Sotera Risk Solutions

Risk Assessment for Milton Fen AHB Level Crossing

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Sotera Risk Solutions Limited
22 Glanville Road
Bromley
Kent BR2 9LW
United Kingdom
Tel: +44 (0)20 82890384
Email:
chris.chapman@sotera.co.uk
Internet: www.sotera.co.uk

REVISIONS

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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
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APPROVAL

Approved by:	Name:	Chris Chapman
	Job Title:	Risk Specialist
	Date:	8th January 2020
Accepted By: (RLCM)	Name:	John Prest
	Date:	9th April 2020
Accepted By: (RAM Signalling)	Name:	Sam Longhurst
	Date:	8/4/2020

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	
EACE	Ely Area Capacity Enhancement (project)	
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	

Acronym	Description	Comments
LED	Light Emitting Diode	
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	

Acronym	Description	Comments
TMOB	Trainman Operated Barrier crossing	
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 Milton Fen Level Crossing	Tracsis 1167-WTR Site 26 – July 2018
5.	East Cambridgeshire Local Plan	Adopted April 2015
6.	Level Crossing Guidance Document: Applying Risk Reduction Bednefits in ALCRM When Modelling Safety Enhancements	LCG 14 March 2016
7.	Transforming Level Crossings: A vision-led long-term strategy to improve safety and level crossings on Great Britain's railways	NR17
8.	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
9.	MCB-OD Pedestrian Risk Tool	AD Little V1
10.	AHB+ HAZID Report	AES/1739/R03, Issue 2, 09/07/19
11.	AHB+ System Definition	AES/1739/R01, Issue 1, 29/03/19
12.	AHB+ Option 2 Feasibility Analysis Extract	
13.	RSSB, Safety Risk Model	V8.5.0.2, March 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 Milton Fen 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.

- Specified and carried assessments of the crossing type options using the ALCRM based upon an up-to-date traffic census.

- 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

Milton Fen is an AHB crossing, with two half-width barriers and four RTLs. The RTLs are of the LED type.

The crossing is monitored from Cambridge signal box.

The maximum line speed is 75 mph. The line is electrified with overhead lines.

Figure 1 shows the configuration of the crossing, viewed from the west. *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

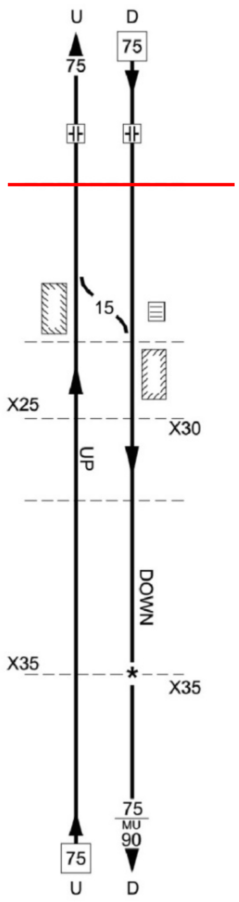
Table 1 Current Level Crossing Details

Level crossing name	Milton Fen
Level crossing type	AHB
ELR and mileage	BGK 59m 10ch
Status	Public Road
Number of running lines	2
Permissible speed over crossing (Up)	75mph
Permissible speed over crossing (Down)	75mph
OS grid reference	TL485624
Postcode	CB24 6AF
Road name and type	Fen Road (undesignated)
Local Authority	Cambridgeshire County Council
Supervising signal box	Cambridge PSB
Electrification and type	Overhead Line

Figure 2 Extract from the sectional appendix

LOR	Seq.	Line of Route Description	ELR	Route	Last Updated
EA1161	011	Bishops Stortford to Ely North Jn	BGK	Anglia	12/11/2016

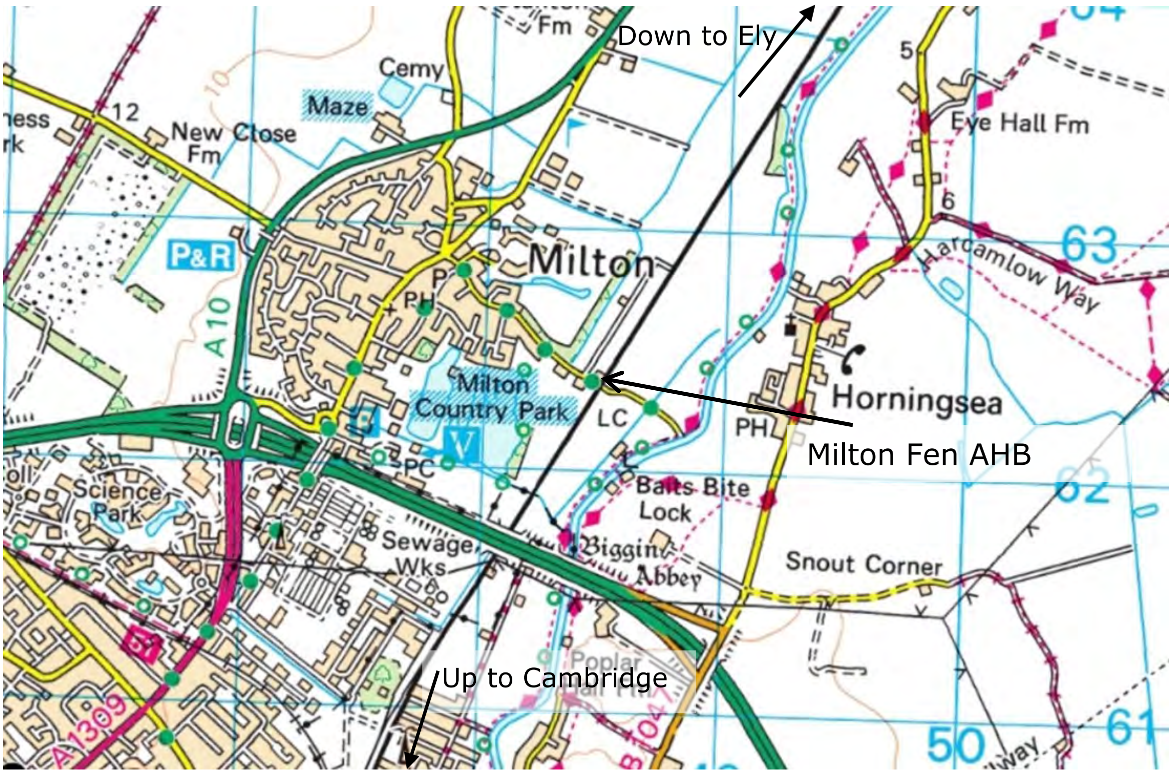
Location	Mileage M	Ch	Running lines & speed restrictions	Signalling & Remarks
				TCB Cambridge SB (CA) RA8 AC: Romford; GSM-R
OHNS	58	71		
Milton Fen LC (AHBC)	59	10		
Waterbeach GSP	60	78		Up platform - 90m (97 yds)
Waterbeach LC (AHBC)	61	00		Down platform - 86m (93 yds)
WATERBEACH	61	01		
Burgess Drove LC (R/G-X)	61	20	T	
Bottisham Road LC (AHBC)	61	48		
Bannolds LC (AHBC-X)	62	70 *		



2.2 Environment

The crossing is located to the west of Milton, on the outskirts of Cambridge, on an undesignated road (Fen Road) leading to the River Cam. The area is mainly farmland with a residence in the immediate vicinity of the crossing. The crossing provides access to walks alongside the River Cam and also to farmland 'trapped' between the railway line and the River Cam as shown in *Figure 3*.

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



Satellite views of the location are shown in *Figure 4* and *Figure 5*.

Environmentally significant sites are shown in *Figure 6*.

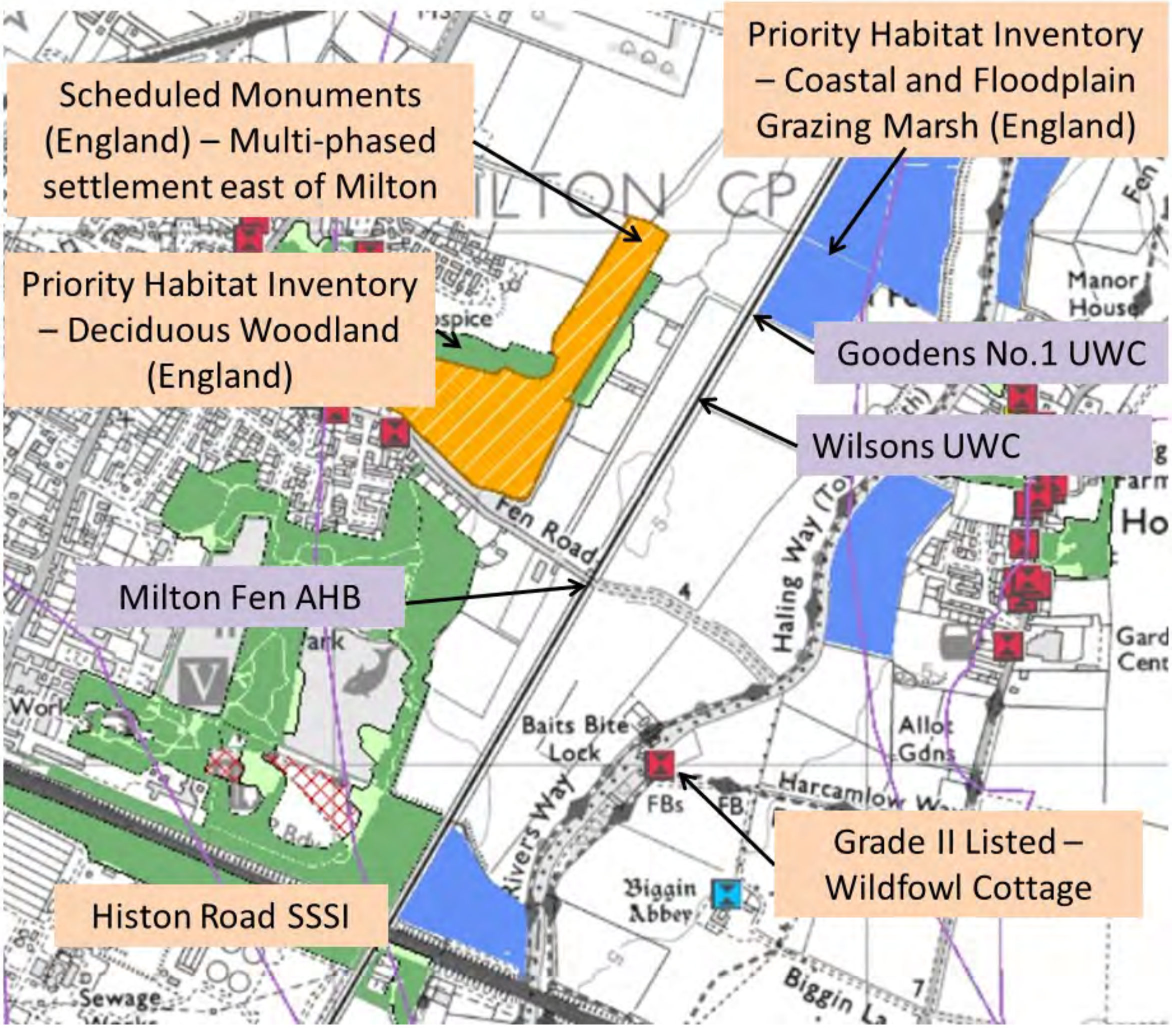
There are a number of priority habitats in the vicinity of the crossing.

There is a Scheduled Monument (Multi-phased settlement east of Milton) north-west of the crossing.

Figure 4 Satellite view showing the location of the crossing

Figure 5 Closer satellite view showing the location of the crossing

Figure 6 Environmentally significant sites



2.3 Footpath approaches

There are footways on both sides of the crossing as seen in *Figure 1*. The footway width on the north side (*Figure 7*) is approximately 1.0m. The footway width on the south side (*Figure 8*) varies between 0.96m and 1.0m. The footways are becoming overgrown with vegetation.

There are no pavements along the road for the footways to join. There are no tactile thresholds on the footway.

The footways are 10.3m long from barrier to barrier.

