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A30 Chiverton to Carland Cross
Environmental Statement

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Flood risk assessment

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APFP Regulation 5(2)(e)

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Foreword (project context)

The A30 is the most important route serving the county of Cornwall. It runs from the M5 motorway at Exeter in Devon, along the middle of the south-west peninsula, to Penzance. The route is approximately 103 miles in length, 77 miles of which are dual carriageway. The section between Chiverton and Carland Cross is single carriageway and is part of the key strategic link between the motorway network and west Cornwall.

The A30 Chiverton to Carland Cross scheme is included in the Roads Investment Strategy (RIS) published in December 2014, as:

'Upgrading the A30 to dual carriageway north of Truro, connecting together the dual carriageway section around Bodmin with the dual carriageway Redruth bypass. Coupled with the Temple to Higher Carblake scheme and smaller scale safety enhancements on the route, this improves the A30 to a consistent Expressway standard from Camborne to the M5'.

This scheme is included in the Highways England Delivery Plan to commence construction in the RIS 1 period, i.e. by the end of March 2020, with a planned opening to traffic on 31st December 2022.

The scheme will upgrade the 8.7 miles of this section of the A30 to dual two lane carriageway, as outlined in Figure 1. This enhancement, along with the upgrading of the A30 between Temple and Higher Carblake from single carriageway to dual two lane carriageway, will improve the A30 to a consistent standard from Camborne to the M5, a distance of 97 miles.

13.1 Introduction

Background and scope

13.1.1 Highways England (HE) have appointed Ove Arup & Partners (Arup) to undertake a Flood Risk Assessment (FRA) in relation to the proposed works on the A30. The scheme involves upgrading 13.8 kilometres of existing single carriageway to dual carriageway between Chiverton Cross and Carland Cross junctions, the locations of which are shown in Figure 13-1. This work forms part of HE's plans for the A303, A30 and A358 corridor, which seeks to improve this vital connection between the South West of England and the rest of the UK.

