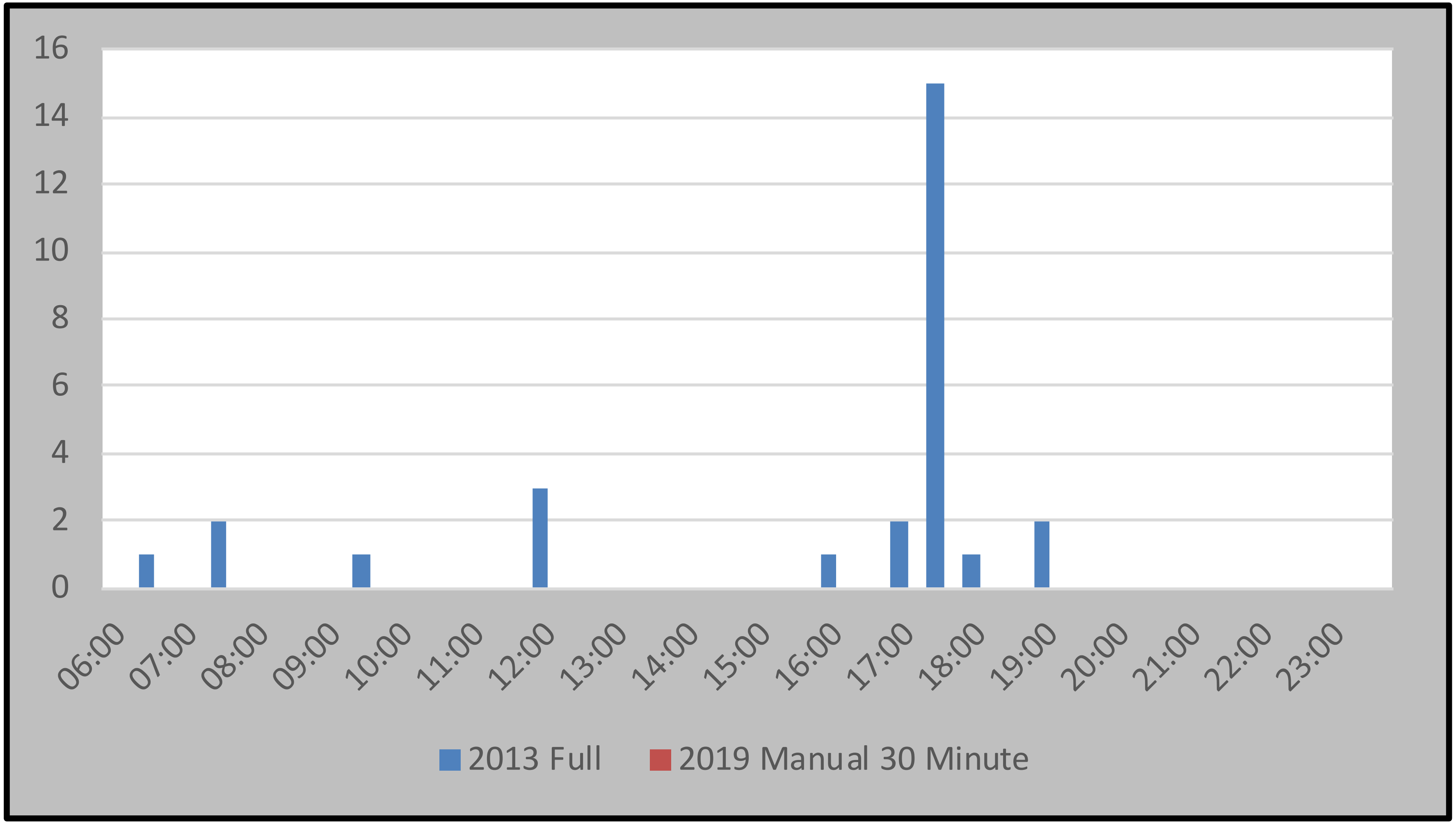


Figure 21 **Comparison to 2019 30 minute census - pedestrians**



3.2 Rail approach and usage

The crossing is located between Coldham Lane Junction and Haughley Junction. The route is single line; however Dullingham station is a passing loop, therefore there are two lines over the crossing. The passing loop is only scheduled to be used once per day. The line is not electrified. It is a moderately used stretch of line with a weekday average of 34 passenger trains per day (17 in each direction). The linespeed in both directions is 60mph on the main line and 40mph on the passing loop (Down direction only). There is no freight traffic over the line.

The Down rail approach

The track is slightly curved in this direction giving the train driver limited advance sighting of the crossing as shown in *Figure 22*.

For trains travelling in the up direction and derailing after hitting a vehicle on the crossing, the station platform could exacerbate the potential derailment consequences. The line speeds are likely to be low due to the station and the location being a passing point on the line, although not all trains stop at the station.

Figure 22 View of Down rail approach (looking towards Coldham Lane Jn)

The Up rail approach to the crossing

The track is also curved in this direction giving the train driver limited advance sighting of the crossing as shown in *Figure 23*.

For trains travelling in the down direction and derailing after hitting a vehicle on the crossing, only the track curvature might result in escalation of the incident.

Figure 23 **View of Up rail approach (looking towards Haughley Junction)**

3.3 Incident / near miss history

Ten years of Incident data have been analysed for the crossing, which was provided by RSSB (the data period ends in August 2016). A summary by incident type is listed in *Table 3*.

The crossing has a lower than average number of near miss/misuse incidents for the crossing type.

It is recognised that not all incidents are reported into RSSB's SMIS database.