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 Milton Fen, based upon a 9-day census, is 126. 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 an average pedestrian frequency of 216 per day. The footways are, therefore, not in compliance with the minimum width of 1.5m specified in ORR guidance. However, the road usage is low and the majority of pedestrians walk down the middle of the road.

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

Figure 7 Footway – North side

Figure 8 Footway – South side

2.4 Road approaches

Road approach to the crossing from the east

The key features of the approach are:

1. The road is curved and the crossing can just be seen from the distant signage about 110m from the level crossing as shown in *Figure 11* on the approach, and rises up to the crossing. The road has a speed limit of 30mph and the 85th percentile road approach is only 15.8mph indicating that this is a slow road approach along a narrow road.

2. It can be seen that there is an entrance into a field just before the crossing as shown in *Figure 14.* This could cause blocking back, especially as vehicles turn right into the entrance, but vehicle usage at the crossing is low (only 80 vehicles per day) indicating that this is unlikely to occur frequently.

3. There is also a gate entrance into a field 100m from the crossing as shown in *Figure 12.* This is very unlikely to cause blocking back as vehicle usage at the crossing is low (only 80 vehicles per day).

4. The road approach is orientated east to west at the crossing, indicating that low sun could be a problem, but there is substantial screening from trees in summer.

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 10* to *Figure 13*.

A plan of the key features is shown in *Figure 9;* the numbers in the figure refer to the above numbered list of features.

Figure 9 Key features on the eastern approach to the crossing

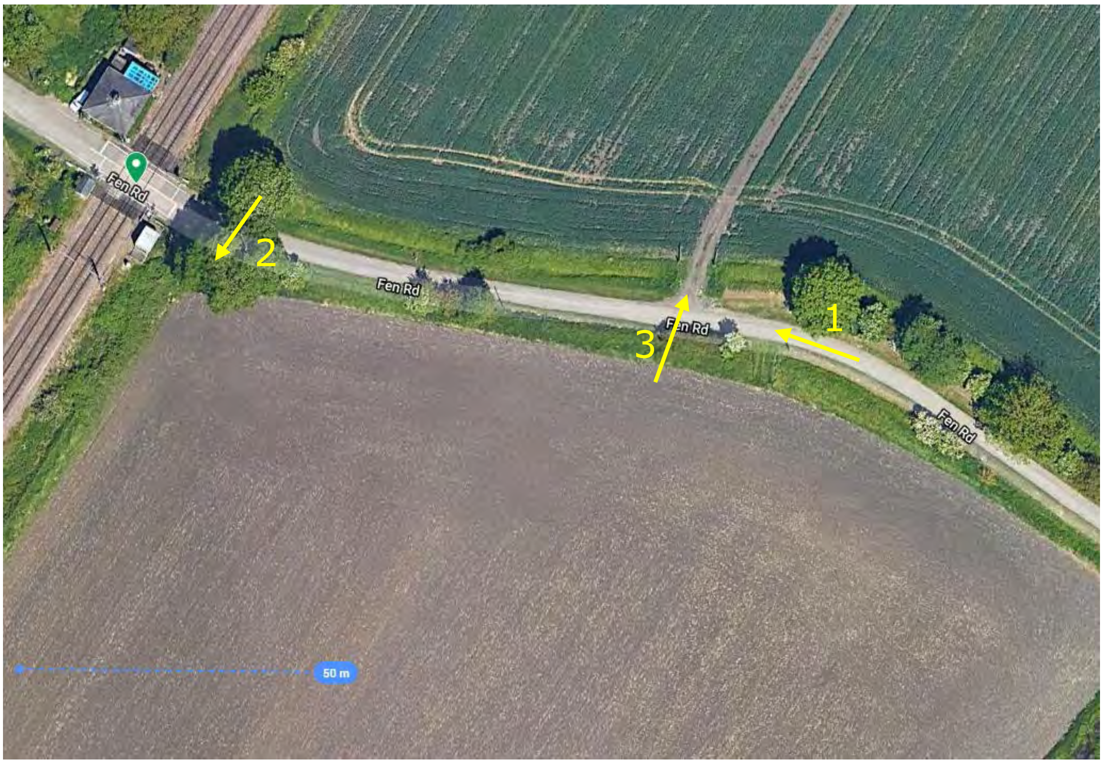


Figure 10 Road approach to crossing (east approach)

Figure 11 Intermediate View of Crossing (east approach)

Figure 12 Entrance to field 100m from crossing

Figure 13 Near view from Crossing of road approach (east approach)

Figure 14 Entrance to field close to crossing

Road approach to the crossing from the west

The key features of the approach are:

1. The approach to the crossing from the west is shown in *Figure 16*. The road is straight on this approach and rises up slightly to the crossing. The road has a speed limit of 30mph and the 85th percentile road approach is only 18.3 mph indicating that this is a slow road approach along a narrow road. Vegetation impairs views of RTLs on the approach from the west.

2. It can be seen that there is a house immediately adjacent to the crossing. A car reversing into the space shown in *Figure 19* could cause blocking back but vehicle usage at the crossing is low (only 80 vehicles per day) indicating that this is unlikely to be frequent.

3. The road approach is orientated west to east at the crossing, indicating that low sun could be a problem, but there is screening from trees.

4. The RTLs are visible from about 125m 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 northwest are shown in *Figure 16* to *Figure 18*.

A plan of the key features is shown in *Figure 15;* the numbers in the figure refer to the above numbered list of features.

Figure 15 Key features on the western approach to the crossing

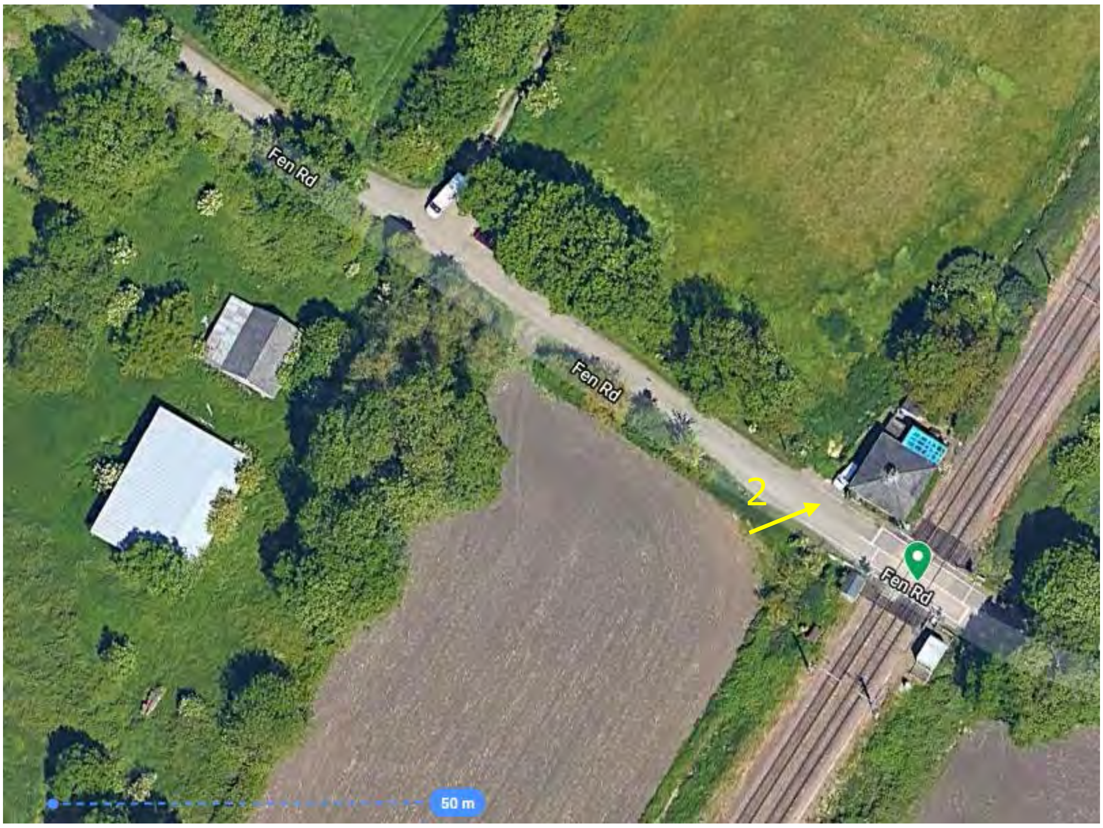


Figure 16 Distant View of Crossing (west approach)

Figure 17 Intermediate View of Crossing (west approach)

Figure 18 Near View of Crossing (west approach)

Figure 19 House Near to Crossing (west approach)

2.5 Impact of low sun on the crossing

Milton Fen level crossing is a southeast-northwest facing crossing (for the road) and, 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. Days when the sun aligns most closely with the road approaches are shown in *Figure 20*.

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 and the dark orange line the direction of sunset.

Westbound approach

There are two potential issues with low sun when approaching the crossing westbound:

1. In the spring and autumn, the rising sun would shine towards the RTLs, potentially washing them out. There is vegetation alongside the road and behind the level crossing and the road approach is slow. The RTLs are of the conventional lamp type.
2. In the summer, the setting sun would be straight behind the crossing, potentially causing glare. There is vegetation alongside the road and behind the level crossing and the road approach is slow.

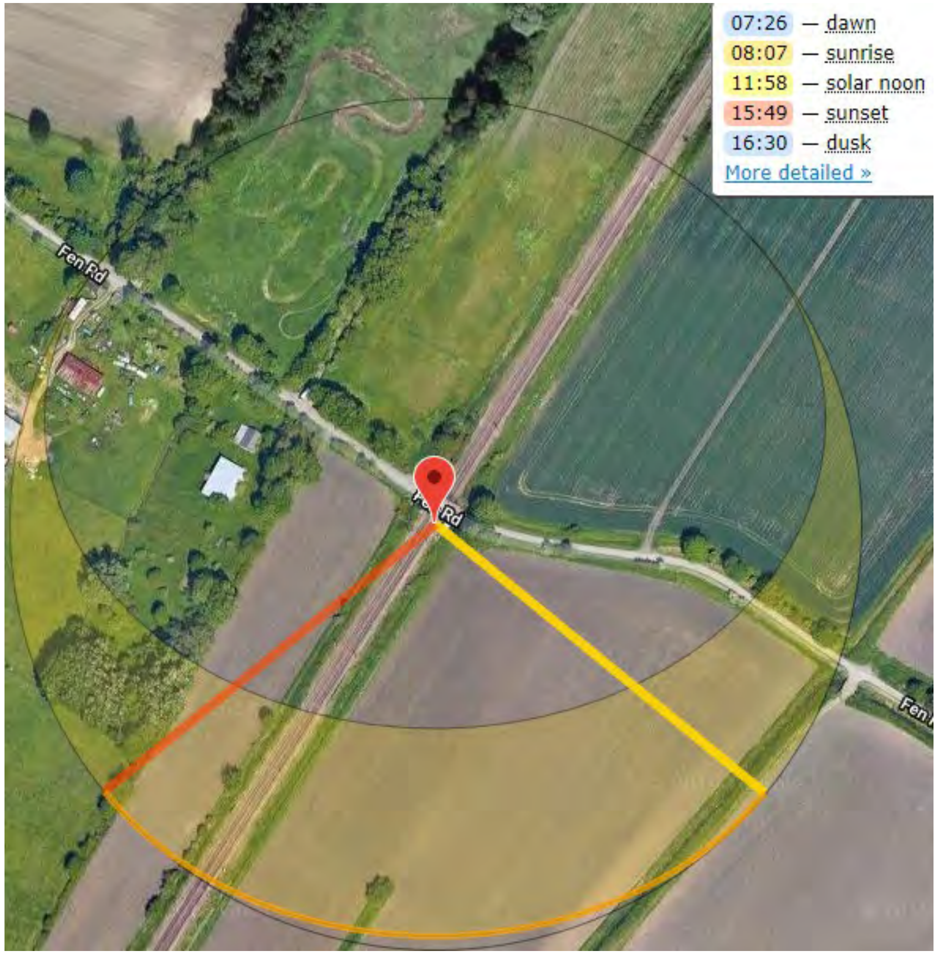
Eastbound approach

There are two potential issues with low sun when approaching the crossing eastbound:

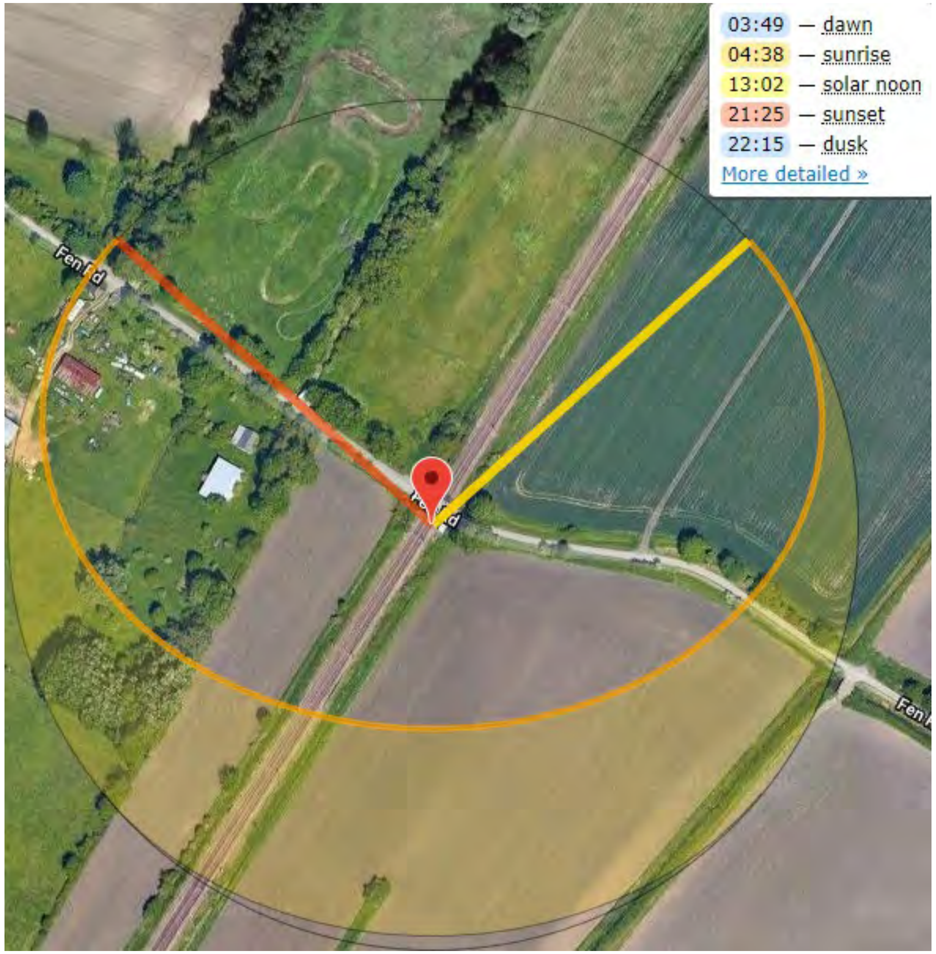
1. In the summer the setting sun would shine towards the RTLs, potentially washing them out. There is vegetation alongside the road and behind the level crossing and the road approach is slow. The RTLs are of the conventional lamp type.
3. In the winter, the rising sun would be straight behind the crossing, potentially causing glare. There is vegetation alongside the road and behind the level crossing and the road approach is slow.

None of these issues is considered to be significant, however LED type RTLs, perhaps with semi-extended hoods, would reduce the impact of any sun wash out that might occur.

Figure 20 Suncalc diagrams



Shortest day



Longest Day

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, 24-hour traffic census by continuous recording was carried out at the crossing between 28th April and 6th May 2018. The following provides a summary of the results obtained from this census.

Train frequency	**Weekday**	172
	Saturday	130
	Sunday	79
Road closure (min:secs)	**Average**	00:45
	Maximum	03:29
Road vehicle frequency	**Busiest day**	295
	Average weekday	142
Blocking Back Observations		3 Amber
85th percentile speed (free flowing cars only)	**Eastbound**	15.8
	Westbound	14.6
Pedestrian and cyclist frequency	**Busiest day**	592
	Average week day	192
Train Pedestrian Value (TPV)		126
Pedestrian Category		C

The observed train, vehicle and pedestrian usage is presented in *Table 3* and *Table 4*; the nine-day average hourly distribution of usage is shown graphically in *Figure 24*.

The notable observations recorded in the report were:

- There were a total of three amber blocking back incidents, where a vehicle pulled in beyond the crossing and allowed a vehicle travelling in the opposite direction to pass as shown in *Figure 21*, *Figure 22* and *Figure 23*. It can be seen although the vehicular use is low, blocking back cannot be completely ruled out due to the narrow road approaches.
- There was some observed use by vulnerable pedestrian users.

Figure 21 Car pulls in close to crossing to allow vehicle travelling in opposite direction to pass

Figure 22 Tractor pulls in close to crossing to allow vehicle travelling in opposite direction to pass

Figure 23 Vehicle stops for a period beyond crossing for no obvious reason

The crossing was compliant with ORR guidance for train arrival times as shown in *Table 2*.

Table 2 Train arrival times

AHB train arrival times Milton Fen	ORR guidance	Observed	ORR Guidance met
Crossing length (m)		10	
% Train arrival within 50s	≥ 50%	97.0%	Yes
% Train arrival within 75s	≥ 95%	99.5%	Yes

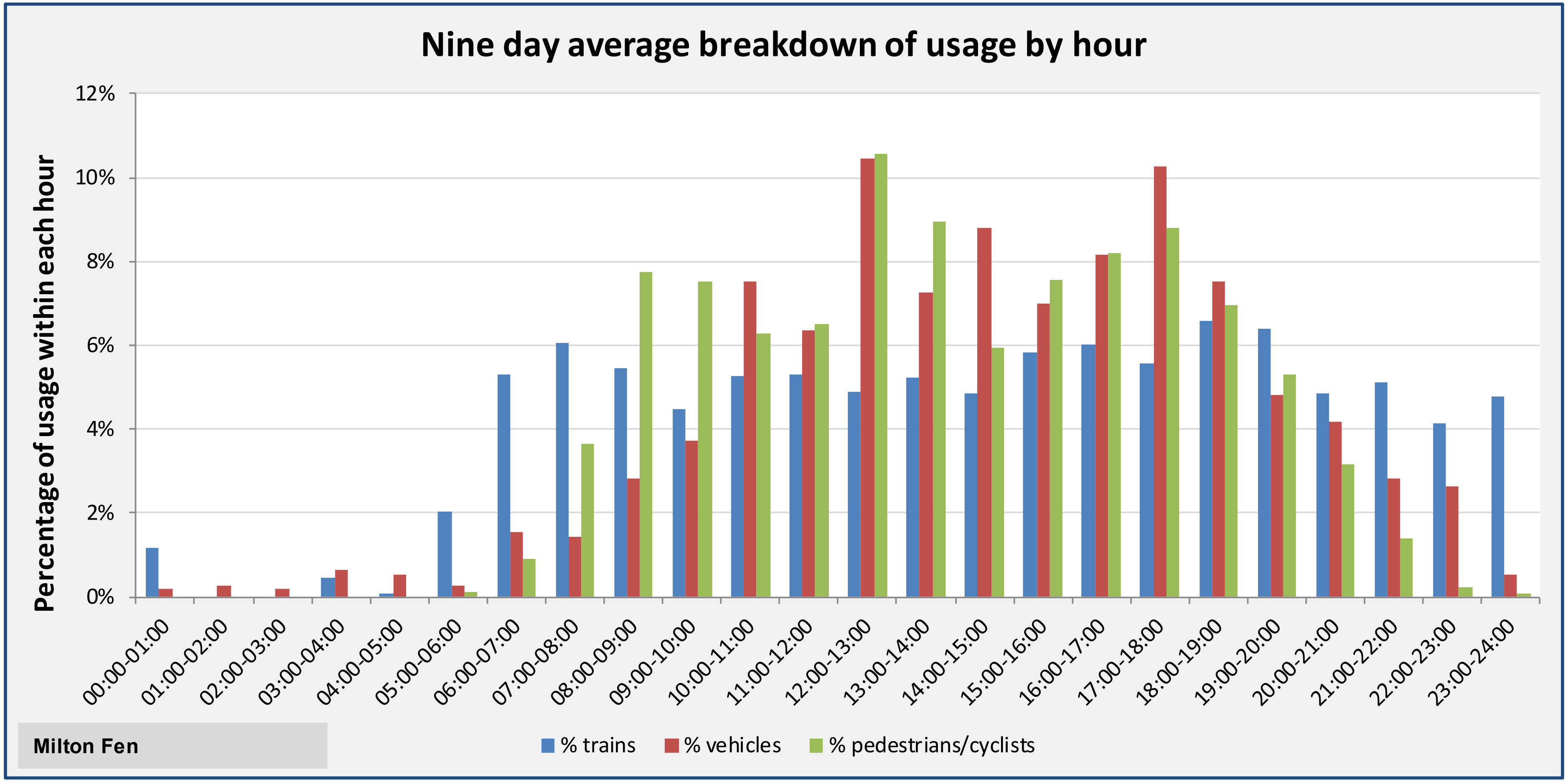
Table 3 Traffic survey observed usage

Census Site 26 - Milton Fen			Totals per day										
			Vehicles							Pedal cyclists and pedestrians			
Day		No. trains per day	Cars	Vans / small lorries	HGVs	Buses	Tractors	Motor cycles	Total	Pedal cycles	Herded animals and horses	Pedestrians	Total
Saturday	28-Apr-18	131	41	6	0	0	0	0	47	52	0	156	208
Sunday	29-Apr-18	78	53	4	1	0	0	4	62	80	0	287	367
Monday	30-Apr-18	171	45	7	0	0	0	0	52	38	0	141	179
Tuesday	01-May-18	166	60	12	2	0	12	3	89	133	0	282	415
Wednesday	02-May-18	176	51	6	0	0	0	0	57	212	0	177	389
Thursday	03-May-18	166	56	25	4	0	0	4	89	154	0	154	308
Friday	04-May-18	183	74	18	4	0	2	1	99	174	0	222	396
Saturday	05-May-18	129	109	11	0	0	2	2	124	235	0	325	560
Sunday	06-May-18	80	78	14	0	0	0	4	96	295	0	297	592
Highest		183	109	25	4	0	12	4	124	295	0	325	592
7 day average		153	61	12	2	0	2	2	79	149	0	216	364
Weekday average		172	57	14	2	0	3	2	77	142	0	195	337

Table 4 Observed pedestrian usage

Pedestrian census		Totals per day									
Site 26 - Milton Fen											
Day		Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
Saturday	28-Apr-18	141	6	0	4	0	0	5	0	0	156
Sunday	29-Apr-18	255	28	0	4	0	0	0	0	0	287
Monday	30-Apr-18	134	0	0	1	0	0	6	0	0	141
Tuesday	01-May-18	273	0	0	2	0	0	7	0	0	282
Wednesday	02-May-18	169	0	0	2	0	0	6	0	0	177
Thursday	03-May-18	149	1	0	0	0	0	4	0	0	154
Friday	04-May-18	208	2	0	0	0	4	8	0	0	222
Saturday	05-May-18	310	6	0	2	1	0	5	1	0	325
Sunday	06-May-18	289	3	0	0	0	0	3	0	2	297
Highest		310	28	0	4	1	4	8	1	2	325
7 day average		204	4	0	1	0	1	5	0	0	216
Weekday average		187	1	0	1	0	1	6	0	0	195

Figure 24 Nine Day Average Breakdown of Usage by Hour



3.2 Rail approach and usage

The crossing is located between Coldham Lane Junction and Ely Dock Jn. There are two tracks at the crossing and the line is electrified by means of overhead wires. It is a relatively highly utilised stretch of line with a weekday average of 172 trains per day (approximately 86 in each direction). There is limited freight traffic over the line (typically 5 trains per day). There is potential that the number of trains could increase up to 228 trains per day if the Ely Area Capacity Enhancement (EACE) project goes ahead.

The Down rail approach

The train speeds are limited to 75mph along this stretch of track. The track is straight in this direction giving the train driver good sighting of the crossing as shown in *Figure 25*.

For trains travelling in the Up direction and derailing after hitting a vehicle on the crossing, only the lineside overhead line equipment may exacerbate the potential derailment consequences.