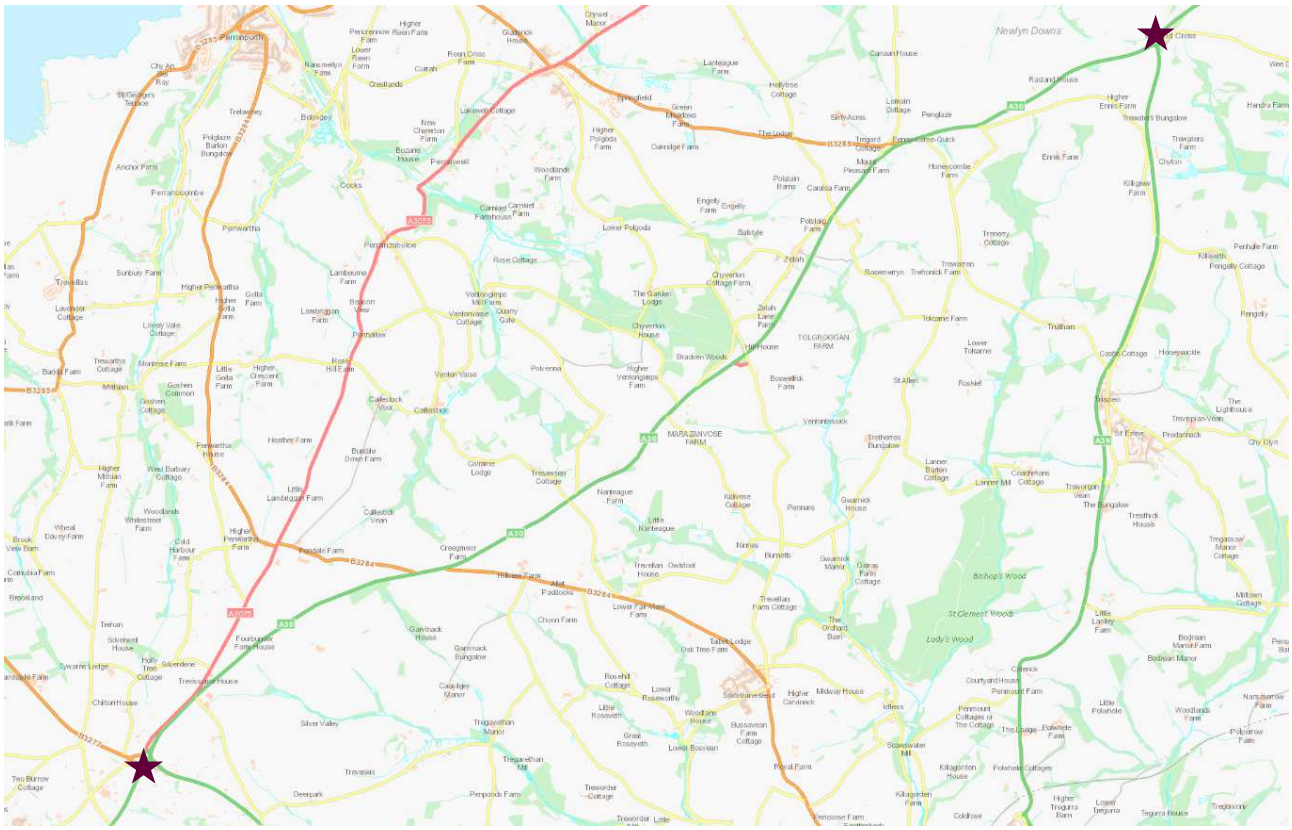

Figure 13-1 Map showing section of A30 between Chiverton and Carland Cross junctions

13.1.2 Arup's scope forms part of the Highways England Project Control Frameworks (PCF). The scope is for all of the products associated with Stages 3 & 4 of the PCF – preliminary design & statutory procedures and powers – leading to submission of the Development Consent Order (DCO) in 2018.

13.1.3 This Flood Risk Assessment has been undertaken using the principles set out in Governmental Planning Guidance, the National Planning Policy Framework (NPPF) (August 2018) and the associated Technical Guidance.

13.1.4 This report is prepared for Highways England and takes into account their particular instructions and requirements.

13.2 Proposed Development

Site location

13.2.1 The section of the A30 on which the works are proposed is located south of Newquay and North-West of Truro. The Chiverton Cross junction is located at OS grid reference SW747469, close to the settlement at Three Burrows. The Carland Cross junction is located at OS grid reference SW846539. A motorists' service area, including a filling station, is located at the Carland Cross junction.

Main objective

13.2.2 The main scheme transport objectives are outlined below:

- A key objective is to unlock the South West for growth, and contribute to the regeneration and sustainable economic growth by supporting employment and residential development opportunities.
- Reducing congestion by making the route more reliable, reducing the journey times and providing capacity for the anticipated future growth.
- Maintain a route for local and non-motorised users, and provide bridges and passes to separate local traffic from strategic.
- Deliver a better environmental outcome.
- Where appropriate, the scheme will be designed to new highway standards to improve safety, operation and efficiency.

Proposed works

13.2.3 The proposed works are for a new dual carriageway located to the north of the existing location of the A30 between Chiverton and Chybucca, and south of the existing A30 between Chybucca and Carland Cross. The existing route of the A30 between Chiverton and Carland Cross is to remain as a local route. The proposed scheme for the A30 section is shown in Figure 13-2.

13.2.4 The upgrade includes mainly off-line design with majority of the new road alignment located on agricultural fields. The proposed alignment occasionally crosses over the existing A30 and smaller B roads. The design includes 12 structures associated with the road 7 underbridges for traffic, 2 underbridges for pedestrians, 2 overbridges, and 1 green bridge.