Table 3 Summary of Incidents

SMIS classification	Incidents in data set	Average for LC type	Ratio to average for LC type
Train - striking road vehicle or gate at LC	0	0.07	0.00
Train - striking or being struck	0	0.03	0.00
Non-rail vehicles (incl. vehicle on line)	1	0.71	1.40
Person - personal accident	1	0.47	2.11
Level Crossing/LC equipment - misuse/near misses	2	5.04	0.40
Near miss - train with person (not at LC)	0	0.01	0.00
Train - striking animal	0	0.03	0.00
Animals - on the line	0	0.02	0.00
Person - trespass	0	0.05	0.00
Person - vandalism	0	0.08	0.00
Train - signal passed at danger	0	0.02	0.00
Train - running over LC (when unauthorised)	0	0.00	-
Irregular working (pre 25/11/2006)	0	0.06	0.00
Irregular Working	0	0.21	0.00
Level crossing - equipment failure	1	2.02	0.50
Signalling system - failure	0	0.04	0.00
Permanent way or works - failure	0	0.01	0.00
All incidents	5	9.02	**0.55**

Note, the data in this table is not normalised, therefore a crossing with high use would generally be expected to have higher ratios.

The following incidents are noteworthy at the crossing:

- Two incidents of pedestrian misuse including one where a man got his foot stuck in a cattle grid;
- An incident where a young girl tripped and fell over;
- An incident of a car breakdown on the crossing.

- A car drove at the gate as the crossing keeper was closing it.

More recent SMIS data, for one year to 13th March 2019, shows an incident where a passenger crossed the line in front of the train at Dullingham Station (18/03/18).

3.4 Future demand and use of the level crossing

Any decision to install a level crossing needs to account for both the current use and any reasonably foreseeable increase in future demand that may affect the risk to passengers and the public.

Key factors that can affect the future use are:

- Planned increases to train services or train speeds;
- Local developments (e.g. opening schools, retail outlets, factories);
- Closure of adjacent level crossings, meaning that the road and pedestrian traffic of any closed crossings now use the one subject to assessment.

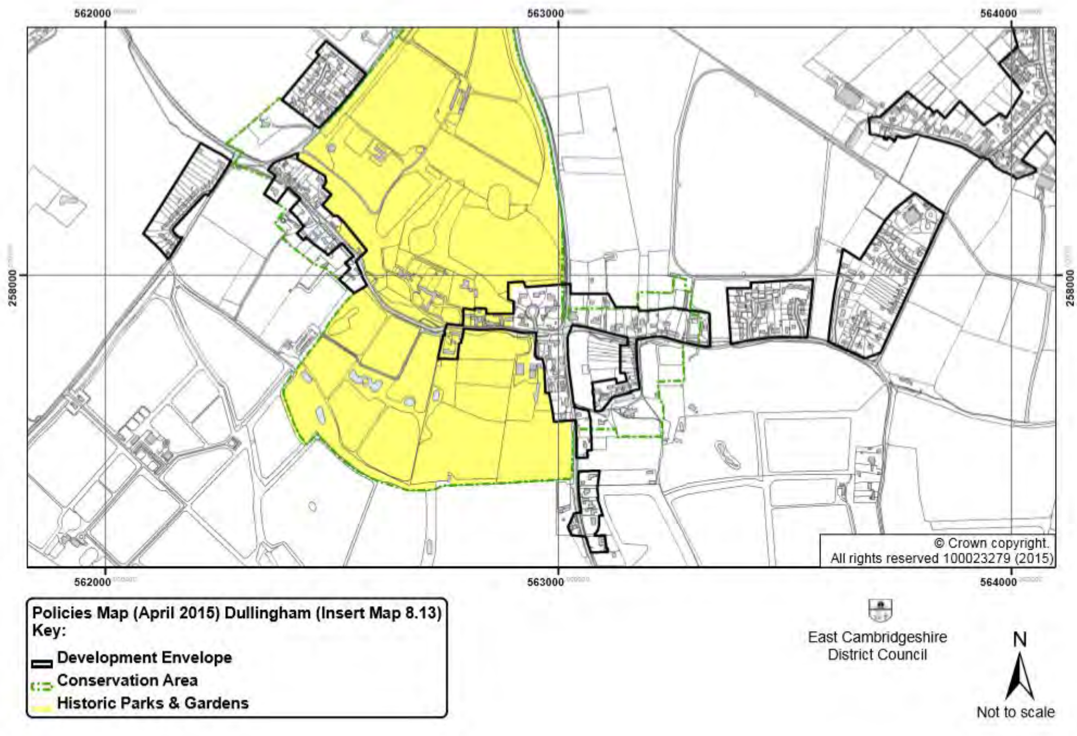
Little development is planned for the Dullingham area, as is shown in *Figure 24*, with only about 12 dwellings expected to be permitted [9].

There are no planned changes to the frequency of train service.

The level of use of Dullingham crossing by trains, and pedestrians is relatively low for the type, the use by road vehicles is fairly average; a modest future increase in use would, therefore, not mean that the level crossing is unsuitable at the location.

It is important, as for all level crossings, that Network Rail ensures it is consulted about any change of use for the businesses and area adjoining the crossing and seeks compensation for further upgrade should anything be proposed which would significantly increase the usage of the crossing.

Figure 24 East Cambridgeshire District Council Policies Map of Dullingham



Road closure time predictions

Road closure time is an important parameter that impacts level crossing risk as well as utility. This is because a high road closure time can cause aggravation and frustration for users which can lead to increased misuse.

Sotera has used a fairly simple model to estimate the potential impact of any upgrade to an MCB-type fall barrier crossing (MCB-OD or MCB-CCTV). For Dullingham, this suggests that the busiest hour road closure time would decrease from about 23% now (as an MGH level crossing) to about 16%.

4 OPTIONS ASSESSMENT

Sotera carried out an initial assessment of options for the crossing, which was then reviewed and updated in a workshop with Network Rail staff. The results of the assessment are described in this section.

4.1 Options assessment workshop

The attendees of the workshop at One Stratford Place on 8th April 2019 were as follows.