Figure 25 View of Down rail approach (looking towards Coldham Lane Junction)

The Up rail approach to the crossing

The train speeds are again limited to 75mph along this stretch of track. The track is straight in this direction giving the train driver good sighting of the crossing as shown in *Figure 26*.

For trains travelling in the Down direction and derailing after hitting a vehicle on the crossing, only the lineside overhead line equipment might exacerbate the potential derailment consequences.

Figure 26 View of Up rail approach (looking towards Ely Dock 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 5*.

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 5 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	0.10	0.00
Train - striking or being struck	1	0.15	6.60
Non-rail vehicles (incl. vehicle on line)	1	1.55	0.65
Person - personal accident	1	0.28	3.59
Level Crossing/LC equipment - misuse/near misses	1	5.36	0.19
Near miss - train with person (not at LC)	1	0.01	110.50
Train - striking animal	0	0.07	0.00
Animals - on the line	1	0.11	9.40
Person - trespass	1	0.12	8.34
Person - vandalism	0	0.25	0.00
Train - signal passed at danger	0	0.05	0.00
Train - running over LC (when unauthorised)	0	0.02	0.00
Irregular working (pre 25/11/2006)	0	0.05	0.00
Irregular Working	0	0.24	0.00
Level crossing - equipment failure	3	9.38	0.32
Signalling system - failure	0	0.11	0.00
Permanent way or works - failure	0	0.03	0.00
All incidents	10	18.10	**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:

- A suicide and attempted suicide
- A near miss with a group of trespassers
- An incident of vehicle misuse with a car
- An incident where a tractor and trailer crossed and took a barrier off

- Two cases of vandalism related to the removal of a sign and a troughing lid being placed on the line

More recent SMIS data, for one year to 13th March 2019, shows there was a reported failure of a RTL (17/04/2018), and an incident where a stationary car was observed by the train driver in the middle of the level crossing with the barriers in the lowered position. The driver slowed the train down & sounded up and the car subsequently moved (17/02/2019).

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.

There are two potential significant developments in the vicinity of Milton Fen:

- The Cambridge Sports Lakes Trust has plans for a large sporting complex west of the railway as shown in *Figure 30*, which would cut off Fen road and would facilitate closure of Milton Fen and the adjacent user worked crossings - Wilsons and Goodens No. 1. It is not clear how vehicular access would be maintained to land trapped between the railway and the River Cam under this proposal. It is understood that the Cambridge Sports Lakes Trust withdrew their plans in July 2018 but there are plans for resubmission in 2019. Network Rail should consult with the local authority and the Cambridge Sports Lakes Trust and investigate whether it is possible to support such a proposal if it facilitates closure of the level crossings.
- The second proposal, which is less directly significant, is to construct 5,200 homes on the north east fringe of Cambridge (see *Figure 29*) as well as other large developments in Waterbeach. Such a proposal would tend to increase the population who might make use of Milton Fen for leisure activities.

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.

There are no proposals for increasing the line speed. Whilst not a resignalling project as such in this area, proposed renewals as full-barrier MCB type crossings will require islands of resignalling to provide appropriate protecting signals and signal spacing.

A separate project, the EACE project, is considering significant enhancement to the train frequency in the long term. The EACE project is considering increasing rail usage at Milton Fen from the current level of 178 trains per day to 228 trains per day. If such an increase were to occur it would significantly increase the risk at the crossing, or in the event of renewal as a full-barrier MCB type crossing, would result in much higher road closure times.

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 Milton Fen this suggests that the busiest hour road closure time would increase from about 15% now to about 50%; this would be further increased should any train frequency increases occur. If 100% of the EACE traffic increase occurred, the road closure time would increase to about 62% in the busiest hour as shown in *Figure 27*. The average daytime road closure time is shown in *Figure 28*.

Figure 27 Road closure time in the busiest hour

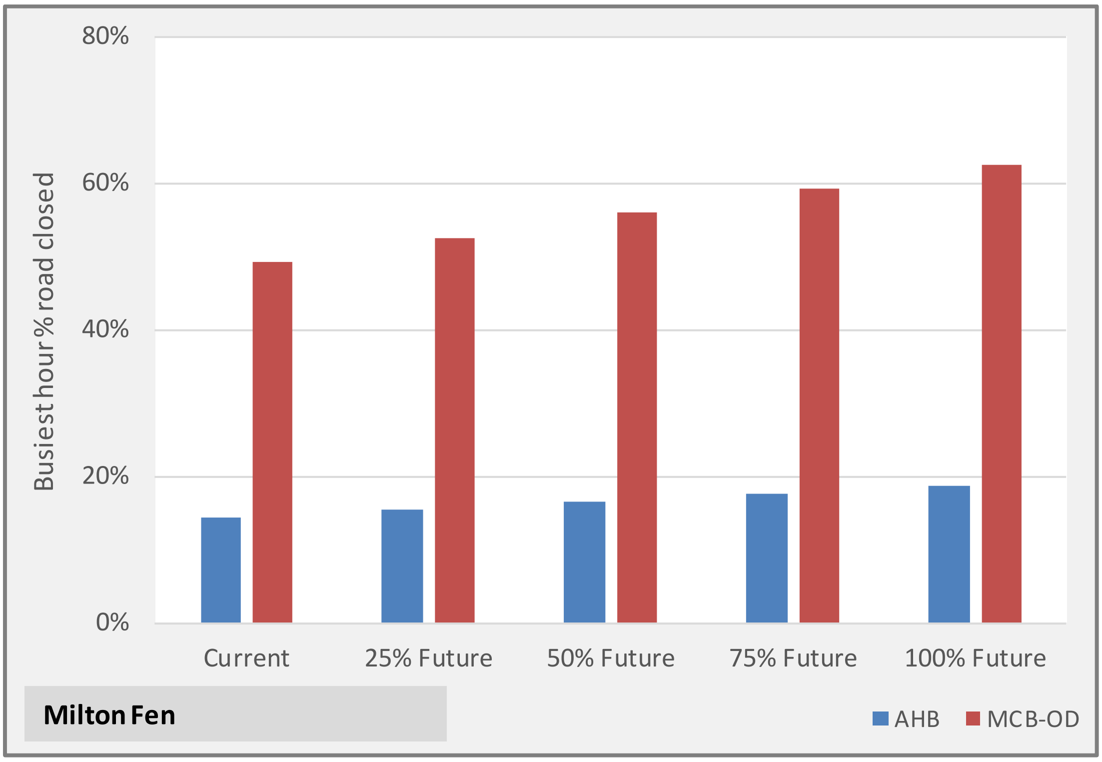


Figure 28 Average daytime road closure time

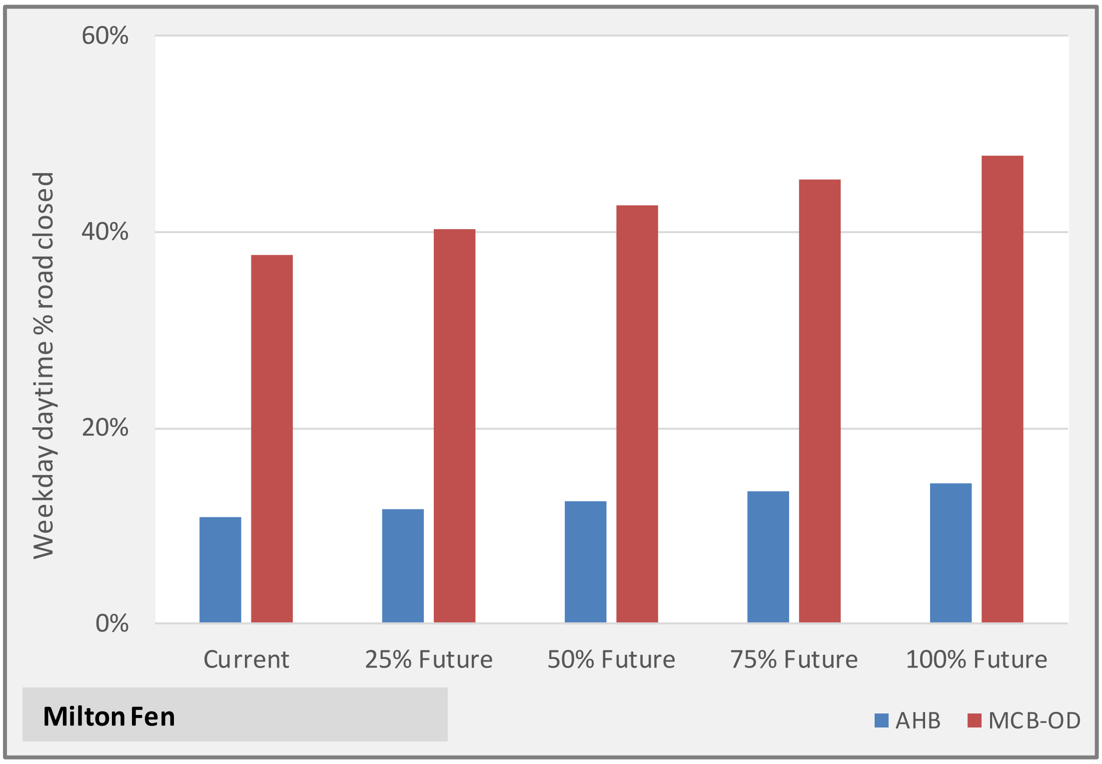


Figure 29 Cambridge Northern Fringe Development

Figure 30 New sports lake planned west of wailway

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 workshops

The attendees of the initial workshop at One Stratford Place on 3rd April 2019 were as follows.

Present	Role
David Swift	Project Engineer Signalling
Bode Asabi	Project Manager
Ray Spence	Senior Delivery Manager
John Prest	Route Level Crossing Manager
Sam Longhurst	Senior Asset Engineer, Signalling
Nathan Garratt	DPE
Brendan Lister	LCM
James Taylor	Programme Manager, Level Crossing Development Team
Chris Chapman	Sotera, Workshop Chair
David Harris	Sotera, Workshop Secretary

Following this initial workshop, The Safety Review Panel commented that a more robust consideration should be made of a new type of full barrier level crossing (AHB+), which is being developed by Network Rail. The basic premise of this type of level crossing is envisaged to be an adaptation of the existing AHB crossing type, adding exit barriers whilst retaining the AHB’s train approach initiated method of operation. Road closure times would be comparable with those of existing AHB level crossings. The lowering function of the exit barriers would be controlled by obstacle detection technology.

As such two further workshops were held:

i) To understand better the functionality of AHB+ level crossings and the progress of the AHB+ development project;

ii) To assess the potential benefits of AHB+ at crossings at the specific crossings that were proposed for upgrade as part of the Cambridge resignalling and recontrol project.

The attendees at the first AHB+ workshop on 9th September 2019 were:

Present	Role
Bode Asabi	Project Manager
Nathan Garratt	DPE
Brendan Lister	LCM
Chris Chapman	Sotera, Workshop Chair
Ben Chipman	Level Crossing Designer
Gavin Scott	RAM Signals Anglia
Sam Rose	Graduate
Paul Fletcher	Signaller / Project Operations Interface Specialist
Paige Skinner	Scheme Project Manager
Darren Witts	STE Principal Engineer
Will Cavill	Principal Designer

The attendees at the second AHB+ workshop on 25th October 2019 were:

Present	Role
Bode Asabi	Project Manager
Nathan Garratt	DPE
Brendan Lister	LCM
Chris Chapman	Sotera, Workshop Chair
Ben Chipman	Level Crossing Designer
Gavin Scott	RAM Signals Anglia
Sam Rose	Graduate Engineer
Paul Fletcher	Signaller / Project Operations Interface Specialist
Paige Skinner	Scheme Project Manager
Darren Witts	STE Principal Engineer
John Prest	Route Level Crossing Manager
Charles Muriu	Asset Engineer
Gabrielle Hodlaun	Delivery Manager
Harry Newgas	Graduate Engineer
Isaac Dozen-Anane	Assistant Project Engineer
Rebecca Wiecigroch	Asset Engineer - Signalling

4.2 Assessment of AHB+

Overall risk benefit

Currently the All Level Crossing Risk Model (ALCRM) does not include an assessment of AHB+ and does not include a breakdown of AHB hazards to enable such an assessment to be made. In order to make an assessment of potential benefits of AHB+, RSSB's Safety Risk Model (SRM) v8.5.0.2 (13) can be used. The risk at an AHB level crossing is broken down into 66 contributory events in *Table B1* of the SRM. The most significant contributors to risk at an AHB crossing are shown in *Table 7*. It can be seen that not all risk contributors are expected to be affected by fitment of AHB+ e.g. '*RV struck by train - on AHB - RV stranded/failed on LC*' is not expected to be affected by the fitment of the additional barrier as there are no protecting signals with which to stop a train. One of the highest contributors to risk at an AHB level crossing is, however, '*MOP (non-trespasser) pedestrian or cyclist struck/crushed by train on AHB - ignores lights/barriers*' and it is reasonable to assume that an AHB+ type crossing, which would have an offside barrier lowering as the same time as the entrance barrier, would provide a greater deterrent to level crossing users who might use the open off side to traverse the railway with the lights on and barriers down. In this instance, a 75% reduction in risk from this source is estimated.

