Submission ID: 5294

To date we have heard and read repeated assurances from the applicant that the â€œbasis of design to dateâ€• is to â€œAcquire the minimum amount of land necessary.â€•
This forms the basis of our concern that the scheme to date does not fulfil this statutory requirement.
We have been presented with a more expensive proposal that requires the acquisition of more of our land. We remain skeptical of the reasons we have been given by the applicant that this excessive land acquisition is necessary.
It seems logical to us that if there is an opportunity to reduce land take as well as provide â€œthe best value for moneyâ€• then the Applicant would seek to pursue this?!
Losing in excess of 4 acres of our land and it appears bearing the entire burden of this part of the scheme, we need a greater understanding of the weighting that is given to neighbour objections versus cost, reduced land take and the apparent â€œstandard Highways England practice to keep to a minimum the number of affected landowners.â€•
Whilst we accept it is necessary to respond to feedback from local residents (in our case feedback from Nags Head Lane Residents) where their objections are baseless and our belief ridiculous it is not acceptable to us to increase land take simply to silence â€œaggressive objectors.â€•
Lacklustre arguments and reasoning that centre around habitat preservation, screening, light pollution have been successfully refuted during our email responses. It is therefore not acceptable to us that the Applicant then fails to respond to us when we refute their evidence!
We feel certain there will be assurances of â€œextensive engagement.â€• To this end we would need from the Applicant a definition of what constitutes â€œeffectiveâ€• or extensive engagement. We do not believe there has been meaningful engagement.
To date we have merely endured: repetition of arguments that have been successfully refuted, assurances that our concerns raised are not unjustified or unreasonable only for them then to be ignored, and the withholding of key reports, statistics and calculations what would alleviate our concerns that our land is being used to compensate others.
Our concerns are not mutually exclusive and addressing one area of concern does not, we believe justify the ignorance of other areas of concern.
We attach a file entitled â€œAnthony WSP Tech Noteâ€• to this submission. This is a report we have paid for which poses many unanswered questions that will be key to our understanding of the avoidance of some areas of land and alleviate our concern that we are losing our land unnecessarily and enduring a major impact to our development opportunity.
To conclude we are asking the applicant to produce the evidence that justifies their design and in accordance with this fulfil their obligation to â€œseek to acquire only that land which is required.â€• At present we do not have that clarity.

TECHNICAL NOTE

(Doc Ref: 1368-WSP-00-XX-RP-CV-0002)

DATE:	09 June 2021	**CONFIDENTIALITY:**	Restricted
SUBJECT:	Alternative highway and drainage options for Roxton Road link (north)		
PROJECT:	70061368 – Dove House Farm, Wyboston	**AUTHOR:**	Anthony Groom / Joe Leslie
CHECKED:	Livio Martelli	**APPROVED:**	Livio Martelli

INTRODUCTION

This technical note has been prepared to assist our clients, Duncan & Maxine Buchanan, of Dove House Farm, The Lane, Wyboston, with making a formal representation to the Planning Inspectorate (PINS) in relation to the following elements of Highways England's A428 Black Cat to Caxton Gibbet proposed highway improvement scheme (the Scheme) that would directly impact on their property:

- Roxton Road link (north)
- Two attenuation basins on either side of the proposed Nags Head Lane link
- Two flood compensation areas on either side of Roxton Road link (north)

JULY 2019 REVIEW & ALTERNATIVE DESIGN

In July 2019, WSP provided an outline engineering assessment of the proposed Roxton Road link (north) that also included an alternative design proposal. Highways England (HE) provided a response to this alternative design proposal in September 2020 (see Technical Note ref HE551495-ACM-GEN-GEN_ZN1_SR_Z_ZZ-TN-CH-0001 in Appendix A) with the following main findings:

- The Scheme design would require less land than the alternative design;
- Comments regarding the alignment of the horizontal radii forming the double bend;
- The alternative design moves the road closer to existing residential properties; and
- The alternative design requires the removal of at least 25m of existing hedge.

Our response to these findings is summarised below, in order of the above bullet points:

i) Whilst the alternative design may require more land than the proposed layout, according to HE's calculations this would equate to 0.0386 hectares of additional land which is considered to be a modest amount in the overall context of the Scheme. Furthermore, due to the drainage design issues described on pages 3 & 4 of this note, subject to further design iteration there would appear to be an opportunity to reduce the land requirement of the alternative design such that the overall land requirement of each design could be broadly similar.

ii) These comments are largely due to drafting issues when preparing the alternative design as it was only possible to use pdf versions of the Scheme drawing to generate the alternative design. They could be satisfactorily addressed through further design iteration and through the availability of drawings and topographical information in AutoCAD format.

iii) As the extent and amount by which the link road (alternative design) is closer to residential properties is localised, this is not considered to be a significant issue and appropriate noise mitigation measures could be provided if necessary.

iv) Similar to iii) above, the nature of this issue is not considered to be significant and could be addressed through localised landscape mitigation works.