Present	Role
Ray Spence	Senior Delivery Manager
Charles Muriu	Asset Engineer
Nathan Garratt	DPE
Brendan Lister	LCM
Ben Chipman	Level Crossing Designer
Huma Hameed	Scheme Project Manager
Chris Chapman	Sotera, Workshop Chair
David Harris	Sotera, Workshop Secretary

4.2 Options for closure or alternate level crossing designs

Options Assessment

The following options were considered:

- Crossing closure (via diversions);
- Crossing closure with a pedestrian bridge only provided;
- Crossing closure with an underpass for road vehicles and pedestrians;
- Crossing closure with a full road bridge provided and accessible bridge or underpass to retain pedestrian access at Dullingham station;
- Retain 'As-Is' as MGH type;
- Renew as ABCL;
- Renew as an automatic full barrier (AHB+);
- Upgrade to an MCB-CCTV or MCB-OD, which provide the highest level of protection as a level crossing.

Table 4 provides a summary of the results of the workshop. The main arguments are then discussed below.

In the table the residual safety risk of each option has been converted into monetised safety cost in Net Present Value (NPV) terms over the life of the crossing. This is based on the VpF for 2018 published by RSSB and a safety discount rate of 1.5%. It represents the total financial value of safety for accidents at the crossing over a life of 30 years should that option be pursued. It includes minor (injury) accidents such as slips, trips and falls as well as more serious accidents involving vehicles or pedestrians being struck by trains.

Table 4 Closure / level crossing type assessment

Option/ Crossing type	ALCRM 2019 usage			Feasibility	Cost		Justification for cost estimate
	FWI	Score	NPV (30)		Capital	Annual	
Current crossing type (MGH)	3.3 E-4	H6	£15,530	Life-for-like renewal or retaining 'As-Is' provides a low level of safety risk but incurs large operational costs due to the requirement to attend the crossing. There is a significant risk to the signaller particularly considering the downhill approach on the Down side, which is not included in the risk calculated by ALCRM. Signal box is being closed so not likely to retain current type. Polo club in vicinity drives intermittent use, also use this for music festivals.		£200,000	Standard cost, if renewal is required. SICA Renewal date: 2023
Closure	0		£0	Closure of the crossing is not a viable option for the following reasons: - Closure would introduce a detour of approximately 6 miles for users to get from one side of Dullingham station to the other - It is the only means of crossing the line at the station			
Closure + pedestrian bridge	0		£0	Main use is road vehicles so would not enable closure.			

Option/ Crossing type	ALCRM			Feasibility	Cost		Justification for cost estimate
	2019 usage						
	FWI	Score	NPV (30)		Capital	Annual	
Closure + road bridge (in-situ)	0		£0	The road is on a bend and a significant slope, therefore a bridge would be an expensive option. The relatively narrow road would also cause difficulty with arranging access to the station. Hence this is not a viable option. May be a possible scheme with an underpass or accessible bridge to the northeast of the station but would be a major build.	£12m		£7m for bridge + £3m for accessible bridge or underpass + £2m for link roads and land purchase
Closure + underpass	0		£0	No advantages over bridge above and towards the base of the hill would be subject to flood risk.			
Closure with off-line bridge	0		£0	Likely to be feasible off-line to the northeast Likely require ramped bridge for cross platform access	£12m		Assume: Road bridge £7m Link road 600m at £3k per m assumed Plus land purchase Plus pedestrian ramped bridge (£3m)
ABCL	-	-	-	Not a viable option as would introduce a significant increase in risk and enable trespass to the station platforms. ABCL additionally would require a line speed reduction, although this may not be a practical issue due to the location at the station.	£1,336,708	£16,933	

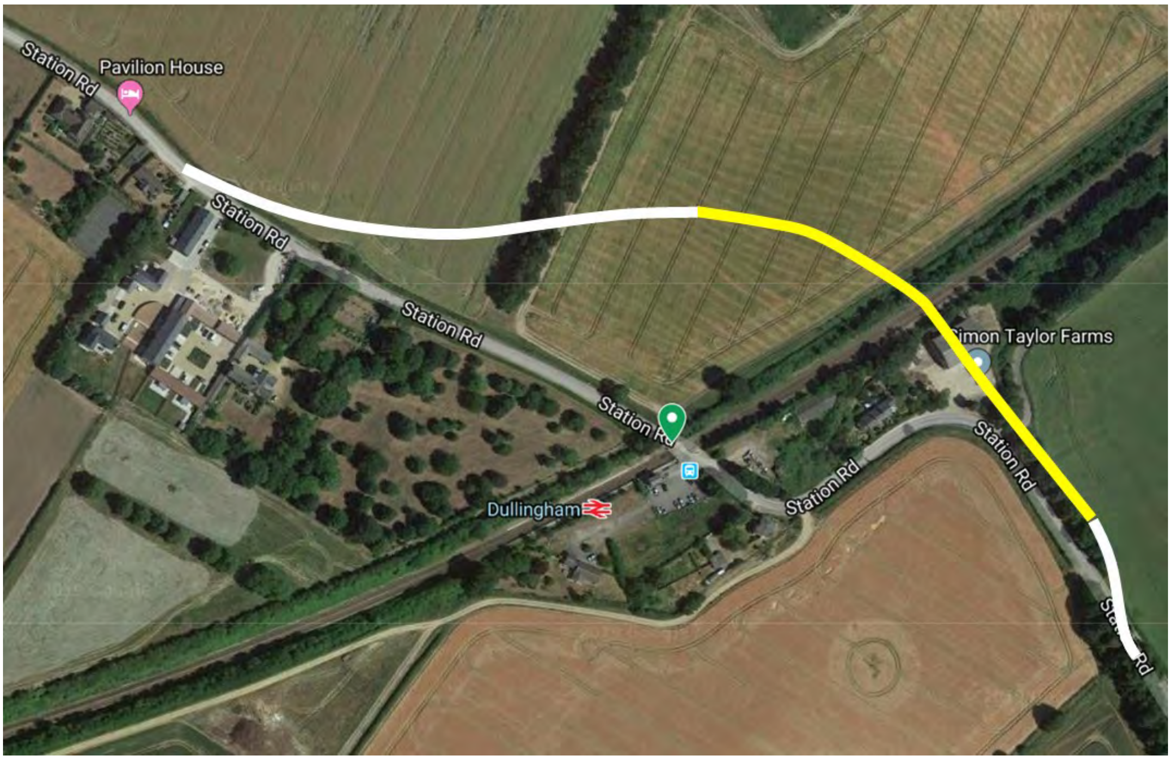
Option/ Crossing type	ALCRM			Feasibility	Cost		Justification for cost estimate
	2019 usage						
	FWI	Score	NPV (30)		Capital	Annual	
AHB+	-	-	-	The suitability of AHB+ at a station would be in doubt due to the incentive for pedestrians to cross to the opposite platform Not a type approved option and the Cambridge project is too sensitive to accommodate a trial site.			
MCB-CCTV	1.4 E-4	J6	£6,747	Feasible, and would enable a linespeed increase. Additional protecting signals may be required. Would need to risk assess the signal on the loop line as is 23m from the crossing. It should be noted that there is only one scheduled use of the loop line per day. Will need to determine whether platform length is sufficient - likely OK if only 3 car service. The southern platform (which is bi-directionally signalled) is shorter. Based on current signalling, the nearest mainline signal for the Down direction is at 1129m from the crossing – new signal required. The Up protecting signal is just over 600m but cannot be moved any closer to the crossing as it is at a junction.	£2,989,316	£54,265	CP6 standard renewal costs, 2.5 x SEUs assumed for additional end of platform signal CA427 and to upgrade CA425 on the loop line to three aspect. This would still leave CA428 in a non-compliant location 692m from the level crossing.