Of the 66 AHB contributors identified in the SRM, the following change in risk was estimated for AHB+:

- 10 were considered to be reduce
- 3 were considered to increase (additional barriers likely to result in more strikes on people)
- 53 were considered to be similar (no change in risk estimated).

The risk contributors for which change is predicted is shown in *Table 8*. It was noted in the first workshop that if the off-side barrier was not fully lowered, the train driver would report it as a '*failure*'. As such, it is expected that AHB+ level crossings will only be installed in locations where the off-side OD controlled barriers very rarely fail to lower i.e. AHB+ will only be fitted to crossings that do not have high peak pedestrian/cyclist use, not at a busy station or where there is pedestrians are not going to be able to traverse the crossing in time due to a long traverse distance or slow/vulnerable users. As such, the benefits of AHB+ is assessed on this basis.

Generally, the following factors are taken into account:

- The '*second train coming*' benefits are taken to be greater than for first train as the likelihood that the off-side barriers have lowered is greater;
- Whilst an AHB+ is not considered suitable for a busy station environment, the benefits at a station would be considered lower

as there is an incentive to cross to catch a train on the opposite platform;

- Road vehicles generally get a higher level of benefit than pedestrians/cyclists as it will be more of a violation to drive through a barrier than to duck under or climb the barrier;
- A minor benefit is taken for users that have failed to observe the level crossing, which is likely to be associated with those that approach from the off side; and
- A disbenefit is predicted for users being potentially struck by barriers.

It should be noted that existing AHB precursors from the SRM have been modified; there may be new error mechanisms such as users going onto the crossing while the barriers are held up incorrectly believing that the crossing is safe. Such potential precursors have not been assessed.

Taking these benefits into consideration, the risk at all current AHB level crossings and total benefit if all these crossings were upgraded to AHB+ is shown in *Table 6*. It can be seen that overall, upgrade to AHB+ is expected to approximately halve the risk compared to an AHB.

Table 6 Overall risk benefit if all AHB level crossings were upgraded to AHB+.

Parameter	SRMv8.5 Risk (FWI/yr)
AHB	1.62
AHB+	0.84
AHB+ Benefit	0.78
% AHB+ Benefit	48%

Table 7 Most significant contributors to risk at an AHB level crossing

Hazardous Event Code	Precursor code	Cause precursor description	Risk cont. (FWI/year)	% of Total	Assessment of AHB reduction in risk	Comment
HEM-27E	KAHB-WALKH	MOP (non-trespasser) pedestrian or cyclist struck/crushed by train on AHB - ignores lights/barriers	0.627	39%	75%	AHB+ barriers will be down in vast majority of instances such that a pedestrian would have to climb over or under barrier, rather than walk around the barrier.
HET-10E	VAHB-DELTH	RV struck by train - on AHB - zigzags barriers	0.245	15%	85%	AHB+ barriers would be lowered in vast majority of instances to prevent a zig zagging car being struck by the approaching train. There may be some unreliability of OD and small objects may prevent barrier lowering. Note that there is no 'fail safe' for OD system – if there is an OD system failure, the exit barrier will not lower.
HET-10E	VAHB-STRTE	RV struck by train - on AHB - RV stranded/failed on LC	0.090	6%		
HET-10E	VAHB-EBLTE	RV struck by train - on AHB - RV incorrectly on LC due to environmental factors/driver error: user brakes too late	0.068	4%		
HEM-27E	KAHB-2TRAH	MOP (non-trespasser) pedestrian or cyclist struck/crushed by train on AHB - second train coming	0.063	4%	85%	AHB+ barrier will be down in vast majority of instances by the time a second train arrives so pedestrian would have to climb over or under a barrier.
HET-10E	VAHB-ASETH	RV struck by train - on AHB - fails to observe level crossing	0.050	3%	2%	Additional barrier would give a small increase in visibility if approaching from the off-side
HET-10E	VAHB-VANTE	RV struck by train - on AHB - RV deliberately placed on level crossing	0.043	3%		
HET-10E	VAHB-ESNTE	RV struck by train - on AHB - RV incorrectly on LC due to environmental factors: sunlight obscures crossing/lights	0.043	3%		
HET-10E	VAHBRTA-TE	RV struck by train - on AHB - RV incorrectly on LC due to RTA	0.036	2%		
HEM-27E	KAHB-SLOWH	MOP (non-trespasser) pedestrian or cyclist struck/crushed by train on AHB - slow moving/short warning	0.035	2%		

Table 8 Changes in Risk with AHB +

Hazardous Event Code	Precursor code	Cause precursor description	Risk cont. (FWI/year)	% of Total	Assessment of AHB+ reduction in risk	Comment
HET-10E	VAHB-ASTTH	RV struck by passenger train - on AHB - second train coming	1.15E-03	0.1%	90%	AHB+ barrier will be down in vast majority of instances by the time a second train arrives so vehicle would have to drive through barrier. There may be some unreliability of OD and small objects may prevent barrier lowering.
HET-11E	VAHB-ASTTH	RV struck by freight train - on AHB - second train coming	1.36E-04	0.0%	90%	AHB+ barrier will be down in vast majority of instances by the time a second train arrives so vehicle would have to drive through barrier. There may be some unreliability of OD and small objects may prevent barrier lowering.
HEM-27E	KAHB-2TRAH	MOP (non-trespasser) pedestrian or cyclist struck/crushed by train on AHB - second train coming	0.063	3.9%	85%	AHB+ barrier will be down in vast majority of instances by the time a second train arrives so pedestrian would have to climb over or under a barrier.
HET-10E	VAHB-DELTH	RV struck by passenger train - on AHB - zigzags barriers	0.245	15.1%	85%	AHB+ barrier will be down in vast majority of instances by the time a zig zagging car that would be hit by a train arrives. Unreliability of OD and small object being detected. There may be some unreliability of OD and small objects may prevent barrier lowering. Note that there is no 'fail safe' for OD system – if there is an OD system failure, the exit barrier will not lower.
HET-11E	VAHB-DELTH	RV struck by freight train - on AHB - zigzags barriers	0.029	1.8%	85%	AHB+ barriers would be lowered in vast majority of instances to prevent a zig zagging car being struck by the approaching train.
HEM-11E	PAHB-2TRAH	Passenger struck/crushed by train on AHB adjacent to station - second train coming	0.030	1.9%	75%	AHB+ barrier will be down in vast majority of instances by the time a second train arrives so pedestrian would have to climb over or under a barrier. There is an Incentive to cross at a station to join the arriving train.

Hazardous Event Code	Precursor code	Cause precursor description	Risk cont. (FWI/year)	% of Total	Assessment of AHB+ reduction in risk	Comment
HEM-27E	KAHB-WALKH	MOP (non-trespasser) pedestrian or cyclist struck/crushed by train on AHB - ignores lights/barriers	0.627	38.7%	75%	AHB+ barriers will be down in vast majority of instances such that a pedestrian would have to climb over or under barrier, rather than walk around the barrier.
HEM-11E	PAHB-WALKH	Passenger struck/crushed by train on AHB adjacent to station - ignores lights/barriers	5.41E-03	0.3%	50%	AHB+ barriers will be down in vast majority of instances such that a pedestrian would have to climb over or under barrier, rather than walk around the barrier. There is an incentive to cross at a station as the passenger may attempt to join the arriving train.
HET-10E	VAHB-ASETH	RV struck by train - on AHB - fails to observe level crossing	0.050	3.1%	2%	Additional barrier would give a small increase in visibility if approaching from the off side
HET-11E	VAHB-ASETH	RV struck by train - on AHB - fails to observe level crossing	5.90E-03	0.4%	2%	Additional barrier would give a small increase in visibility if approaching from the off side
HEN-44E	KEQUAHB-1H	MOP (non-trespasser) pedestrian or cyclist/motorcyclist struck/trapped by level crossing equipment on AHB - user error	9.38E-04	0.1%	-50%	Assumed that near side barriers are a threat to those entering of leaving the crossing while the off side barriers are a threat only to those entering the crossing
HEN-44E	KEQUAHB-3H	MOP (non-trespasser) pedestrian or cyclist/motorcyclist struck/trapped by level crossing equipment on AHB - other	9.38E-04	0.1%	-50%	
HEN-44E	KEQUAHB-2H	MOP (non-trespasser) pedestrian or cyclist/motorcyclist struck/trapped by level crossing equipment on AHB - incorrect use	4.69E-04	0.0%	-50%	

Level crossing specific risk benefit

The risk reduction at a particular crossing will be dependent at the risk contributors at that crossing. The following scaling factors were taken to apply:

Pedestrian/cyclist hazards were taken to scale with:

- The number of pedestrian/cyclists relative to the average at AHB level crossings;
- The number of trains relative to the average at AHB level crossings.

Vehicular hazards were taken to scale with:

- The number of pedestrian/cyclists relative to the average at AHB level crossings;
- The number of trains relative to the average at AHB level crossings.

Second train coming hazards were taken to scale with the square of the number of trains relative to the average at AHB level crossings unless there was a single track, in which case, the factor was set to zero.

Road approach speed was used to generate the scaling factors for the *brakes too late* hazard. The methodology used is summarised in *Table 9*. The value for each level crossing is the average of the factors for the two approaching directions.

Table 9 Road approach speed factor

85% tile Speed (mph)	Road approach speed factor
<20	0.1
20-30	0.2
30-40	0.5
40-50	2
50-60	6
>60	10
>60 long straight	15

The level crossing usage from the 2018 census and scaling factors for the Cambridge level crossings are shown in *Table 10*. The risk benefit from upgrading to AHB+ can then be calculated and the benefit to cost ratio for renewing as an AHB+ level crossing as compared with renewing as an AHB can also be calculated assuming the renewal costs are as follows:

- AHB renewal cost £1.46m
- AHB+ renewal cost £2.007m

These costs are based on the CP6 unit rates for level crossings and, in particular, the AHB+ cost was based on the cost of an MCB-OD level crossing without lower LIDAR.

A benefit to cost ratio greater than 1 in *Table 11* does not indicate that AHB+ is the preferred upgrade. Indeed, at very high risk level crossings, it is likely that the preference will be to upgrade to a protected full barrier crossing (MCB-OD or MCB-CCTV), as this will give a higher level of safety benefit. The risk for each crossing as an AHB, AHB+ and as an MCB-OD is shown in *Figure 31*.

The cost benefit analysis for upgrading to an MCB-OD type crossing relative to upgrading to an AHB+ type level crossing is shown in *Table 12*. The second to last column in this table compares the safety benefits and costs for upgrading to an MCB-OD type with upgrading to AHB+. A higher value indicates that and MCB-OD type crossing is justified from a safety perspective and a value less than 1 indicates that investing in and MCB-OD is disproportionate to the safety benefit. However, whether cost is grossly disproportionate also needs to be considered, and as such, other factors such as a road closure time and modifying signal locations are likely to be factors.

From *Table 12,* it can be seen that the high levels of risk at Milton Fen mean that the upgrade to MCB-OD is justified despite the costs of the additional signalling although the case is marginal and AHB+ gives a high level of benefit at this crossing. The other issue is the road closure time but road use is not high and so the higher road closure time is not expected to result in congestion.