JUNE 2021 FURTHER REVIEW

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 require that the Environmental Statement contains a description of the reasonable alternatives studied by the applicant and describes the main reasons for the options chosen taking into account the effects of the development on the environment. With this in mind, and having reviewed HE's Assessment of Alternatives (Application document reference TR010044/APP/6.1), the principal matters regarding the Scheme we wish to draw to the attention of PINS as part of this further review are summarised below (specific questions we wish to raise are shown in italics for ease of reference).

A. Lack of alternative options/corridors for Roxton Road Link

It is unclear what alternative alignments for the proposed Roxton Road link HE has investigated and why it considers that the proposed alignment is the most appropriate.

We are aware that HE undertook a consultation event in December 2018 specifically for the Roxton Road link road, where it only proposed a single route corridor for the proposed link road. We note that the proposed Roxton Road link road alignment essentially follows this single route corridor. We also note that alternative routes (Orange, Purple & Pink) for the proposed dual carriageway between the Black Cat and Caxton Gibbet junctions have been investigated, however, it is unclear why a similar level of assessment has not been undertaken with respect to the Roxton Road link. *Can HE please clarify the optioneering process it has undertaken in selecting the route corridor for the Roxton Road link and how this satisfies the above EIA Regulations?*

Appendix B contains an example of a concept design for an alternative Roxton Road link layout. It should be noted that this concept design assumes that, instead of using the proposed Roxton Road link (south), traffic would use the existing Roxton Road between Chawston Lane and the proposed Roxton Road bridge over the realigned A421. *Would HE consider an alternative design for the Roxton road link, such as the one illustrated in Appendix B? If not, can HE please provide clear reasons that support such a decision?*

TECHNICAL NOTE

(Doc Ref: 1368-WSP-00-XX-RP-CV-0002)

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B. Drainage proposals

In terms of proposed drainage catchments, the Drainage Strategy (Application document ref. TR010044/APP/6.3) and Drainage Engineering Plan HE551495-ACM-LSI-ZN1_SW_Z_ZZ-DR-DC-0502 indicates that Roxton Road link is split into two catchments, as follows:

- Roxton Road link (north) Catchment 1 (covering the extents of the link road between South Brook and Begwary Brook); and
- Roxton Road link (north) Catchment 2. (covering the proposed link road north of Begwary Brook)

Catchment 1 is proposed to discharge to the Begwary Brook via a flow control and the two un-numbered ponds either side of the proposed Nags Head Lane link, however it is assumed based on required volumes the southern pond is Pond 1 and the northerly pond is Pond 2.

Catchment 2 is proposed to discharge to the Begwary Brook via a flow control with required attenuation volumes fulfilled by oversized pipes.

The location of the two ponds within the catchment would appear to be appropriate based on the Roxton Link Road (North) - Work No. 29a long-section found on plan HE551495-ACM-LSI-ZN1_SW_Z_ZZ-DR-DC-2418, as they are located at a low point of the proposed road catchment. However, on examination of the long-section, Roxton Road Link (South) – Work No.18 on plan HE551495-ACM-LSI-ZN1_SW_Z_ZZ-DR-DC-2417, a further sag/low point at approximate chainage 990m is noted which has prompted us to investigate an alternative outline drainage design (see plan at Appendix C). The main features of this alternative design would involve removing the impermeable area south of Chawston Lane (shaded red on Appendix C plan) from the current catchment 1 and providing an additional pond west of Roxton Road link (south), adjacent to the above low point and within the current order limits, to attenuate flows from the additional catchment area before discharging into South Brook. The size of this additional pond has been calculated as follows:

i) South of Chawston Road the catchment comprises approx. 0.28ha of impermeable area. Based on a source control storage estimate utilising FSR data in Microdrainage and an assumed discharge rate of approx. 0.6 lites/sec (from the HR Wallingford Greenfield estimation tool), a storage requirement of 220m3 would be required in a 1 in 100 + 40% climate change allowance storm event.

ii) At a depth of 1.5m (including a 300mm freeboard) and 1 in 3 side slopes a pond of top area of 335m2 would appear to be sufficient for this additional pond.

iii) Referring to the Microdrainage output in Appendix D, the calculations undertaken are considered to be a conservative approach and the sizing could be reduced if further design detail was provided by HE.