Option/ Crossing type	ALCRM 2019 usage			Feasibility	Cost		Justification for cost estimate
	FWI	Score	NPV (30)		Capital	Annual	
MCB-OD	1.4 E-4	J6	£6,747	Feasible. Additional protecting signals would be required as per MCB-CCTV. Profile may be an issue, but less so if MCB-OD Mk. 2 used. Would need to consider the signal on the loop line as is 23m from the crossing. On normal line there is no signal between the platform and the level crossing. Will need to determine whether platform length is sufficient if an additional signal was put in. The southern platform (which is bi-directionally signalled) is shorter. Likely need land purchase and moving vehicular access to station to provide space for MCB-OD equipment; might drive CCTV rather than MCB-OD or might need to look at extending the car park	£3,157,532	£20,154	CP6 standard renewal costs, 2.5 x SEUs assumed for additional end of platform signal CA427 and to upgrade CA425 on the loop line to three aspect. This would still leave CA428 in a non-compliant location 692m from the level crossing.

4.3 Conclusions regarding closure of the crossing

The first priority should be to close the crossing where possible. The only option identified that could be feasible is a major scheme to bypass the existing crossing with new link roads and provide step free access at the Dullingham station with an accessible bridge or underpass (*Figure 25*).

Figure 25 Scheme to close Dullingham level crossing



Since this scheme would likely cost £12m or more, the cost would be grossly disproportionate to the safety benefit compared with the alternative of renewing Dullingham as MCB-OD with a cost of about £3.2m and a moderate residual risk.

Significant train frequency increases are not expected at this location and a road closure time of about 16% in the busiest hour for an MCB-CCTV or MCB-OD type crossing would be sustainable.

It is, therefore, concluded that whilst closure of the crossing could be feasible, crossing renewal provides a more viable and cost-effective option.

4.4 Conclusion about crossing type

Retaining an MGH crossing would not be the preferred option as it presents a high operational cost with the need to maintain a crossing keeper on site and its location towards the base of a hill presents a hazard from vehicle strike to the crossing keeper.

An automatic full barrier (AHB+) type crossing is not likely to be a viable option at this location due to the incentive for pedestrians to cross to the opposite platform. This type of crossing also does not have type approval.

The preferred option is therefore to renew the crossing as MCB-CCTV or MCB-OD; both of these crossing types would offer significant risk reduction compared with MGH from 3.3×10^{-4} to 1.4×10^{-4} FWI per year.

The crossing is just outside the 20km Cambridge MERLIN radio telescope planning zone so there are no issues with providing MCB-OD Mk. 1; the Mk. 2 MCB-OD units are understood to be even be less problematic in this respect should they be available and have type approval in time for this project.

The choice between MCB-OD and MCB-CCTV is therefore likely to be made on the basis of feasibility, signaller workload, road closure time and cost. The space available for the location of equipment is also a consideration as this could be somewhat constrained at this crossing unless the station car park can be extended.

New protecting signals will be required for this crossing whichever option is taken. There is a particular need to risk assess (using SORAT-LX) the signal on the loop line as it is only 23m from the crossing. It should however be noted that there is only one scheduled use of the loop line per day. It will also need to determined whether the platform length is sufficient as it is only thought to be suitable for a 3 car service. The southern platform (which is bi-directionally signalled) is shorter. Based on current signalling, the nearest mainline signal for the Down direction is at 1129m from the crossing and, therefore, a new signal is required. The Up protecting signal is just over 600m but cannot be moved any closer to the crossing as it is at a junction.

4.5 Options for additional controls

The key level crossing hazards at the crossing have been considered to determine what additional controls should be provided upon renewal (see *Table 5*).

The additional controls identified for consideration include:

- The road approach to the crossing is downhill on the Down side giving an elevated risk of misuse, late braking and barrier strikes. Additional controls to consider include an anti-slip road surface, count down markers and low cost VASs.