Table 10 Scaling factors for individual AHB level crossings

Level crossing	Daily usage 2018			Factors 2018					
	Vehicles	Pedestrians/ cyclists	Trains	Vehicles	Pedestrians/ cyclists	Trains	Trains[2] (Second train coming)	Station	Road approach speed
Milton Fen	77	366	178	0.05	4.0	2.4	5.5	0	0.1
Waterbeach	4,880	889	178	3.0	9.7	2.4	5.5	Yes	0.4
Dimmocks Cote	6,330	133	178	3.8	1.4	2.4	5.5	0	6.0
Six Mile Bottom	7,826	99	35	4.7	1.1	0.5	0.0	0	3.3
Brinkley Road	1,626	60	35	1.0	0.6	0.5	0.0	0	4.0
Black Bank	1,378	59	127	0.8	0.6	1.7	2.8	0	4.0
Croxton	4,466	15	67	2.7	0.2	0.9	0.8	0	10.5
Meldreth Road	1,455	124	194	0.9	1.4	2.6	6.6	0	1.3

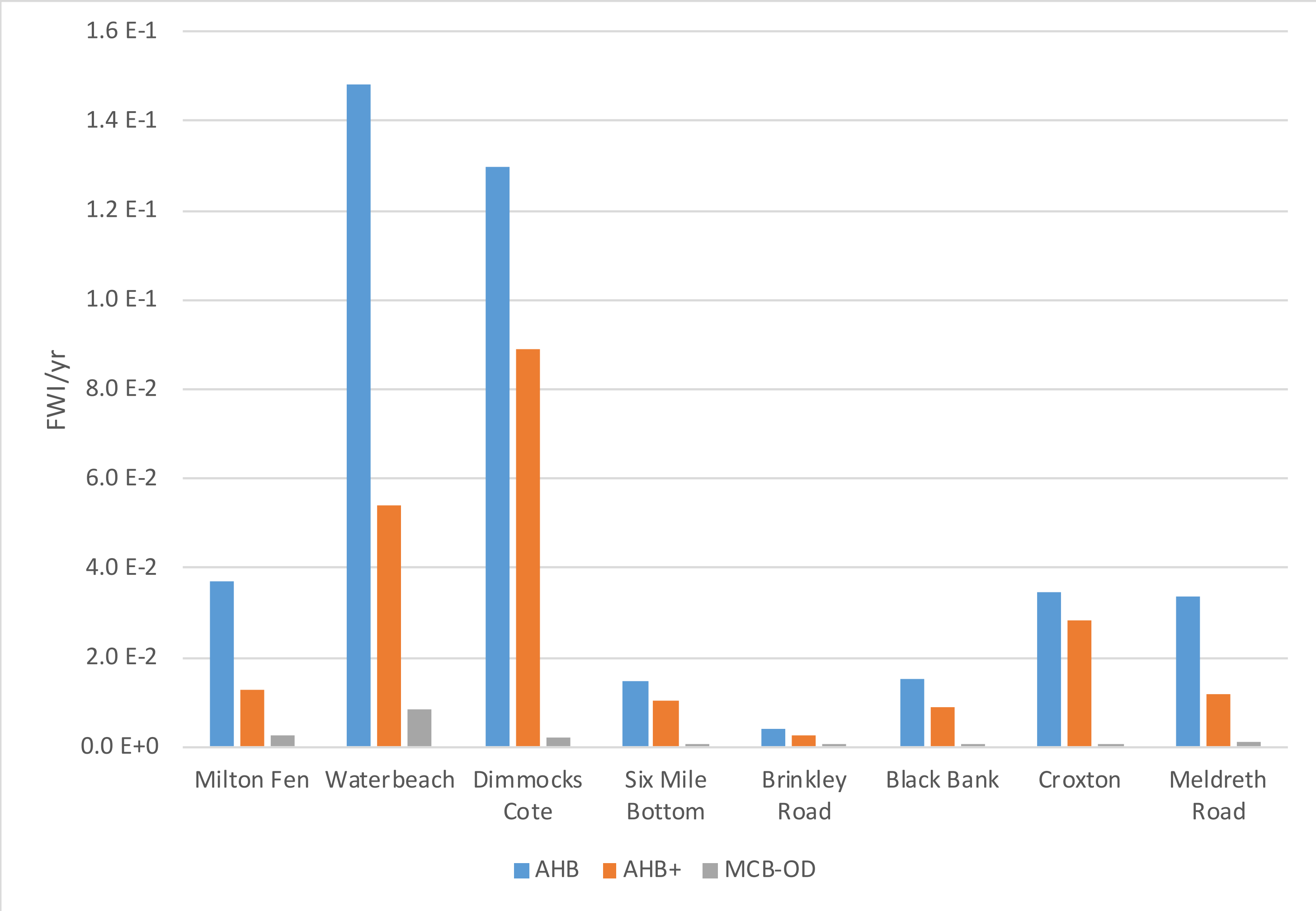
Table 11 Risk benefit and cost benefit analysis for renewing as AHB+ relative to AHB

Level crossing	ALCRM Risk as AHB	%Risk Benefit for AHB+ from SRM	Comments	Risk as AHB+	AHB+ Risk Benefit	NPV of safety benefit over 30 years (AHB+)	Benefit to cost ratio for renewing as AHB+ relative to AHB)
Milton Fen	3.7 E-2	65%	High pedestrian and rail use	1.3 E-2	2.4 E-2	£1,145,935	2.09
Waterbeach	1.5 E-1	64%	High level of benefit for AHB+ but currently at a station and so probably would not be suitable for fitment as AHB+	5.4 E-2	9.4 E-2	£4,466,196	8.16
Dimmocks Cote	1.3 E-1	31%	Does not address late braking	8.9 E-2	4.1 E-2	£1,929,555	3.53
Six Mile Bottom	1.5 E-2	31%	No second train coming benefit (single track)	1.0 E-2	4.6 E-3	£217,390	0.40
Brinkley Road	4.0 E-3	36%	No second train coming benefit (single track)	2.6 E-3	1.5 E-3	£68,963	0.13
Black Bank	1.5 E-2	40%	Does not address late braking e.g. southwest bound traffic. Vehicles do slow down for crossing.	9.0 E-3	6.1 E-3	£288,859	0.53
Croxton	3.4 E-2	17%	Does not address late braking etc.	2.8 E-2	6.0 E-3	£285,008	0.52
Meldreth Road	3.4 E-2	65%	Addresses second train coming; relatively high pedestrian use	1.2 E-2	2.2 E-2	£1,047,676	1.91

Table 12 Cost benefit analysis for renewing as AHB+ relative to renewing as MCB-OD

Level crossing	NPV of safety benefit over 30 years (MCB-OD)	%Risk Benefit (AHB to MCB-OD)	Cost of providing MCB-OD or MCB-CCTV	MCB-OD Cost justification	Benefit to cost ratio (AHB to MCB-OD)	Benefit to cost ratio (Difference between upgrading MCB-OD and AHB+)	Comments
Milton Fen	£1,627,290	93%	£2,482,532	1 SEU	0.66	1.01	Some concern about vulnerable users with AHB+ (4 uses by wheelchair user and 1 scooter in 9 days)
Waterbeach	£6,610,690	94%	£2,932,532	2 SEUs	2.25	2.32	AHB + at a station not likely to be preferred. May be suitable if station is moved
Dimmocks Cote	£6,059,183	98%	£4,732,532	Six additional signals 6 SEUs	1.28	1.52	Much higher benefit for full barrier level crossing
Six Mile Bottom	£691,693	98%	£3,832,532	4 SEUs	0.18	0.26	To be considered in conjunction with Brinkley Road
Brinkley Road	£184,971	97%	£2,032,532	0SEUs - assume signals already in place for Six Mile Bottom	0.09	4.58	Brinkley Road would not cost significantly more to renew as MCB-OD if the signals have already been put in place for Six Mile Bottom. Mix of crossing types for protecting signal if not upgraded.
Black Bank	£694,912	97%	£3,157,532	2 new signals and 2 signal re-heads (2.5 SEUs)	0.22	0.35	If signals installed at Black Bank, a train stopped at the signal would stand over adjacent AHB level crossings introducing a new hazard at those AHB level crossings
Croxton	£1,617,385	99%	£3,832,532	4 SEUs	0.42	0.73	Only a full barrier crossing with signal protection addresses the main hazards at Croxton level crossing and facilitates the removal of the TSR. Skew crossing and so any pedestrians may hold up exit barrier.
Meldreth Road	£1,543,040	96%	£2,032,532	0SEUs	0.76	19.54	The only benefit of AHB+ relative to a full barrier crossing is the shorter road closure time

Figure 31 Chart showing risk as AHB, AHB+ and MCB-OD



4.3 Options for closure or alternate level crossing designs

Options Assessment

The following options were considered:

- Crossing closure (via diversions);
- Crossing closure with an underpass for road vehicles and pedestrians;
- Crossing closure with a full road bridge provided (in-situ);
- Crossing closure with a full road bridge provided (off-line);
- Crossing closure with a pedestrian bridge only provided;
- Retain 'As-Is' as AHB 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 13 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 13 Closure / level crossing type assessment

Option/ Crossing type	ALCRM			Feasibility	Cost		Justification for cost estimate
	2018 usage				Capital	Annual	
	FWI	Score	NPV (30)				
Current crossing type (AHB)	3.7 E-2	C2	£1,751,054	Feasible but very high level of existing risk means upgrade or closure will be required; it is contrary to NR policy to renew such a high risk crossing as AHB. SICA renewal date is 2023. Increased usage under EACE project will increase risk further.	£1,460,010	£16,933	Standard cost, if renewal is required. SICA Renewal date: 2021
Closure	0			The crossing provides the sole means of vehicular access to fields east of the railway and also provides access from Milton to a riverside pedestrian cycleway. It is therefore considered that it would not be practical to close the crossing without providing an alternative means of access over the railway. There is also potential to close Goodens No.1 and Wilsons UWC crossing by diverting to Milton Fen, which would not be possible if Milton Fen was closed without other arrangements being made.			
Pedestrian/cycle bridge and downgrade vehicular access to locked UWCT	1.9 E-3	B4	£91,675	It is understood that the vast majority of traffic is associated with members of the public seeking to access the footpath/cycleway along the River Cam. In discussions, Cambridgeshire council were not averse to reducing status of road to bridleway and allowing a downgrade to a user-worked crossing. There was no horse use in census, and therefore a foot/cycle bridge is likely to meet the needs of the vast majority of users. There is potential to purchase the land to west of crossing to construct a car park then ramped bridge for pedestrians and cyclists (2.5m wide) less than equestrian bridge (3.5m wide). From a legal perspective it is likely to be necessary to take powers to buy land and extinguish rights along road. The cost of ramped cycle bridge is about £3m with an additional £0.5m to purchase land and construct a small car park. The level of residual risk at the crossing for authorised users using a UWC crossing is estimated on the basis of 2 tractors and two HGVs per day using the crossing.	£3.5m		£3m for accessible bridge; £500k to purchase land an build small car park; £20k to install telephone

Option/ Crossing type	ALCRM			Feasibility	Cost		Justification for cost estimate
	2018 usage				Capital	Annual	
	FWI	Score	NPV (30)				
				Potential for misuse of crossing even if the gate is locked.			
Pedestrian/cycle bridge and downgrade vehicular access to locked UWCM	1.3 E-3	B4	£60,813	As above but with MSL rather than telephone for crossing protection. Signal CA229 (PL) is between the potential strike in point and the crossing on the Down approach and signal CA230 (PL) is between the potential strike in point and the crossing on the Down approach and so an MSL integrated with the signalling is likely to be required.	£4.3m		£3m for accessible bridge; £500k to purchase land an build small car park; £800k for an MSL
Closure + road bridge	0			It would be feasible to construct a bridge. The old crossing keeper's cottage is located to the north west of crossing. It would be possible to build bridge slightly to the north or the south and alter road alignment. This is likely to be more expensive than a typical road bridge -'standard cost' of around £7m; £8m is the cost assumed for this assessment. As the Cambridge Sports Lakes Trust has plans for the area and it is understood that they have purchased/leased large quantities of land in the area, it would be sensible to liaise with them to establish a solution that is consistent with future plans for the area.	£8m		
Closure + underpass	0			Water courses in the vicinity and River Cam is about 400m away. Hence an underpass would be more expensive than a bridge. Liable to flooding. Probably not practical to make it suitable for large farm machinery.			
Closure with bypass via Horningsea	0			It would be possible to bring access from Horningsea Road to the east but it would be necessary to build a bridge over the River Cam, hence this option would be less viable that an in-situ bridge. An alternative scheme would be a link road from the A14 although the road is elevated at this point; a link road of 1.6km would also need to be constructed. The bridge over railway for A14 has insufficient width to allow an additional road, furthermore the option is estimated to costs about £10m, hence the costs would be grossly disproportionate to the safety benefits.	£10,000,000		Approx. 1600m of 2 carriageway road and bridge connection to A road at £2.5k per m assumed. Plus land purchase