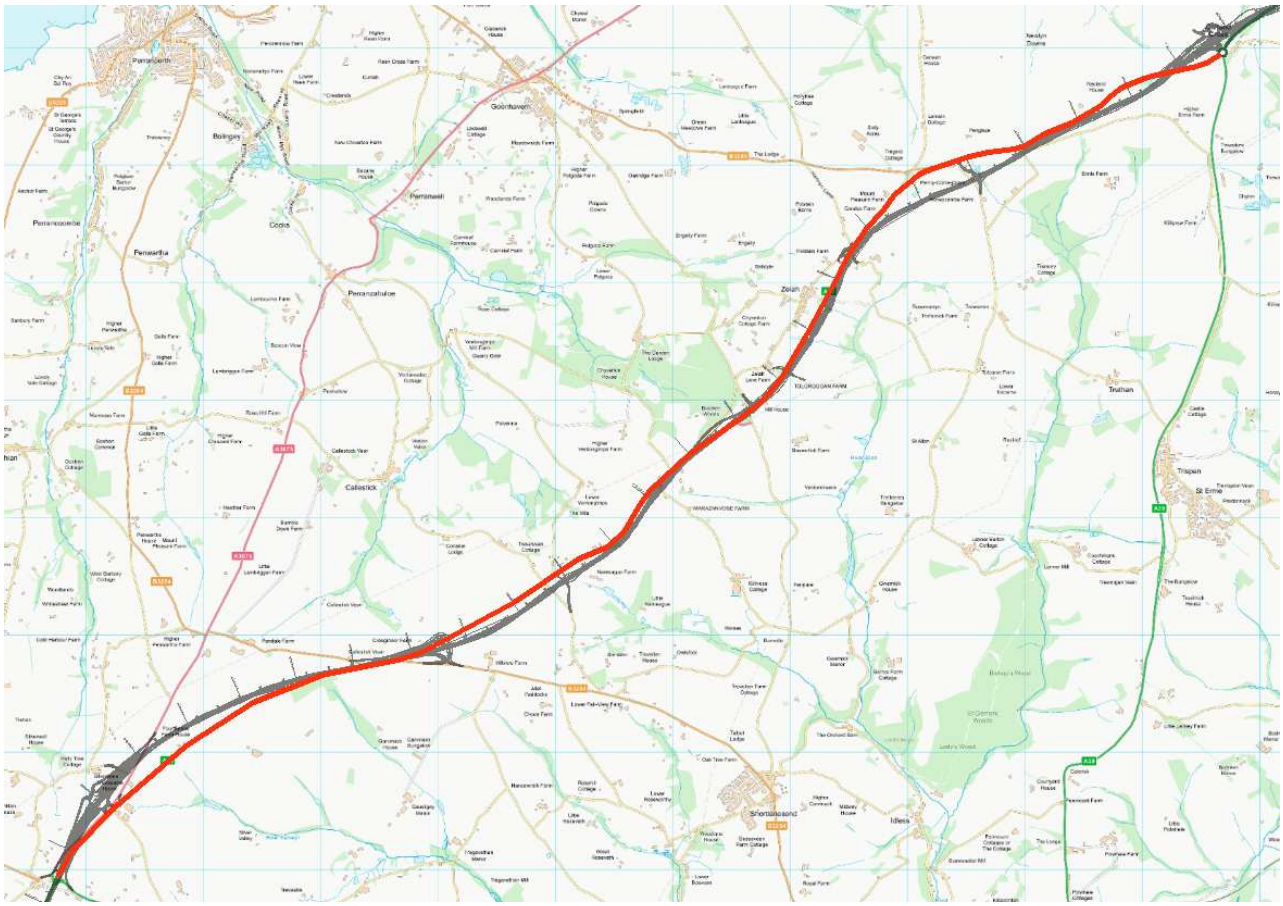

Figure 13-2 Arrangement of the new dual carriageway for the A30 (existing A30 shown in red)

13.3 Justification of site location

13.3.1 The project comprises the improvement of the existing A30 therefore there is limited scope for movement of the site location. All works are limited to the A30 highway corridor itself and the areas directly adjacent to it. The site has been selected following a comprehensive review of options and public consultation in 2016.