- SORAT-LX should be utilised to assess potential risk mitigations for the Down protecting signals on the normal and loop lines.
- '*Keep clear*' markings should be made in front of the station car park entrance.
- Trespass guards and fencing to minimise the potential for pedestrians to cross to the opposite platform.
- New pedestrian footway 1.5m in width on the station side with tactile edges at either end.
- Standing red man indications facing the pedestrian route from the platform exits.
- Additional RTL facing station car park exit when details of the ground plan are known.
- Improved drainage to ensure that water and debris running down the hill on the Down side does not collect on the crossing.
- A pavement on the station car park side for pedestrian access if there is space available.

Table 5 Assessment of additional controls

Hazard	Comment	Standard/existing controls	Potential additional controls	Feasibility	Cost	Recommend
SPAD on Signal on loop line	Loop line only currently scheduled to be used once per day Currently signal is 23m from level crossing but it is proposed to move it to 25m TPWS TSS		TPWS -OSS, SPAD prediction	May be problematic as would need to extend the platform and embankment slippage makes this difficult		Use SORAT-LX to consider mitigations
SPAD on Signal on normal line	Planned to put signal 25m from level crossing		TPWS-TSS, TPWS-OSS, SPAD prediction			Use SORAT-LX to consider mitigations
Up side RTLs visible from less than 70m due to bend in road	Sharp bend in road means that there is a low speed approach.		Count down markers			Consider - likely prefer VAS
			VAS			Consider (low cost VAS)
Vehicle fails to stop down hill		Signage	Anti-slip road surface	Yes if agreed with highways authority	£6k	Recommend
Blocking back due to access to station car park	LCM has never seen this	Audible warnings, RTLs, OD/CCTV monitoring	Keep clear sign	Feasible	£2500	'Keep clear' markings in front of station car park
			Yellow box	Yes		Yes (standard for MCB-OD)

Hazard	Comment	Standard/existing controls	Potential additional controls	Feasibility	Cost	Recommend
Deliberate misuse to access platforms		Trespass guards, CCTV monitoring/obstacle detection	Trespass guards and fencing already provide good protection.			Trespass guards and fencing to be maintained.
Deliberate RV misuse of crossing		Red light enforcement cameras	Red light enforcement camera	Feasible	£150k	No. Misuse is not sufficiently prevalent to warrant investment.
Pedestrian struck by barriers			Tactile edging for visually impaired	Yes	Minimal	Tactile edging on station side due to cross platform access Note: gate off end of platform ramp
Inadequate separation of public and road vehicles			There is currently no designated pedestrian path over the crossing, one would have to be commissioned to change platforms, rather than making pedestrians walk on the road. New footpath 1.5m in width on the station side would be required.	Yes	£10k	New pedestrian footway 1.5m in width on the station side
Accidental misuse - RTLs hard to observe from platform exits		Audible warnings	Standing red man	Yes	1,000	Standing red man indications facing route from platform exits

Hazard	Comment	Standard/existing controls	Potential additional controls	Feasibility	Cost	Recommend
Accidental misuse - RTLs hard to observe from station car park exit		Audible warnings	Additional RTL	Yes	£10k	Consider additional RTL facing station car park exit when details of the ground plan are known
Drainage	Flooding / debris problems due to rain running down road. Signaller cleans flangeway out regularly - this will be lost on closing signalbox		Improved drainage	Yes		Improved drainage required to prevent debris running onto crossing
Pedestrian access			Pavement on road	Maybe		Consider providing a pavement on the station car park side for pedestrian access

4.6 Assessment of the costs and benefits of Lower LIDAR

Network Rail has developed an assessment tool [9] to calculate the benefits of the provision of Lower LIDAR at MCB-OD level crossings. The rationale for undertaking the assessment is that the Lower LIDAR, whilst providing some additional safety benefit, reduces the overall reliability of the crossing with a knock-on impact for delaying trains. The system also has associated capital and maintenance costs. The capital cost can be very high for some crossings due to the stringent demands it places on the flatness of the road profile.

The project currently anticipates that it will use the Mk. 2 version of MCB-OD, although this currently does not have type approval. It is expected that the Mk. 2 system will not require LIDAR as the RADAR would be configured to provide equivalent functionality. An assessment of lower LIDAR is however made in case the Mk. 2 system is not available or does not obviate the need for LIDAR.

The Costs of Lower LIDAR

Based upon accepted Network Rail HQ costs and adjustments [8], the costs for providing Lower LIDAR are taken to be as shown in *Table 6*.

Table 6 Assumed Lower LIDAR costs

Type of cost	Costs	
	Low Level LIDAR Child vulnerable user group (175mm beam height)	**Low Level LIDAR Adult (elderly) vulnerable user group (280m m beam height)**
Materials	£17,141	£17,141
Installation and set up	£8,206	£8,206
Civils work	£site specific, may be zero	£site specific, may be zero
Maintenance costs - attending failure (over 30 year asset life)	£17,987	£17,987
Faulting / local control over (30 years asset life)	£17,987	£8,993
Total cost associated with Lower LIDAR	£61,321 + Civils work	£52,327 + Civils work

No civil engineering or train delay cost estimate for Lower LIDAR is available currently; therefore, in order to provide an onerous assessment case these have been assumed to be zero.

The benefits of Lower LIDAR

The key inputs to and outputs from the numerical assessment are as follows:

Inputs		
Recommended height setting		Adult
Train frequency per day		35
Pedestrians per day		28
Cycles per day		28
Motorcycles per day		8
Other road vehicles per day		710
Crossing is at a station		Y
If at a station, the number of stopping trains per day		20
Is line speed at the crossing 20mph or less?		N
Outputs		
Safety benefit	**FWI per year**	1.12E-04
	NPV_{30}	£4,500
Cost	**NPV_{30}**	£52,327
Safety benefit to cost ratio over 30 years		0.09

From these inputs, the current safety benefit of the Lower LIDAR is 1.1 x 10^{-4} FWI per year. This is equivalent to a monetised benefit over 30 years of £4,500.