Option/ Crossing type	ALCRM 2018 usage			Feasibility	Cost		Justification for cost estimate
	FWI	Score	NPV (30)		Capital	Annual	
ABCL				Not a viable option due to the restriction in linespeed that would be necessitated and would be very high risk	£1,336,708	£16,933	
AHB+	1.3E-2	-	£605,120	While the site is generally suitable for AHB+ with slow road approach speeds and no periods where very high usage levels are expected, the high levels of risk at Milton Fen mean that the upgrade to MCB-OD is justified despite the costs of the additional signalling although the case is marginal and AHB+ gives a high level of benefit at this crossing. The other issue is the road closure time but road use is not high and so the higher road closure time is not expected to result in congestion.	£2,007,185	£20,154	CP6 standard renewal costs for MCB-OD without lower LIDAR and no signalling costs
MCB-CCTV	2.6 E-3	E4	£123,764	Feasible. The Down existing signal position is acceptable (@183m). The Up protecting signal is over 600m (@737m) but as the line speed is 75 mph and the crossing is lightly used, this is probably satisfactory. The signal could be moved forward slightly. 1 SEU assumed.	£2,314,316	£54,265	CP6 standard renewal costs, 1 x SEU
MCB-OD	2.6 E-3	E4	£123,764	Feasible. Arrangements at the PSB/ROC is likely to make OD crossing preferable. May require some reprofiling.	£2,482,532	£20,154	CP6 standard renewal costs, 1 x SEU

4.4 Conclusions regarding closure of the crossing

The first priority should be to close the crossing where possible. As described in *Section 3.4*, the Cambridge Sports Lakes Trust has plans for a large sporting complex west of the railway as shown in *Figure 30*, which would cut off Fen road and would facilitate closure of Milton Fen and the adjacent user worked crossings - Wilsons and Goodens No. 1. It is not clear how vehicular access would be maintained to land trapped between the railway and the River Cam under this proposal. It is understood that the Cambridge Sports Lakes Trust withdrew their plans in July 2018 but there are plans for resubmission in 2019. Network Rail should consult with the local authority and the Cambridge Sports Lakes Trust and investigate whether it is possible to support such a proposal if it facilitates closure of the level crossings.

The only other closure option identified that could be viable is closure via a close to in-situ bridge. The old crossing keeper's cottage is located to the north west of crossing. It would be possible to build a bridge slightly to the north or the south and alter road alignment. This is likely to be more expensive than a typical road bridge - '*standard cost*' of around £7m; £8m is the cost assumed for this assessment. As the Cambridge Sports Lakes Trust has plans for the area and it is understood that they have purchased/leased large quantities of land in the area, it would be sensible to liaise with them to establish a solution that is consistent with future plans for the area.

Closure has the advantage of delivering the maximum safety benefit without the high road closure time implications of an MCB-CCTV or MCB-OD type crossing. Should the train frequency increases under consideration by the EACE project occur, then a future road closure time of about 62% in the busiest hour might be considered an irritant to users and misuse could become prevalent. Usage is not, however, so high that congestion is considered to be likely.

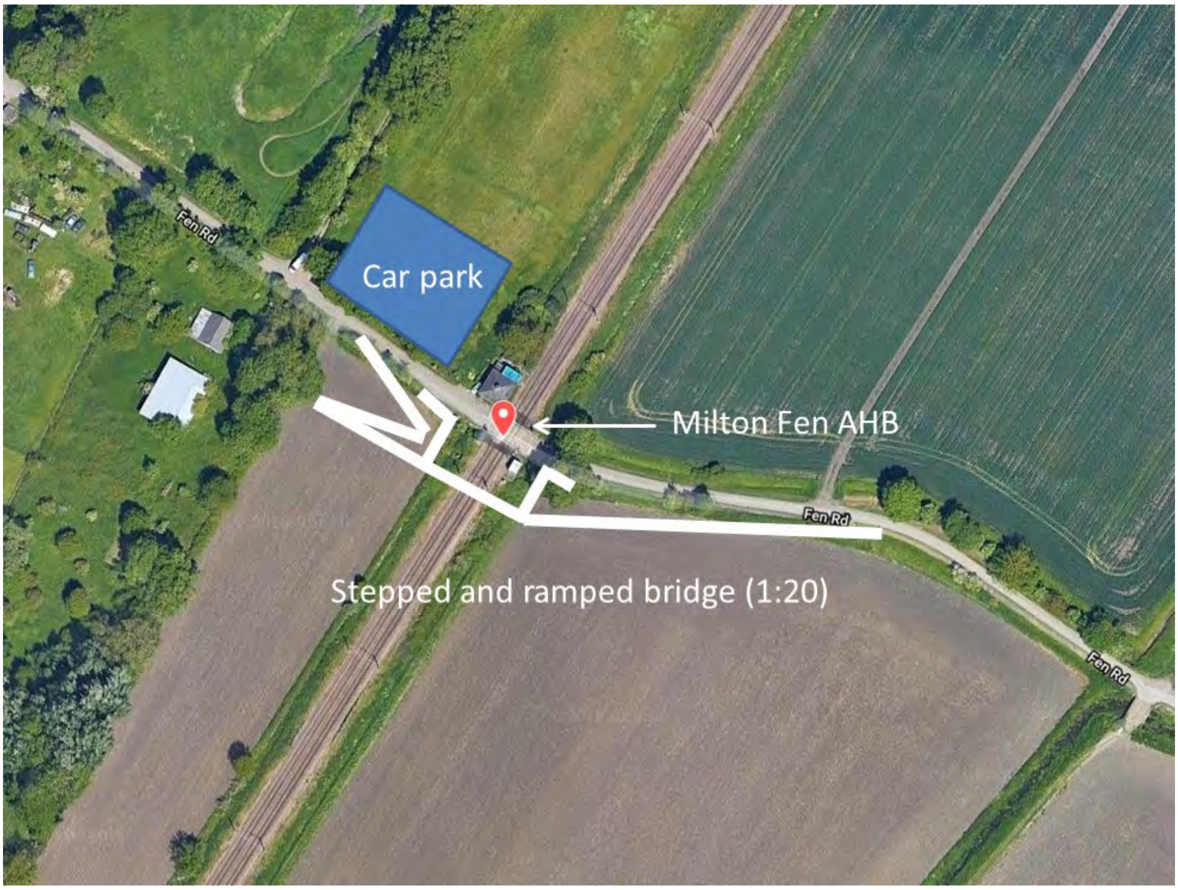
Depending on state of progress of the Cambridge Sports Lakes Trust plans, it may be more cost effective to pursue closure; this would facilitate the Ely capacity enhancement project.

4.5 Conclusion about crossing type

Like-for-like renewal as an AHB crossing would not be the preferred option as it presents a very high level of risk of 3.7×10^{-2} FWI per year. It also is exposed to hazards associated with high pedestrian/cyclist use. Renewal of a crossing with an ALCRM score of C2 as an AHB would also be contrary to Network Rail's strategy of upgrading higher risk AHB level crossings.

It is understood that the vast majority of users are leisure users seeking to gain access to the riverside walks alongside the River Cam and there is a smaller group of users who require vehicular access for agricultural purposes. There is potential to provide a car park and an accessible bridge for leisure users and downgrade the public road and the level crossing to a locked user worked crossing, which would only be permitted for use by authorised users as shown in *Figure 32*. It is understood that the Cambridge Sports Lakes Trust control much of the land to the west of the crossing and Network Rail should consult with the local authority and the Cambridge Sports Lakes Trust and investigate whether it is possible whether such a proposal is consistent with future planned use of the land.

Figure 32 Downgrade crossing to UWC and replace with pedestrian bridge and car park



While the site is generally suitable for upgrade to an AHB+ type crossing with slow road approach speeds and no periods where very high usage levels are expected, the high levels of risk at Milton Fen mean that the upgrade to MCB-OD is justified despite the costs of the additional signalling although the case is marginal and AHB+ gives a high level of benefit at this crossing. The other issue is the road closure time but road use is not high and so the higher road closure time is not expected to result in congestion. The AHB+ project is in development with a trial site expected to be installed in 2020 and there is potential for further trial sites. The project risk of utilising a number of trial sites on this project due to the uncertainty of when AHB+ will be available to install as a renewal is a significant concern.

In the event that closure and downgrade options, prove not to be feasible, the preferred renewal option is, therefore, MCB-CCTV or MCB-OD; both of these crossing types would offer significant risk reduction compared with AHB from 3.7×10^{-2} to 2.6×10^{-3} FWI per year.

The crossing is within the 20km Cambridge MERLIN radio telescope planning zone so precautions against interfering with this would need to be taken should MCB-OD Mk. 1 be provided; it is understood, however, that the project would use Mk2 radar and so proximity to the MERLIN telescope should not be an issue.

Both MCB-CCTV and MCB-OD types would lead to similarly high road closure times. 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.

4.6 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 14*).

The additional controls identified for consideration include:

- Consider relocating the Up direction signal from its current non-compliant location 737m from level crossing to a compliant location. If Network Rail were carrying this out as a standalone project, it may not be cost effective to add/move signals, but because resignalling is taking place at adjacent level crossings (Waterbeach etc.), signals may be moved in the area and as such there may be potential to optimise protecting signal placement in order to minimise barrier downtime;
- Provide one footway of compliant width (1.5m) with ORR guidance rather than both as there is a desire not to narrow the road width;
- Consider providing an additional passing place further from the crossing, or extend the length of double track road at the crossing, to minimise the risk of blocking back; and
- Consider providing extended hoods (with LED RTLs fitted as standard) to mitigate low sun.

Table 14 Assessment of additional controls

Hazard	Standard/existing controls	Potential additional controls	Feasibility	Cost	Recommend
Long road closure times from Up direction signal being in non-compliant location 737m from level crossing		Additional protecting signal close to level crossing	Yes		Because resignalling for Waterbeach etc signals may be moved in the area and as such there may be potential to optimise for Milton Fen. If were doing stand alone may not add / move signals. Cambridge Outer, but this area effectively becoming a mini-resignalling project due to the level crossing renewals driving signal repositioning.
SPAD at protecting signals	Run by protection Signal will be in compliant location at least 50m from the level crossing				Further controls may not be considered necessary with signals in compliant location but SORAT-LX could be used to confirm this
Footpaths are narrower (approx.. 1 m) than would be required by ORR guidance (1.5m)	Footways are currently about 1m	Increase footpath width to 1.5m	Road is narrow (only 5m) based on existing footpath width of 1m		Interpret ORR guidance such that need to have one footway that is compliant rather than both (used this on previous crossings where 2 compliant footways would narrow the road)
Pedestrian/cyclist fall on crossing		Lower LIDAR justified by assessment tool			If Mk 1 radar is utilised, lower LIDAR is justified
Blocking back - no red only amber		BPM - criteria not met			N – better to increase road width further from the crossing to alleviate potential for blocking back

Hazard	Standard/existing controls	Potential additional controls	Feasibility	Cost	Recommend
		Additional passing place further from crossing (or extend length of double track road)	Yes		Recommended
Deliberate RV misuse of crossing	Red light enforcement cameras	Red light enforcement camera	Feasible	£60k	No. Misuse is not sufficiently prevalent to warrant investment at a full barrier level crossing.
Pedestrian struck by barriers		Tactile edging for visually impaired	Yes	Minimal	No need to recommend this Standard but makes no real sense DIA recommended to consider this Also recommend road safety audits
Low sun - The road runs east to west and so low sun is a potential issue	The approach is tree lined, quite level and low speed	Extended hoods Large backboards Anti-glare road surface Rumble strips		Minimal	LCM recommends extended hoods as minimal disadvantage / cost - LED RTLs are proposed Other mitigations likely not required
No lighting - no street lights over crossing		Low lux lighting			Would need lighting for CCTV No - Do need believe MCB-ODs need any extra lighting, expect users to bring torches if use in dark. No proximity to station.