13.4 Site Characteristics

Geology

13.4.1 The region comprises varied geology mainly underlain by Upper Palaeozoic rock of Devonian age. The local geology is dominated by well fractured Mid Devonian interbedded mudstones, slates, siltstones and sandstones locally known as 'Killas'. The strata in the region have a prevailing dip to the south, but the rocks have been strongly deformed and folded. There are numerous intrusive dykes crossing this area. Mineralisation in the area occurs in planar structures known as lodes which occupy former fissures in the Killas bedrock.

13.4.2 The superficial deposits for the local area comprise alluvial deposits of coarse silty gravels with an abundance of cobbles, mainly in the river valley areas, and head deposits of gravelly sand whose original structure disrupted in some areas with associated open cracks.

Elevation

13.4.3 The elevation along the length of the A30 road ranges from approximately 150m to less than 70m at its lowest point. Figure 13-3 shows the elevation profile from the Chiverton Cross to Carland Cross.

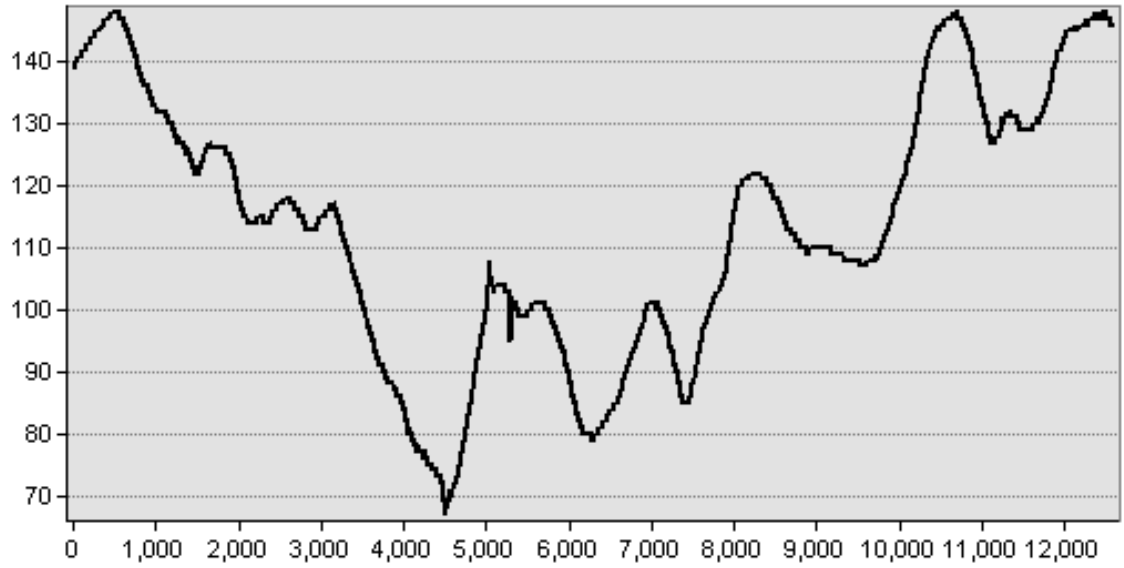

Figure 13-3 Elevation profile from Chiverton Cross to Carland Cross

13.4.4 The low points and high points in the existing A30 arrangement compared to the proposed are generally at the same location. There are a small number of differences with potential to reassign discharge to different catchments, discussed in the next section.

Hydrology

13.4.5 Generally, the existing road alignment runs along a surface water watershed. The River Gannel and its tributaries flow to the north, the Rivers Kenwyn, Tresillian and Allen and tributaries flow to the south.

Figure 13-4 Hydrology network in the area around Chiverton Cross and Carland Cross

Watershed reassignment

13.4.6 At CH 13+300, east of a high point in the proposed arrangement, the drainage flows will be discharged into the original catchment, albeit further down. To the west of the same high point, there is a small area, estimated at approximately one hectare, which discharges into a new catchment further west, of 55ha instead of its original catchment of 50ha. This increases the receiving drainage catchment area by approximately 2%. This is deemed insignificant as discharges are being attenuated back to 3.5 l/s for a 1:1 year event and infiltration will be incorporated into the design as appropriate.