Can HE please clarify why an alternative drainage design, as illustrated on the plan included in Appendix C, has not been considered and why their proposed drainage design for Roxton Road link (north) is the most appropriate?

It is anticipated that this alternative design would enable the size and associated land-take of Ponds 1 & 2 to be reduced and could enable the proposed alignment of Roxton Road link (north) to be amended such that the impact on our client's land would be reduced and land-take from other landowners identified in the HE Technical Note in Appendix A could be reduced.

Furthermore, it is also not clear from the drainage strategy report which rainfall data has been used for the sizing of Ponds 1 & 2 or whether they are based on greenfield discharge limits or 5 litres/sec to prevent blockage as stated (or if this is a recommendation for future work). *Can HE please clarify the position in this regard so that further investigation of the size of Ponds 1 & 2 can be undertaken?*

C. Flood compensation areas

The Flood Risk Assessment (FRA), Application document ref. TR010044/APP/6.3, details flood risk from different sources and states that flood compensatory storage is required to offset new permanent construction within identified floodplain.

Plan HE551495-ACM-LSI-ZN1_SW_Z_ZZ-DR-DC-2302 (WORKS PLAN REGULATION 5(2)(j) Sheet 2) shows flood compensation areas adjacent to Begwary Brook, directly east and west of the proposed Roxton Road link (north). It is assumed this is to compensate for the loss of flood plain caused by the link road, as this is not detailed within the FRA. Assuming this is the case, *can HE please confirm whether compensatory storage has been considered further upstream, as an alternative?* This would present an opportunity to relocate the proposed storage (Work No's 34 & 35) further away from Dove House Farm and other nearby properties between the existing A1 and proposed Roxton Road link (north).

TECHNICAL NOTE

(Doc Ref: 1368-WSP-00-XX-RP-CV-0002)

DATE:	09 June 2021	**CONFIDENTIALITY:**	Restricted
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PROJECT:	70061368 – Dove House Farm, Wyboston	**AUTHOR:**	Anthony Groom / Joe Leslie
CHECKED:	Livio Martelli	**APPROVED:**	Livio Martelli

CONCLUSION

The purpose of this technical note is to assist our clients, Duncan & Maxine Buchanan, with making a formal representation to PINS regarding aspects of the Scheme that would impact on their property at Dove House Farm.

Firstly, and further to the submission of an alternative design for the Roxton Road link (north) in July 2019, WSP has provided responses to the main findings from the HE Technical Note in Appendix A and requests that the alternative design is reconsidered in light of these responses.

Secondly, having undertaken a further review of the Scheme in June 2021, WSP has identified a number of additional queries (shown in italics) described in parts A, B & C above for which responses are requested.

APPENDIX A

TECHNICAL NOTE

Project:	**A428 Black Cat to Caxton Gibbet**				
Title:	**Roxton Road Link Alternative Design Proposal at Dove House Farm**				
Doc ID:	**HE551495-ACM-GEN-GEN_ZN1_SR_Z_ZZ-TN-CH-0001**				
Date:	**September 2020**	Version:	**P01**	Status:	**S2**

Revision	Date	Prepared by	Reviewed by	Approved by
P01	24/09/2020	PS		

1 Alternative Design Proposal at Dove House Farm

1.1 WSP Alternative

1.1.1 The owners of Dove House Farm have employed WSP to develop an alternative alignment for the northern section of the Roxton Road Link.

1.1.2 This is described in a WSP technical note “Engineering assessment of the proposed link road between “The Lane” and “Chawston Lane”, Wyboston, Bedfordshire“ (document no. 1368-WSP-00-XX-RP-CV-0001) and shown on WSP drawing no. 1368-WSP-00-XX-SK-CV-0001 rev P02 “LINK ROAD BETWEEN "THE LANE" AND "CHAWSTON LANE" GEOMETRIC ASSESSMENT OF THE HIGHWAY SCHEME”.

1.1.3 The stated objective of the WSP technical note is to “*provide an outline engineering assessment of the proposed road between Chawston Lane and The Lane in Chawston, Wyboston, Bedfordshire*” and is to “*focus on the horizontal geometry of the proposed alignment as well as the drainage strategy employed*”.

1.1.4 Although WSP did not have the design parameters available at the time of writing the technical note, they correctly concluded from the information made available by their Client that the Roxton Road Link (north) had been designed using a Manual for Streets approach rather than the DMRB.