4.7 Assessment of the costs and benefits of Lower LIDAR

Network Rail has developed an assessment tool to calculate the benefits of the provision of Lower LIDAR at MCB-OD level crossings [9]. 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 15*.

Table 15 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		178
Pedestrians per day		216
Cycles per day		149
Motorcycles per day		2
Other road vehicles per day		77
Crossing is at a station		N
If at a station, the number of stopping trains per day		N/A
Is line speed at the crossing 20mph or less?		N
Outputs		
Safety benefit	**FWI per year**	0.00404
	NPV_{30}	£161,859
Cost	**NPV_{30}**	£52,327
Safety benefit to cost ratio over 30 years		3.09

From these inputs, the current safety benefit of the Lower LIDAR is 4.0 x 10^{-3} FWI per year. This is equivalent to a monetised benefit over 30 years of £162k.

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 low usage by unaccompanied children (none in the nine-day census) means that it would not require the lower height setting; the safety benefit is approximately £162k. The benefit to cost ratio for providing Lower LIDAR is 3.1, subject to there not being significant civils cost, which suggests that the cost of providing Lower LIDAR is not 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 17*. This assumes that the crossing is maintained in good condition over its full life.

The following additional controls are recommended for consideration:

- Provide new, level deck with 1.5m footway on one side.

Table 16 summarises the number of hazards afforded each rating before and after the proposed additional controls.

Table 16 Summary 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	10	7

Conclusion about Lower LIDAR

Lower LIDAR is justified at this crossing as the safety benefit to cost ratio is much greater than 0.5.

Table 17 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	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	Vegetation in footway particularly on the north side	Improved footways over whole crossing length	Minor	No
4	Surface – drainage	Pooling of water following rain	Crossing slightly humped so major pooling unlikely and no specific issues identified		No	No
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	Crossing is on a straight road		No	No
7	Layout - skew	Direction of users traverse not orthogonal to tracks. Increased traverse time where skew is significant.	Road is perpendicular to the rails		No	No
8	Layout / environment / conspicuity	Extraneous light and noise sources, short approach, no audible alarm (or hard to hear), poor conspicuity	Crossing is conspicuous on straight approach, audible warnings are of sufficient volume for the small crossing area. No likely distractions.		No	No

Ref:	Topic	Hazards	Site comments	Possible additional controls	Rating pre-mitigation	Rating post-mitigation
9	Gradient / profile	Crossing on a raised profile (gradient up or down to crossing). Crossing itself on a gradient	Relatively flat		No	No
10	Footpath width and road width	Narrow footpath, or narrow roadway meaning less space for pedestrians	Footways are only 1m in width and do not meet ORR guidance. Road width 5m but only lightly used by vehicles. Pedestrians tend to walk in centre of road rather than use the footways.	1.5m footway on one side	Minor	No
11	Pedestrian walkway - edging	Poor marking of edge of crossing / railway	Footways adequately marked.		No	No
12	Pedestrian walkway - obstacles	Posts, fencing, etc protrudes into walkway	No significant intrusions		No	No
13	Lighting	Low levels of lighting in hours of darkness	No light sources nearby, pedestrians may be likely to carry torch at night in this rural location.	Low lux lighting	Minor	Minor
Pedestrian vulnerability factors						
14	Vulnerable - elderly	Used by large numbers of elderly people	The census identified 15 uses by elderly users over 9 days		Minor	Minor
15	Encumbered – push chairs, luggage / baggage	Used by large numbers of adults with push chairs, and/ or lots of travellers	Well used - 5 users per day		Minor	Minor
16	Encumbered - dogs	Used by high proportion of dog walkers	Well used by dog walkers		Minor	Minor

Ref:	Topic	Hazards	Site comments	Possible additional controls	Rating pre-mitigation	Rating post-mitigation
17	Vulnerable – cognitive impairment	Large proportion of users with reduced cognitive capability	There are no specific environs that would encourage a particular user group.		Minor	Minor
18	Vulnerable – other mobility impaired	Large proportion of users with impaired mobility including wheelchair users	Census noted one mobility impaired use and 4 wheelchair user uses over 9 days		Minor	Minor
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 this particular user group.		No	No
20	Impaired users	Users under the influence of alcohol	No pubs nearby		No	No
N/A	Equestrian use	Person thrown from horse	The census identified no use by this group. There are no specific environs that would encourage this particular user group.		No	No
Operational factors						
21	Event hazard	Local event promotes high temporary use of the crossing	No sources identified and events with high pedestrian use of crossing unlikely in this location although it is likely to be busier on a sunny weekend or public holiday		No	No
22	Seasonal hazard	Weather - icy road	Rural location likely subject to occasional icing.		Minor	Minor

4.8 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 18*.

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:

- *Lower LIDAR.* Recommended if the Mk1 POD is fitted.
- *Response time and number of available attendants for CCU operation should it be necessary.* Need to ensure that LCU controls are on the Milton (west) side. Parking needs to be considered at the crossing if feasible.

Table 18 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 received high pedestrian use (a seven day average of 216 pedestrians a day). Usage is relatively well spread - the busiest quarter hourly period occurred at 08:45 on the first Sunday with 44 pedestrians.	N
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 only identified occurrences of 'blocking back' where are vehicle pulled over near to the crossing to allow another vehicle to pass. The BPM criteria were not close to being met.	N
Default time at which time barriers lower (30 secs). Exit barriers at 4 barrier crossing.	Blocking back for extended durations	No prolonged blocking back has been identified from the census. Extending the default time is not recommended.	N
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	Recommended
Minimise distance between barriers	Long traverse at skew crossing giving rise to entrapment risk.	The existing distance barrier-to-barrier is approximately 10.3m as there is no skew. Minimising distance always preferred.	No further action required - already low

MCB-OD configuration factor	Hazards	Consideration at level crossing	Recommended
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 10.3 m and so the crossing distance is relatively short. 4 uses by wheelchair users, 1 use by mobility scooter and usage by elderly/pushchair users. Hence an extended anti-trapping delay is not considered to be necessary.	N - Unless barriers have to be pushed out do not recommend
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. Note: may be two barrier MCB-OD only as a narrow road (up to designer)	N
Hurry call systems integrating with highway traffic lights	Traffic congestion caused by nearby highway traffic lights.	No nearby traffic lights causing blocking back.	N
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 northbound traffic is 14.6mph, the southbound direction is 15.8mph. Light use by HGVs. Hence, extending the sequence to provide road users with additional warning time is not recommended.	N
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, no skew and the low speed makes such events improbable, particularly if the barriers are moved closer to the crossing.	N

MCB-OD configuration factor	Hazards	Consideration at level crossing	Recommended
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.	N
Standing red man indication	High pedestrian use Poorly sited RTLs for pedestrians	Despite the high number of pedestrian users, the RTLs are visible from all normal approaches. No data on visually impaired - DIA. Not a station so not recommended.	N
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.	Would come from Cambridge, but depot may be moving Need to ensure that LCU controls are on the Milton side otherwise access difficult Parking needs to be considered for all crossings and provided where possible, but space may be limited	Y

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 Cambridge Sports Lakes Trust has plans for a large sporting complex west of the railway, which would cut off Fen road and would facilitate closure of Milton Fen and the adjacent user worked crossings - Wilsons and Goodens No. 1. Network Rail should consult with the local authority and the Cambridge Sports Lakes Trust and investigate whether it is possible to support such a proposal if it facilitates closure of the level crossings. A combined consultation strategy with the EACE project is recommended.
2. The only other closure option identified that could be viable is closure via a close to in-situ bridge which would maintain access to the old crossing keeper's cottage which is located to the north west of crossing. As the Cambridge Sports Lakes Trust has plans for the area and it is understood that they have purchased/leased large quantities of land in the area, it would be sensible to liaise with them to establish a solution that is consistent with future plans for the area. A combined consultation strategy with the EACE project is recommended.
3. Closure has the advantage of delivering the maximum safety benefit without the high road closure time implications of an MCB-CCTV or MCB-OD type crossing. Should the train frequency increases under consideration by the EACE project occur, then a future road closure time of about 62% in the busiest hour might be considered an irritant to users and misuse could become prevalent. Usage is not, however, so high that congestion is considered to be likely.
4. It is understood that the vast majority of users are leisure users seeking to gain access to the riverside walks alongside the River Cam and there is a smaller group of users, who require vehicular access for agricultural purposes. There is potential to provide a car park and an accessible bridge for leisure users and downgrade the public road and the level crossing to a locked user worked crossing, which would only be permitted to use by authorised users. As described above, it is understood that the Cambridge Sports Lakes Trust control much of the land to the west of the crossing and Network Rail should consult with the local authority and the Cambridge Sports Lakes Trust and investigate whether such a proposal is consistent with future planned use of the land; this consultation should be arranged jointly with the EACE project. At present, this proposal does not seem consistent with Cambridge Sports Lakes Trust proposals and the significant investment required should only be considered if consistent with the long term land use.

5. Like-for-like renewal as an AHB crossing would not be the preferred option as it presents a very high level of risk of 3.7×10^{-2} FWI per year. It also is exposed to hazards associated with high pedestrian/cyclist use. Renewal of a crossing with an ALCRM score of C2 as an AHB would also be contrary to Network Rail's strategy of upgrading higher risk AHB level crossings.
6. While the site is generally suitable for upgrade to an AHB+ type crossing with slow road approach speeds and no periods where very high usage levels are expected, the high levels of risk at Milton Fen mean that the upgrade to MCB-OD is justified despite the costs of the additional signalling although the case is marginal and AHB+ gives a high level of benefit at this crossing. The other issue is the road closure time but road use is not high and so the higher road closure time is not expected to result in congestion. The AHB+ project is in development with a trial site expected to be installed in 2020 and there is potential for further trial sites. The project risk of utilising a number of trial sites on this project due to the uncertainty of when AHB+ will be available to install as a renewal is a significant concern.
7. In the event that closure and downgrade options, prove not to be feasible, the preferred renewal option is, therefore, MCB-CCTV or MCB-OD; both of these crossing types would offer significant risk reduction compared with AHB from 3.7×10^{-2} to 2.6×10^{-3} FWI per year. Considering these options:
    - The crossing is within the 20km Cambridge MERLIN radio telescope planning zone so precautions against interfering with this would need to be taken should MCB-OD Mk. 1 be considered; hence the Mk2 radar is recommended as it does not present the same interference and planning issues.
    - Both MCB-CCTV and MCB-OD types would lead to similarly high road closure times which may be problematic as the crossing is well used by pedestrian and cyclists, particularly should train frequency increases occur in the future.
    - 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.

Consideration of local hazards and MCB-OD configuration parameters

8. The additional controls identified for consideration include:
    - Consider relocating the Up direction signal from its current non-compliant location 737m from level crossing to a compliant location. If Network Rail were carrying this out as a standalone project, it may not be cost effective to add/move signals, but because resignalling is taking place at adjacent level crossings (Waterbeach etc.), signals may be moved in the area and as such there may be potential to optimise protecting signal placement in order to minimise barrier downtime;

- Provide one footway of compliant width (1.5m) with ORR guidance rather than both as there is a desire not to narrow the road width;
- Consider providing an additional passing place further from the crossing, or extend the length of double track road at the crossing, to minimise the risk of blocking back; and
- Consider providing extended hoods (with LED RTLs fitted as standard) to mitigate low sun.

9. Lower LIDAR is justified at this crossing as the safety benefit to cost ratio is much greater than 0.5. Lower LIDAR may not be required for the Mk2 radar units, which are expected to be utilised.

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

    - *Response time and number of available attendants for CCU operation should it be necessary*. A crossing attendant is likely to come from Ely depot. Hence there the LCU should be sited on the Milton (west) side. Parking needs to be considered at the crossing if feasible (potentially addressed through discussions with Cambridge Sports Lakes Trust).