13.5 Sources of flood risk to the site

Tidal

13.5.1 The nearest tidal water to the site is found at Truro, approximately 6.5km from the closest point of the route of the existing A30. Also as noted above, the elevation of the existing and proposed carriageways is between 70 and 150m AOD. Hence the site is not at risk of tidal flooding.

Fluvial

13.5.2 A number of streams are adjacent to or cross the site of the proposed new route for the A30. The Lead Local Flood Authority for this area is Cornwall Council.

13.5.3 Despite the presence of the streams in the vicinity of the proposed site, the current Environment Agency (EA) Flood Risk Map (October 2017) indicates that the site is located in Flood Zone 1 (Low Probability of flooding). This area has a very low risk of flooding of less than 1 in 1000-year annual probability of fluvial flooding (0.1% annual exceedance probability).

13.5.4 Figure 13-5 shows the areas of Flood Zones 2 and 3 in relation to the existing A30. Flood Zone 3 (high probability of flooding) is based upon a 1 in 100-year annual probability of flooding from rivers or a 1 in 200-year annual probability of flooding from the sea. Flood Zone 2 (medium probability of flooding) relates to areas which have an annual probability of river flooding of between 1 in 100 and 1 in 1000-year or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

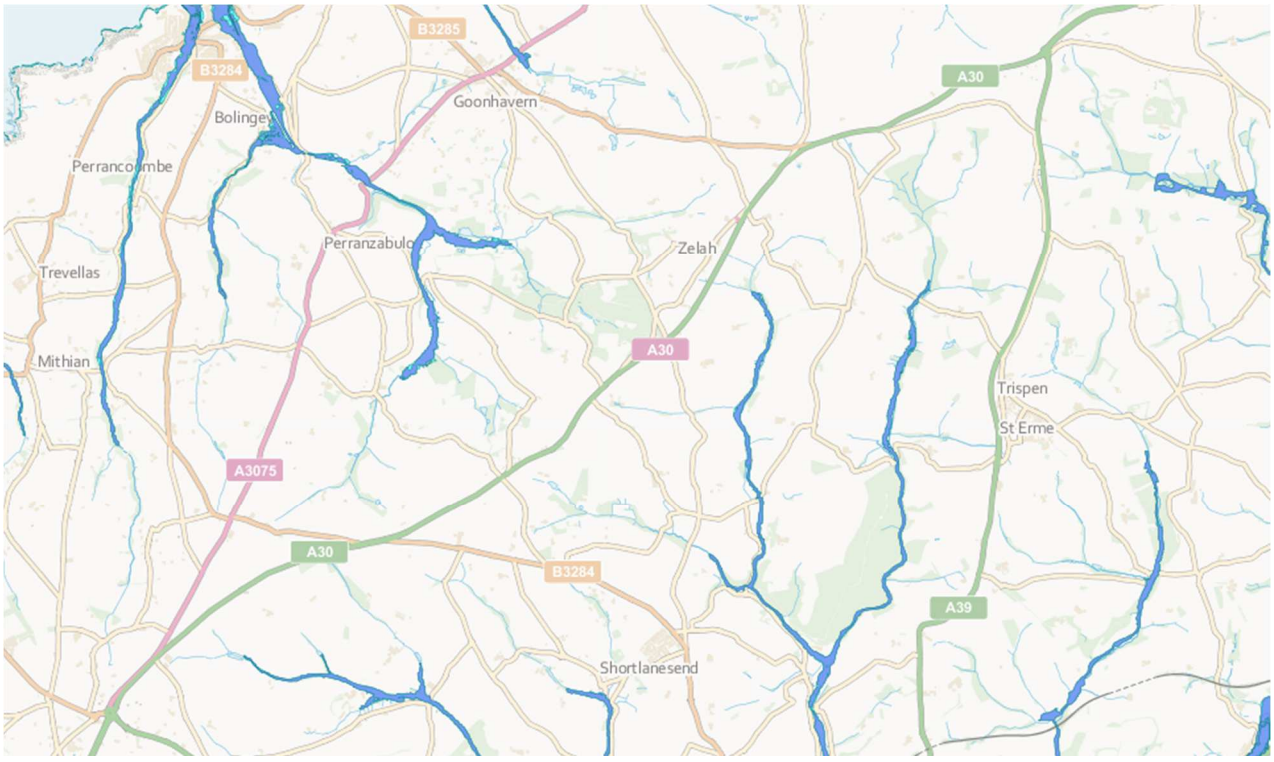

Figure 13-5 Areas of Medium Flood Risk (EA Flood Zone 2, highlighted in cyan) and High Flood Risk (EA Flood Zone 3, highlighted in blue)

13.5.5 The nearest areas of medium and high flood probability are approximately 570m from the existing A30, at the head of the River Kenwyn as highlighted in Figure 13-6 and 430m at the head of the River Allen close to Zelah, as highlighted in Figure 13-7. However, both areas classified as Flood Zone 2 and 3 along these rivers are located at an altitude approximately 30m lower than that of the existing A30 at its nearest points and hence the risk of fluvial flooding is believed to be minimal.