1.1.5 With reference to the horizontal alignment it correctly concludes that the design complies with the minimum radius for a design speed of 60kph, and that the forward visibility provided is towards the lower end of the stopping sight distance required for a 60kph road.

1.1.6 The WSP technical note correctly states that the main principle influencing the design was to control vehicle speeds. It suggests that a design speed of 50kph rather than 60kph would perhaps be more appropriate. It goes on to suggest that a better (i.e. higher standard) horizontal geometry “*would likely promote speeding through the road*.”

1.1.7 The technical note then considers the reason for the landscape strip on the west side of the new road. It was stated that "*the reason for the wide buffer zone (approx. 10m) on the western side of the road is not clear. From a highway engineering perspective, this has no effects in terms of road safety/performance. Nevertheless, it may be related to the construction phase or utilities diversion*." Without full knowledge of the scheme drawings this is an understandable statement and it may not have been clear that this area was intended for landscaping. The landscape design has since been reviewed throughout the whole scheme and this is one of the landscape areas that has been removed.

1.1.8 The WSP technical note suggests an alternative design for the horizontal alignment at the location of the double bend. This uses a 70m stopping sight distance and horizontal radii of 54m and 100m at the double bends. It states that this allows for more flexibility around the central section of the scheme without compromising forward visibility, swept path analysis or safety.

1.1.9 Whilst the use of the 54m radius bend may have a greater speed control effect on vehicles, it is applied over a shorter distance than the equivalent 64m radius used in the scheme design (approximately 56m compared to 77m) so may not have a sustained effect. The suggested use of the 100m radius would reduce the speed control effect when compared to the 64m radius used in the scheme design. The forward visibility along this section is also greater (it was measured from the PDF drawing provided as approximately 85m). Whilst the difference in speed control between the scheme design and WSP suggestion is likely to be marginal, MfS2 Cl. 8.3.8 and MfS1 7.4.4 imply both of these changes could either individually or in combination encourage higher speeds along the section from Chawston Lane to the first bend.

1.1.10 The 100m radius bend also starts closer to Chawston Lane and would result in the removal of approximately 30m of established hedge that would provide visual and noise screening between the new road and the residential properties on Nags Head Lane. It also brings the road closer to these properties. The new road in the scheme design is approximately 120m from the properties but this would reduce to 100m. The loss of part of the hedge would also result in a modest loss of habitat.

1.1.11 Other aspects of the design (carriageway/verges/footpaths width, kerb radii, 2m widening on curves, buffer zone width) are stated to have been replicated. This is not the case for the widening on the 54m radius bend, which measures (from the PDF copy available) as 7m. This would cause safety issues for two HGVs trying to pass one another. The extent of the earthworks replicates the original design, which is not an unreasonable assumption, but it does not fully do this through the realigned section and the overall extent of the earthworks and verge is approximately 1m narrower than shown for the original design.

1.1.12 It is stated that the attenuation basins associated with the road have been reshaped to increase their land usage efficiency. The overall area of each pond is stated as being retained to ensure their capacity. The areas of the two ponds in the scheme design, including the maintenance access berm around each is 1040m^2 and 1495m^2 (north and south of the Nagshead Lane access respectively). The reshaped ponds measure as 1048m^2 and 2287m^2. The smaller pond is obviously intended to be the same area and the small difference in areas is negligible. The reason for the increase in area of the larger pond is not clear. A small landscape planting area has been retained.

1.1.13 The tie in with "The Lane" at the northern end of the link road was considered also. An option to change the proposed layout to a simple T-junction is discussed. It states the merits of doing this but acknowledges that "*it is not ideal from a highway*

engineering perspective" and "*Despite the reduced land take, this is a less desirable scenario and cannot be justified*". The scheme design uses a 64m radius curve to tie-in to The Lane, whereas the alternative design has modified this to use a 54m radius curve. This would slightly reduce the land required, however, the carriageway width of 8m maintains the same widening through the bend as the original design, whereas a width of 8.5m would be more appropriate to avoid issues as two HGVs pass one another.

1.1.14 It is stated that the proposed layout would reduce land take by approximately 2300m^2 on the western side of the road, while increasing the land take on the eastern side by approximately 1960m^2.

1.1.15 The table below compares the permanent areas of land acquisition for the scheme design, the scheme design following review of the landscape strip and the WSP alternative alignment. All areas were assessed using the WSP PDF drawing to ensure areas are measured relative to one another, although the actual areas may be different if measured using the original CAD drawings. Minor adjustment was made to the earthworks extent for the area required for the WSP alternative with landscape review, to accommodate the minor differences in earthwork extents mentioned in 5.1.11.