Lower LIDAR – comparing costs and benefits

The estimated cost of Lower LIDAR at this crossing is at least £52,327 over the life of the asset. It is considered that the crossing is likely to have very low usage by unaccompanied children, so it is assumed not to require the lower height setting; the safety benefit is approximately £4,500. The benefit to cost ratio for providing Lower LIDAR is just 0.09, subject to there not being significant civils cost, which suggests that the cost of providing Lower LIDAR is grossly disproportionate to the safety benefit according to the guidance [8] that *"If above 0.5 Lower LIDAR should be considered. Lower LIDAR may be considered if below 0.5 where there are significant hazards unmitigated"*.

Lower LIDAR risk factors

The tool [9] for the assessment of the benefits to pedestrian slip, trip or fall risk from Lower LIDAR identifies a range of potential local hazards related to the causation of users slipping, tripping or falling on the crossing. This set of hazards has been reviewed and supplemented by Sotera and is considered to represent a fairly comprehensive set of pedestrian slip, trip or fall hazards (some however appear to have only limited relevance to pedestrian slip, trip or fall) but one, relating to equestrian use has been added. Each hazard has been considered in relation to the crossing based upon the site visit and traffic census to determine the potential significance of each hazard based upon the crossing features; it was then discussed in the risk workshop and additional controls considered. Each hazard has been rated as to its significance based upon the tool's three-point rating scale of 'Major', 'Minor' or 'No'.

In assessing whether additional control measures are required, both the rating and the overall level of risk have been considered. Where mitigation is suggested, the post-mitigation risk rating is also provided.

The full list of hazards, ratings and crossing specific comments are presented in *Table 8*. This assumes that the crossing is maintained in good condition over its full life.

The following additional controls are recommended for consideration:

- Improved drainage to ensure that water and debris running down the hill on the down side does not collect on the crossing.
- At least one new footway that meets ORR guidance width of 1.5m along entire length on the station side.
- Manning the crossing if particularly high pedestrian usage is expected for events at the polo club.

Table 7 summarises the number of hazards afforded each rating before and after the proposed additional controls.

Table 7 Number of Pedestrian slip, trip or fall hazards

Hazard rating	Number of hazards afforded stated rating	
	Number before additional mitigation	Number after proposed additional mitigation
Major	0	0
Minor	9	7

Conclusion about Lower LIDAR

Lower LIDAR is not justified at this crossing as the safety benefit to cost ratio is less than 0.5 and there are no '*Major*' ranked hazards that cannot be mitigated.

Table 8 Lower LIDAR Hazards

Ref:	Topic	Hazards	Site comments	Possible additional controls	Rating pre-mitigation	Rating post-mitigation
Topographic/physical features						
1	Surface	Slippery surface	No specific objects likely to cause slip hazard. No existing footway across crossing.		No	No
2	Surface	Uneven surface, differential height of slabs, gaps between panels, holes in asphalt, subsided surface	Some undulations going across deck.	New level deck	Minor	No
3	Surface - loose material	Mud in rural areas, gravel	No existing footways or loose material in run off areas	Improved footway over whole crossing length	Minor	No
4	Surface – drainage	Pooling of water following rain	Water runs downhill onto crossing - so flooding and debris is an issue	Improved road and track drainage would reduce flooding on the crossing	Minor	Minor
5	Surface - flange gap	Degradation of flange gap - bicycle wheels trapped, trip hazard for pedestrians	To standards		No	No
6	Layout – bend	Level crossing on bend	Bend 70m away on Up side		No	No
7	Layout - skew	Direction of users traverse not orthogonal to tracks. Increased traverse time where skew is significant.	Road is 30 degrees off perpendicular to the rails.		Minor	Minor
8	Layout / environment / conspicuity	Extraneous light and noise sources, short approach, no	Crossing is conspicuous on both approach, audible warnings are of sufficient volume for the small crossing		Minor	Minor

Ref:	Topic	Hazards	Site comments	Possible additional controls	Rating pre-mitigation	Rating post-mitigation
		audible alarm (or hard to hear), poor conspicuity	area. Potential distractions from the station and adjacent station car park.			
9	Gradient / profile	Crossing on a raised profile (gradient up or down to crossing). Crossing itself on a gradient	Road runs down to the crossing on Down side. Crossing is relatively flat		No	No
10	Footpath width and road width	Narrow footpath, or narrow roadway meaning less space for pedestrians	Footways meet ORR guidance for footpath width.		No	No
11	Pedestrian walkway - edging	Poor marking of edge of crossing / railway	No footways currently and at least one footway will be required on the station side - ORR guidance suggests the footway should be od 1.5m in width.		No	No
12	Pedestrian walkway - obstacles	Posts, fencing, etc protrudes into walkway	No footways currently	Installation of MCB-OD crossing will remove all objects from new footway	No	No
13	Lighting	Low levels of lighting in hours of darkness	The crossing is lit by the adjacent platform lighting. Footway should be lit to the same standard as the station.	Low lux lighting	Minor	Minor
Pedestrian vulnerability factors						
14	Vulnerable - elderly	Used by large numbers of elderly people	The census identified no use by this group. The crossing is at a station so there will be a range of users.		No	No
15	Encumbered – push chairs,	Used by large numbers of adults with push chairs, and/ or lots of travellers	The census identified no use by this group. The crossing is at a station so there will be a range of users.		No	No