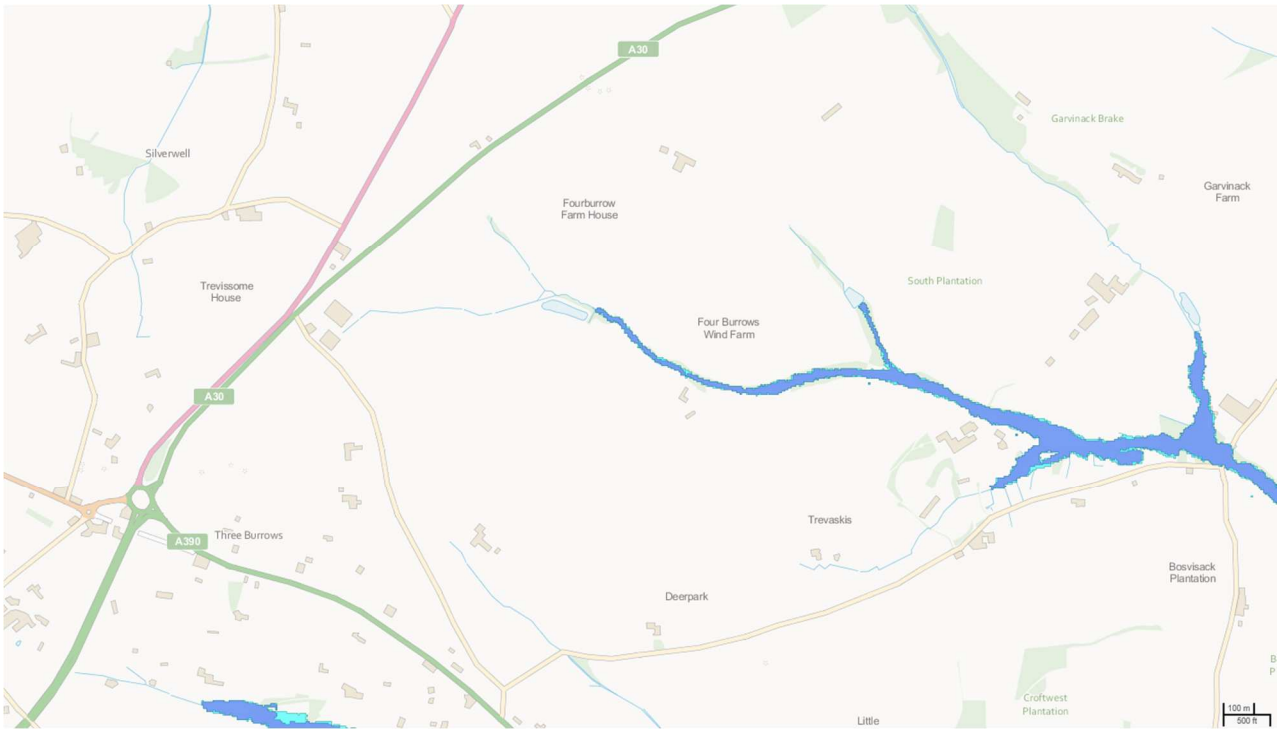

Figure 13-6 Map showing areas of EA Flood Zones 2 (Cyan) and 3 (Blue) at the head of the River Kenwyn

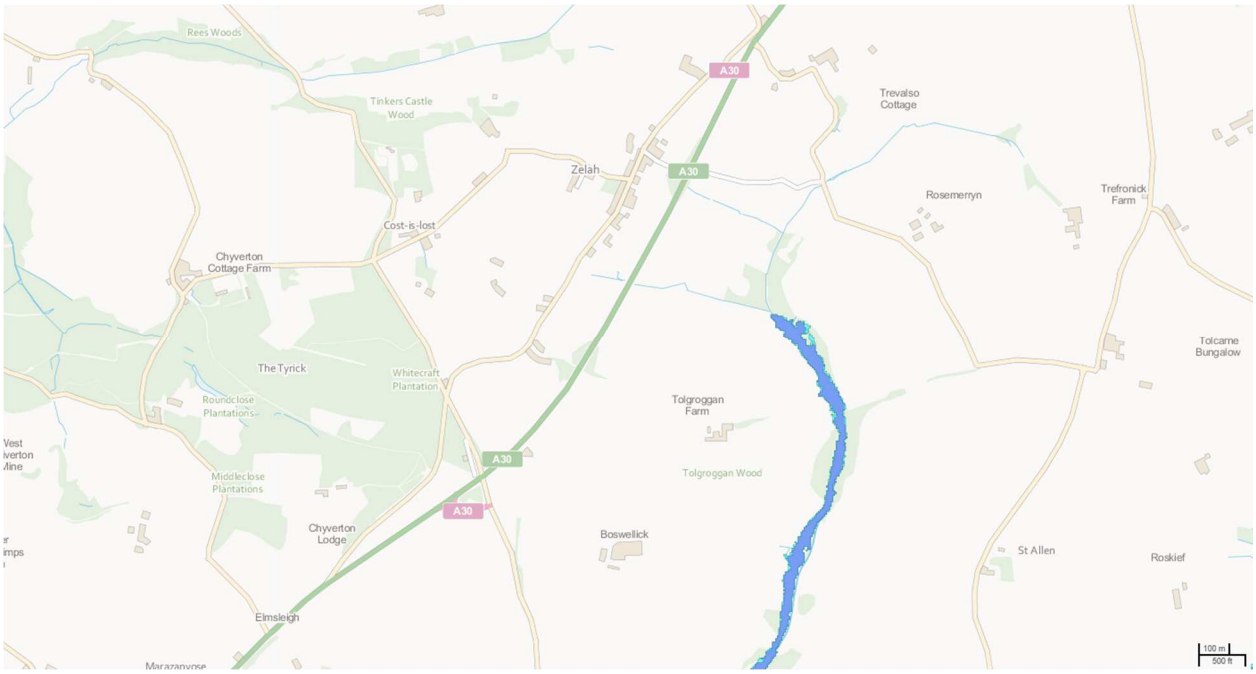

Figure 13-7 Map showing areas of EA Flood Zones 2 (Cyan) and 3 (Blue) at the head of the River Allen

Groundwater

13.5.6 The risk of flooding due to groundwater is limited to areas of superficial deposits as shown in Figure 13-8 to Figure 13-11. This is based upon information collected from the British Geological Survey (BGS) groundwater flooding map for Great Britain. Superficial deposit flooding is driven by the presence of deposits which

have very high to high permeability, overlying bedrocks with low to very low permeability.