Table 1 Areas of land acquisition

	Acquisition from Dove House Farm (m^2)	**Acquisition from others** (m^2)	**Total area** (m^2)
Scheme design	17428	0	17428
Scheme design after landscape review	13910	0	13910
WSP alternative	15590	1943	17533
WSP alternative with landscape review	12353	1943	14296

1.1.16 The total area values in Table 5 show that each case, with or without the landscape review, the scheme design requires less land than the WSP alternative.

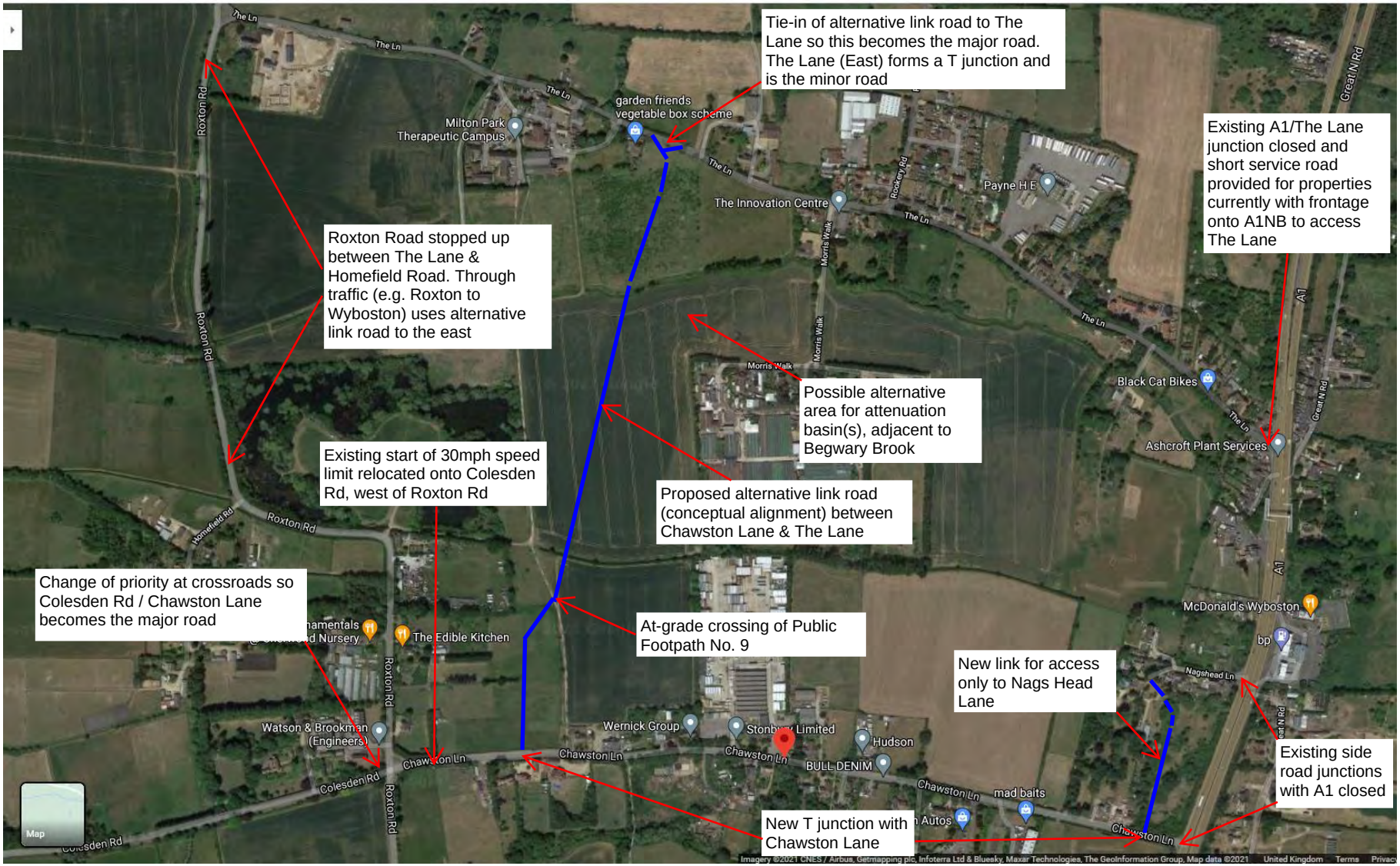
1.1.17 The WSP design does require less land to be acquired from Dove House Farm, but requires land from another landowner in order to achieve this.