Ref:	Topic	Hazards	Site comments	Possible additional controls	Rating pre-mitigation	Rating post-mitigation
	luggage / baggage					
16	Encumbered - dogs	Used by high proportion of dog walkers	The census identified no use by this group. There are no specific environs that would encourage a particular user group.		No	No
17	Vulnerable – cognitive impairment	Large proportion of users with reduced cognitive capability	The census identified no use by this group. There are no specific environs that would encourage a particular user group.		No	No
18	Vulnerable – other mobility impaired	Large proportion of users with impaired mobility including wheelchair users	The census identified no use by this group. The crossing is at a station so there will be a range of users.		No	No
19	Vulnerable – unaccompanied children	Used by large numbers of school children who are not accompanied by adults	The census identified no use by this group. There are no specific environs that would encourage a particular user group.		No	No
20	Impaired users	Users under the influence of alcohol	The census identified no use by this group. There are no specific environs that would encourage a particular user group.		No	No
N/A	Equestrian use	Person thrown from horse	Some use by equestrian users identified		Minor	Minor

Ref:	Topic	Hazards	Site comments	Possible additional controls	Rating pre-mitigation	Rating post-mitigation
Operational factors						
21	Event hazard	Local event promotes high temporary use of the crossing	Polo club events can drive significant pedestrian usage, especially when the location is used for music festivals.	Manning the crossing during events	Minor	Minor
22	Seasonal hazard	Weather - icy road	Is located on a primary gritting route, but snow and ice is a particular hazard due to the steep hill.		Minor	Minor

4.7 MCB-OD Configuration factors

There are a number of design parameters for the MCB-OD system that can be modified to help manage particular hazards at a crossing. Sotera has considered these and they were further assessed in the workshop. This process is documented in *Table 9*.

No firm recommendations are made as the designer would prefer flexibility to make the design decisions to manage the hazards in the most appropriate way, however key considerations for this crossing are listed as follows:

- *Blocking back.* Whist there is no known issue with blocking back currently, the right turn into the car park could provide possible source of blocking back. BPM could therefore be a consideration to manage this although the normal BPM criteria are not met.
- *Anti-trapping delay in lowering and pausing of the exit barriers.* There is some potential for vulnerable use coinciding with use of the loop line platform, however this is only scheduled once per day. Hence an extended anti-trapping delay is not likely to be necessary but should be considered during detailed design.
- *Enhanced OD Control of Barriers Lowering.* This provides an alternative mitigation to increasing the anti-trapping delay. This might particularly be a consideration should BPM also be provided as it utilises the same circuitry, although it can lead to increased misuse. Consider during detailed design, but no specific reason for fitting has been identified.
- *Amber phase duration.* The crossing is has moderate road approach speed but there is a downhill approach on the Down side, which give rise to an increased risk of vehicles failing to brake in time for the crossing. Methods of managing this should be considered and a consideration would be to extend the amber phase of the crossing sequence beyond the default of 3s. The Down side of this would be a slightly increased road closure time; this is not, however, likely to be particularly problematic at this crossing. Consider during detailed design, but no specific justification for extending has been identified.
- *Response time and number of available attendants for CCU operation should it be necessary.* A crossing attendant is likely to come from Cambridge depot and more likely to approach from the Down side and this is, therefore, the preferred location of the CCU.

Table 9 Review of MCB-OD configuration factors

MCB-OD configuration factor	Hazards	Consideration at level crossing	Recommended
Minimum Road Open time (MROT) Default of 10 seconds from when the barriers are fully raised until the amber light coming on for a new closure	**Lower MROT**: May cause entrapment - large queues of pedestrians not having time to cross, eg, at a station. **Higher MROT**: Increasing closure time, higher chance of second train coming - may lead to frustration and misuse.	The crossing generally has low pedestrian use (a seven day average of 27 pedestrian a day). Moderate vehicular use (less than 100 per day). One day was much busier than all the others with 661 pedestrians, perhaps coinciding with an event at the polo club. The busiest 15 minutes slot was 69 pedestrians Despite the station, the usage is not so high that there would be large groups of passengers disembarking the trains and using the crossing at the same time. The station car park is on the same side as the normal platform so train arrival does not tend to give rise to significant surge in pedestrian use. Hence it is not recommended that the MROT is extended.	No
Fitting of BPM at exit barriers or at the exit and entrance barriers. Default is fitment but can be removed based on blocking back survey and assessment of likely hazards to the barrier.	**Provision of BPM:** Manages blocking back risk	The 9-day traffic census did not identify any occurrences of 'blocking back'. Right turns into station car park could lead to barrier strikes so consideration could be given to BPM.	Consider due to turns into car park

MCB-OD configuration factor	Hazards	Consideration at level crossing	Recommended
Default time at which time barriers lower (30 secs). Exit barriers at 4 barrier crossing.	Blocking back for extended durations	No blocking back has been identified from the census. Extending the default time is not recommended.	No
Fitting of lower LIDAR. Default is fitment but can be removed based on risk assessment. LIDAR height – adult or child	Person (pedestrian, cyclist, motorcyclist) incapacitated on crossing.	See separate lower LIDAR risk assessment	Not justified
Minimise distance between barriers	Long traverse at skew crossing giving rise to entrapment risk.	The existing distance barrier-to-barrier is approximately 8.6m as there is no skew (also operated as MGH crossing currently). Minimising distance always preferred.	No
Anti-trapping delay in lowering and pausing of the exit barriers (default is up to 10 seconds)	Long traverse distance Slow, encumbered or vulnerable users	Barrier to barrier distance is 8.6m and so the crossing distance is relatively short. No breakdown by vulnerable groups in census (2013). The car park is on the same side as the normal platform. There is some potential for vulnerable use when the loop line platform is used, however this is only scheduled once per day. Hence an extended anti-trapping delay is not likely to be necessary but should be considered during detailed design.	Consider during design, but no specific reason for this is identified
Enhanced OD Control of Barriers Lowering. There is an option to also require the OD system (i.e. POD and COD) to be clear in order to allow the lowering of any barrier pair (similar to BPM).	Long traverse distance (> 39m, or where BPM also provided) Entrapment	Short distance only. No reason identified for this at this crossing.	Consider during design, but no specific reason