1.1.18 In summary, comparing the two designs;

- The two designs will both provide speed control at the double bend.
- MfS2 clause 8.3.8 and MfS1 clause 7.4.4 imply that the alternative design would not provide as much speed control as the scheme design, firstly because the first bend uses a larger radius and secondly the forward visibility around both bends is greater than required by standards. The impact of the shorter application of the tighter radius is probably marginal.
- The alternative design moves the road closer to existing residential properties.
- The alternative design requires the removal of at least 25m of existing hedge that provides a noise and visual screen to properties on Nags Head Lane.
- The alternative design does not reduce the area of land that Highways England would need to acquire permanently. It does reduce permanent land acquisition at Dove Farm, but requires permanent acquisition of land elsewhere to mitigate.

APPENDIX B

70061368 - Appendix B - Example alternative concept layout for Roxton Road link (north)
June 2021



APPENDIX C

N

CONTINUATION 2.A

SEE CONTINUATION 2.A

ROXTON ROAD LINK NORTH OUTFALL 2 - -PROPOSED MAINTENANCE BY BEDFORD BOROUGH COUNCIL

ROXTON ROAD LINK NORTH CATCHMENT - 2, USES OVERSIZED PIPES & FLOW CONTROL TO ATTENUATE FLOWS

ROXTON ROAD LINK NORTH OUTFALL 1- PROPOSED MAINTENANCE BY BEDFORD BOROUGH COUNCIL

A1 BEGWARY BROOK WEST OUTFALL - PROPOSED MAINTENANCE BY HIGHWAYS ENGLAND

A1 BEGWARY BROOK EAST OUTFALL -PROPOSED MAINTENANCE BY HIGHWAYS ENGLAND

ROXTON ROAD LINK PONDS - PROPOSED MAINTENANCE BY BEDFORD BOROUGH COUNCIL

A1 NORTH BEGWARY BROOK WEST CATCHMENT - NO ATTENUATION REQUIRED

A1 NORTH BEGWARY BROOK EAST CATCHMENT- NO ATTENUATION REQUIRED

FILLING STATION SERVICE ROAD BEGWARY BROOK CATCHMENT - USES OVERSIZED PIPES & FLOW CONTROL TO ATTENUATE FLOWS, DRAINS TO EXISTING HIGHWAY DITCH

OUTFALL TO BEGWARY BROOK VIA AN EXISTING HIGHWAY DITCH - PROPOSED MAINTENANCE BY HIGHWAYS ENGLAND

ROXTON ROAD LINK NORTH CATCHMENT - 1

A1 SOUTH BROOK CATCHMENT - USES A SWALE AND FLOW CONTROL TO ATTENUATE FLOWS

SOUTH BROOK

A1 SOUTH BROOK OUTFALL - PROPOSED MAINTENANCE BY HIGHWAYS ENGLAND

Additional pond here to outfall south to South Book?

ROXTON ROAD LINK SOUTH OUTFALL - PROPOSED MAINTENANCE BY BEDFORD BOROUGH COUNCIL

Additional Catchment between Chawston Lane and South Brook - approx. area 0.28Ha

FILLING STATION SERVICE ROAD SOUTH BROOK CATCHMENT 1- USES OVERSIZED PIPES & FLOW CONTROL TO ATTENUATE FLOWS

POND BC2 OUTFALL - PROPOSED MAINTENANCE BY HIGHWAYS ENGLAND

FILLING STATION SERVICE ROAD SOUTH BROOK OUTFALL 1 - PROPOSED MAINTENANCE BY BEDFORD BOROUGH COUNCIL

FILLING STATION SERVICE ROAD SOUTH BROOK OUTFALL 2 -PROPOSED MAINTENANCE BY BEDFORD BOROUGH COUNCIL

CUT LINE

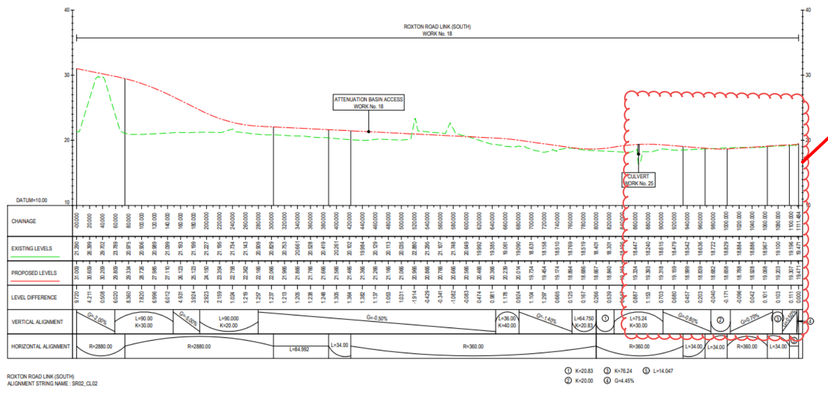
SHEET 1

CUT LINE

CHAWSTON LANE

OLD GREAT NORTH ROAD

A1



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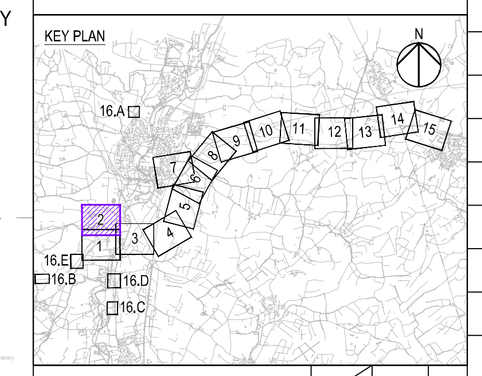
5. THE NAMING OF THE CATCHMENT AREAS ARE TO DIFFERENTIATE BETWEEN THEM AND ARE THE PURPOSE OF THE DRAINAGE ENGINEERING PLANS ONLY.
6. THESE DRAINAGE PLANS SHOULD BE READ IN CONJUNCTION WITH ALL OTHER PLANS AND DOCUMENTATION, IN PARTICULAR THE ROAD DRAINAGE STRATEGY REPORT [TR010044/APP/13.3]

LEGEND
- ORDER LIMITS
- LAND SURROUNDED BY, BUT NOT INCLUDED WITHIN THE ORDER LIMITS
- EXISTING WATERCOURSE
- OUTFALL MAINTAINED BY HIGHWAYS ENGLAND
- OUTFALL MAINTAINED BY LOCAL HIGHWAY AUTHORITY
- POND BC2 HIGHWAY CATCHMENT
- A1 SOUTH BROOK CATCHMENT
- ROXTON ROAD LINK NORTH CATCHMENT - 1
- ROXTON ROAD LINK NORTH CATCHMENT - 2
- FILLING STATION SERVICE ROAD SOUTH BROOK CATCHMENT 1
- FILLING STATION SERVICE ROAD BEGWARY BROOK CATCHMENT
- A1 NORTH BEGWARY BROOK WEST CATCHMENT
- A1 NORTH BEGWARY BROOK EAST CATCHMENT

KEY PLAN



Revision Details	By / Check	Date	Suffix
Final for DCO Application	JB / TD	03/02/21	P04

Purpose of issue
DCO APPLICATION

Client
Highways England
Woodlands
Manton Lane
Manton Industrial Estate
Bedford
MK41 7LW