MCB-OD configuration factor	Hazards	Consideration at level crossing	Recommended
			for this is identified
Hurry call systems integrating with highway traffic lights	Traffic congestion caused by nearby highway traffic lights.	No nearby traffic lights	No
Lengthen the amber phase. Default is 3 seconds	Amber sequence provides inadequate warning - high road approach speeds, difficulty braking, high use by large vehicles.	The 85th percentile road vehicle speeds for westbound traffic is 38.3mph, the eastbound direction is 28.9mph. Moderate road approach speeds. Consider due to downhill approach.	Consider
Sacrificial RADAR reflectors	Road vehicles accidentally driven down the railway, e.g. high skew or Sat. Nav. errors with nearby junctions.	There are no nearby junctions and so such events are improbable, particularly if the barriers are close to the crossing. Station platform lit at night. Low risk at this location, although greater than current with MGH. Note: MCB-OD Mk. 2 there may not be such a thing as sacrificial reflectors. Also, if no longer have LIDAR then have reduced the protection against this vs Mk. 1.	No
Provide audible warning at all four wig-wags	Large crossing area, local background noise or high likelihood that would be set to low volume due to nearby properties meaning that audible warning cannot be heard.	The crossing area is small, therefore additional audible warning is not considered to be necessary. No residential properties close by	No

MCB-OD configuration factor	Hazards	Consideration at level crossing	Recommended
Standing red man indication	High pedestrian use Poorly sited RTLs for pedestrians	Poor visibility of RTLs on approach from station platforms. Loop only for station; it should be rare that barriers come down when passengers are leaving the station.	Likely to be required
Response time and number of available attendants for CCU operation should it be necessary	Crossing spends a long duration in a failed state, delaying trains.	Maintainers from Cambridge, could approach from either direction but more likely approach down the hill - prefer LCU on the Down side.	Consider

Note: Some of the considerations in the above table refer to the Mk.1 MCB-OD, if the new Mk.2 MCB-OD crossing is available and pursued, alternative configuration factors may apply.

5 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made from the analysis:

Strategic options

1. The only feasible closure option identified is to bypass the existing crossing with an off-line bridge and new link roads and provide step free access at Dullingham station with an accessible bridge or underpass. Since this scheme would likely cost £12m or more the cost would be grossly disproportionate to the safety benefit compared with the alternative of renewing Dullingham as MCB-OD at a cost of about £3.2m and a moderate residual risk.

2. It is, therefore, concluded that whilst closure of the crossing could be feasible, crossing renewal provides a more viable and cost-effective option.

3. Retaining the existing MGH crossing would not be the preferred option as it presents a high operational cost with the need to maintain a crossing keeper on site and its location towards the base of a hill presents a hazard from vehicle strike to the crossing keeper. The preferred option is therefore to renew the crossing as MCB-CCTV or MCB-OD. The choice between MCB-OD and MCB-CCTV is likely to be made on the basis of feasibility and cost including the operational cost associated with signaller workload. The space available for the location of equipment is also a consideration as this could be somewhat constrained at this crossing unless the station car park can be extended.

Consideration of local hazards and MCB-OD configuration parameters

4. The additional controls identified for consideration include:

    - The road approach to the crossing is downhill on the Down side giving an elevated risk of misuse, late braking and barrier strikes. Additional controls to consider include an anti-slip road surface, count down markers and low cost VASs.

    - SORAT-LX should be utilised to assess potential risk mitigations for the Down protecting signals on the normal and loop lines.

    - '*Keep clear*' markings should be provided in front of the station car park.

    - Trespass guards and fencing to minimise the potential for pedestrians to cross to the opposite platform.

    - New pedestrian footway 1.5m in width on the station side with tactile edges at either end.

- Standing red man indications facing the pedestrian route from platform exits.

- An additional RTL facing the station car park exit when details of the ground plan are known.

- Improved drainage to ensure that water and debris running down the hill on the Down side does not collect on the crossing.

- A pavement on the station car park side for pedestrian access if there is space available.

5. Lower LIDAR may not be required for the Mk. 2 MCB-OD units. If lower LIDAR is a consideration, then it is not likely to be required at this crossing as the safety benefit to cost ratio is less than 0.5 and there are no Major ranked hazards that cannot be mitigated.

6. MCB-OD design parameters that should be considered to manage the risk for this crossing are listed as follows:

   - *Blocking back.* Whist there is no known issue with blocking back currently, the right turn into the car park could provide possible source of blocking back. BPM could therefore be a consideration to manage this although the normal BPM criteria are not met.

   - *Anti-trapping delay in lowering and pausing of the exit barriers.* There is some potential for vulnerable use coinciding with use of the loop line platform, however this is only scheduled once per day. Hence an extended anti-trapping delay is not likely to be necessary but should be considered during detailed design.

   - *Enhanced OD Control of Barriers Lowering.* This provides an alternative mitigation to increasing the anti-trapping delay. This might particularly be a consideration should BPM also be provided as it utilises the same circuitry, although it can lead to increased misuse. Consider during detailed design, but no specific reason for fitting has been identified.

   - *Amber phase duration.* The crossing is has moderate road approach speed but there is a downhill approach on the Down side, which give rise to an increased risk of vehicles failing to brake in time for the crossing. Methods of managing this should be considered and a consideration would be to extend the amber phase of the crossing sequence beyond the default of 3s. The Down side of this would be a slightly increased road closure time; this is not, however, likely to be particularly problematic at this crossing. Consider during detailed design, but no specific justification for extending has been identified.

- *Response time and number of available attendants for CCU operation should it be necessary.* A crossing attendant is likely to come from Cambridge depot more likely to approach from the Down side so this is the preferred location of the CCU.