Working on behalf of highways england

Development Consent Order Number
TR010044

Project Title
A428 BLACK CAT TO CAXTON GIBBET IMPROVEMENTS

Drawing Title
DRAINAGE ENGINEERING PLAN
REGULATION 5(2)(O) & 6(2)
SHEET 2

Designed	Drawn	Checked	Approved	Date
JJP	JB	JMW	TD	03/02/21

Internal Project No.	Suitability
60541541	D7
Scale @ A1	Zone
1:2500	ZN1

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Rev P04

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APPENDIX D

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.544	0.544	0.4	74.8	O K
30 min Summer	0.663	0.663	0.5	96.3	O K
60 min Summer	0.770	0.770	0.5	117.5	O K
120 min Summer	0.867	0.867	0.5	138.1	O K
180 min Summer	0.918	0.918	0.5	149.5	O K
240 min Summer	0.950	0.950	0.5	157.0	O K
360 min Summer	0.990	0.990	0.6	166.6	O K
480 min Summer	1.017	1.017	0.6	173.2	O K
600 min Summer	1.036	1.036	0.6	177.8	O K
720 min Summer	1.049	1.049	0.6	181.1	O K
960 min Summer	1.066	1.066	0.6	185.3	O K
1440 min Summer	1.077	1.077	0.6	188.0	O K
2160 min Summer	1.066	1.066	0.6	185.3	O K
2880 min Summer	1.044	1.044	0.6	179.6	O K
4320 min Summer	1.001	1.001	0.6	169.1	O K
5760 min Summer	0.961	0.961	0.5	159.6	O K
7200 min Summer	0.925	0.925	0.5	151.3	O K
8640 min Summer	0.892	0.892	0.5	143.8	O K
10080 min Summer	0.861	0.861	0.5	136.9	O K
15 min Winter	0.596	0.596	0.4	83.9	O K
30 min Winter	0.723	0.723	0.5	107.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.506	0.0	33.4	27
30 min Summer	92.482	0.0	36.9	42
60 min Summer	56.713	0.0	74.0	72
120 min Summer	33.633	0.0	79.5	132
180 min Summer	24.479	0.0	82.1	190
240 min Summer	19.441	0.0	83.7	250
360 min Summer	13.973	0.0	85.5	370
480 min Summer	11.062	0.0	86.5	488
600 min Summer	9.223	0.0	87.1	608
720 min Summer	7.947	0.0	87.3	728
960 min Summer	6.278	0.0	87.3	966
1440 min Summer	4.498	0.0	85.8	1444
2160 min Summer	3.218	0.0	166.7	2160
2880 min Summer	2.536	0.0	165.2	2516
4320 min Summer	1.811	0.0	157.7	3248
5760 min Summer	1.424	0.0	285.6	4040
7200 min Summer	1.182	0.0	282.8	4896
8640 min Summer	1.015	0.0	273.1	5704
10080 min Summer	0.892	0.0	263.7	6472
15 min Winter	143.506	0.0	35.0	27
30 min Winter	92.482	0.0	38.6	41

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.838	0.838	0.5	131.8	O K
120 min Winter	0.942	0.942	0.5	155.1	O K
180 min Winter	0.996	0.996	0.6	168.0	O K
240 min Winter	1.032	1.032	0.6	176.6	O K
360 min Winter	1.076	1.076	0.6	187.7	O K
480 min Winter	1.106	1.106	0.6	195.4	O K
600 min Winter	1.127	1.127	0.6	201.0	O K
720 min Winter	1.142	1.142	0.6	205.1	O K
960 min Winter	1.162	1.162	0.6	210.5	O K
1440 min Winter	1.180	1.180	0.6	215.1	O K
2160 min Winter	1.178	1.178	0.6	214.6	O K
2880 min Winter	1.160	1.160	0.6	209.8	O K
4320 min Winter	1.111	1.111	0.6	196.9	O K
5760 min Winter	1.066	1.066	0.6	185.3	O K
7200 min Winter	1.021	1.021	0.6	173.9	O K
8640 min Winter	0.977	0.977	0.5	163.4	O K
10080 min Winter	0.935	0.935	0.5	153.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	56.713	0.0	77.8	70
120 min Winter	33.633	0.0	83.3	130
180 min Winter	24.479	0.0	85.9	188
240 min Winter	19.441	0.0	87.4	246
360 min Winter	13.973	0.0	89.1	364
480 min Winter	11.062	0.0	90.1	482
600 min Winter	9.223	0.0	90.5	598
720 min Winter	7.947	0.0	90.7	716
960 min Winter	6.278	0.0	90.5	950
1440 min Winter	4.498	0.0	88.7	1412
2160 min Winter	3.218	0.0	174.4	2084
2880 min Winter	2.536	0.0	172.2	2736
4320 min Winter	1.811	0.0	164.0	3424
5760 min Winter	1.424	0.0	305.1	4336
7200 min Winter	1.182	0.0	298.9	5264
8640 min Winter	1.015	0.0	292.2	6144
10080 min Winter	0.892	0.0	282.0	7064

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.280

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.093	4	8	0.093	8	12	0.093

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Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	105.0	1.200	276.5	1.500	332.1

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0034-6000-1200-6000
Design Head (m)	1.200
Design Flow (l/s)	0.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	34
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	0.6	Kick-Flo®	0.304	0.3
Flush-Flo™	0.152	0.4	Mean Flow over Head Range	-	0.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.4	1.200	0.6	3.000	0.9	7.000	1.3
0.200	0.4	1.400	0.6	3.500	1.0	7.500	1.4
0.300	0.3	1.600	0.7	4.000	1.0	8.000	1.4
0.400	0.4	1.800	0.7	4.500	1.1	8.500	1.4
0.500	0.4	2.000	0.8	5.000	1.1	9.000	1.5
0.600	0.4	2.200	0.8	5.500	1.2	9.500	1.5
0.800	0.5	2.400	0.8	6.000	1.2		
1.000	0.6	2.600	0.8	6.500	1.3		

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