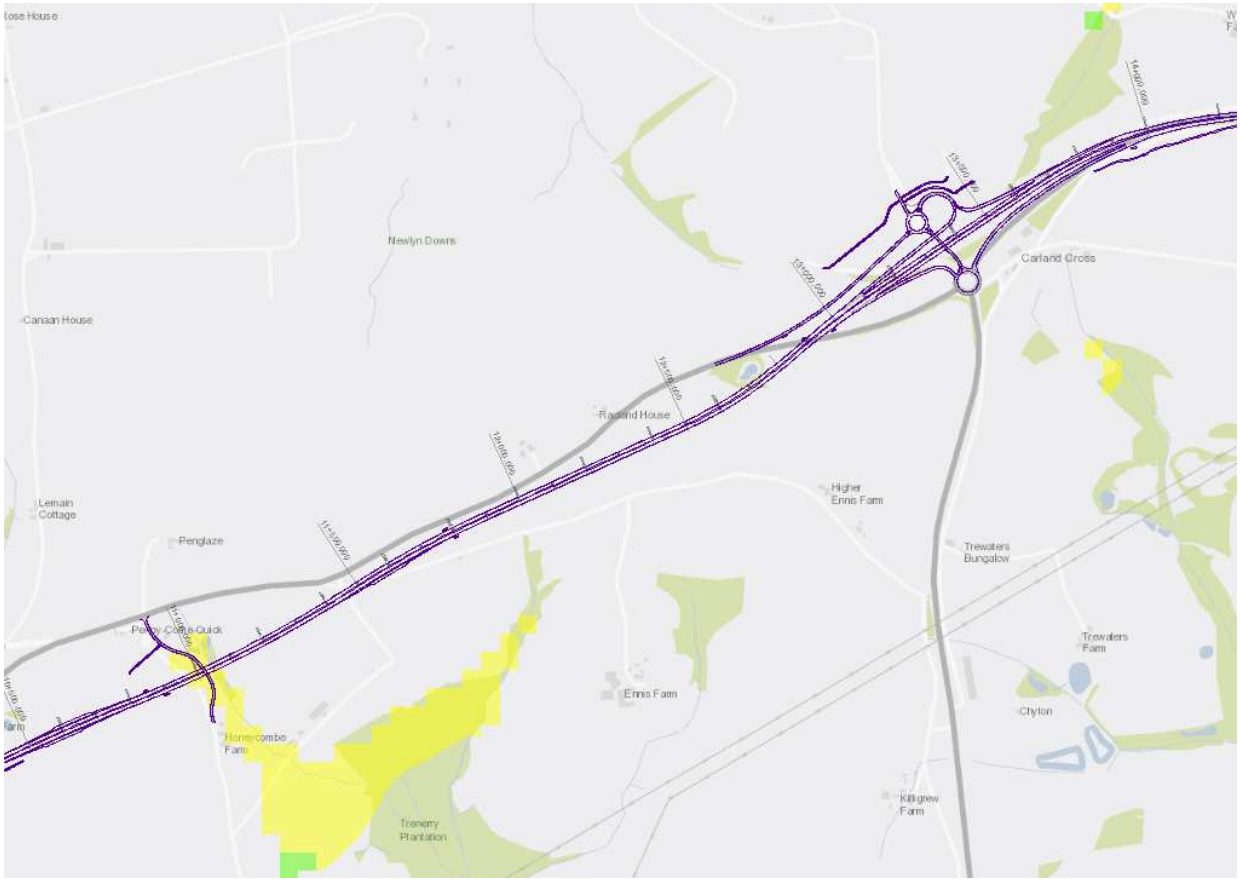

Figure 13-8 Areas at risk of groundwater flooding. Highlighted areas correspond to superficial deposits flooding. Part 1: Carland Cross junction to Pennycomequick

Figure 13-9 Areas at risk of groundwater flooding. Highlighted areas correspond to superficial deposits flooding. Part 2: Pennycomequick to Zelah

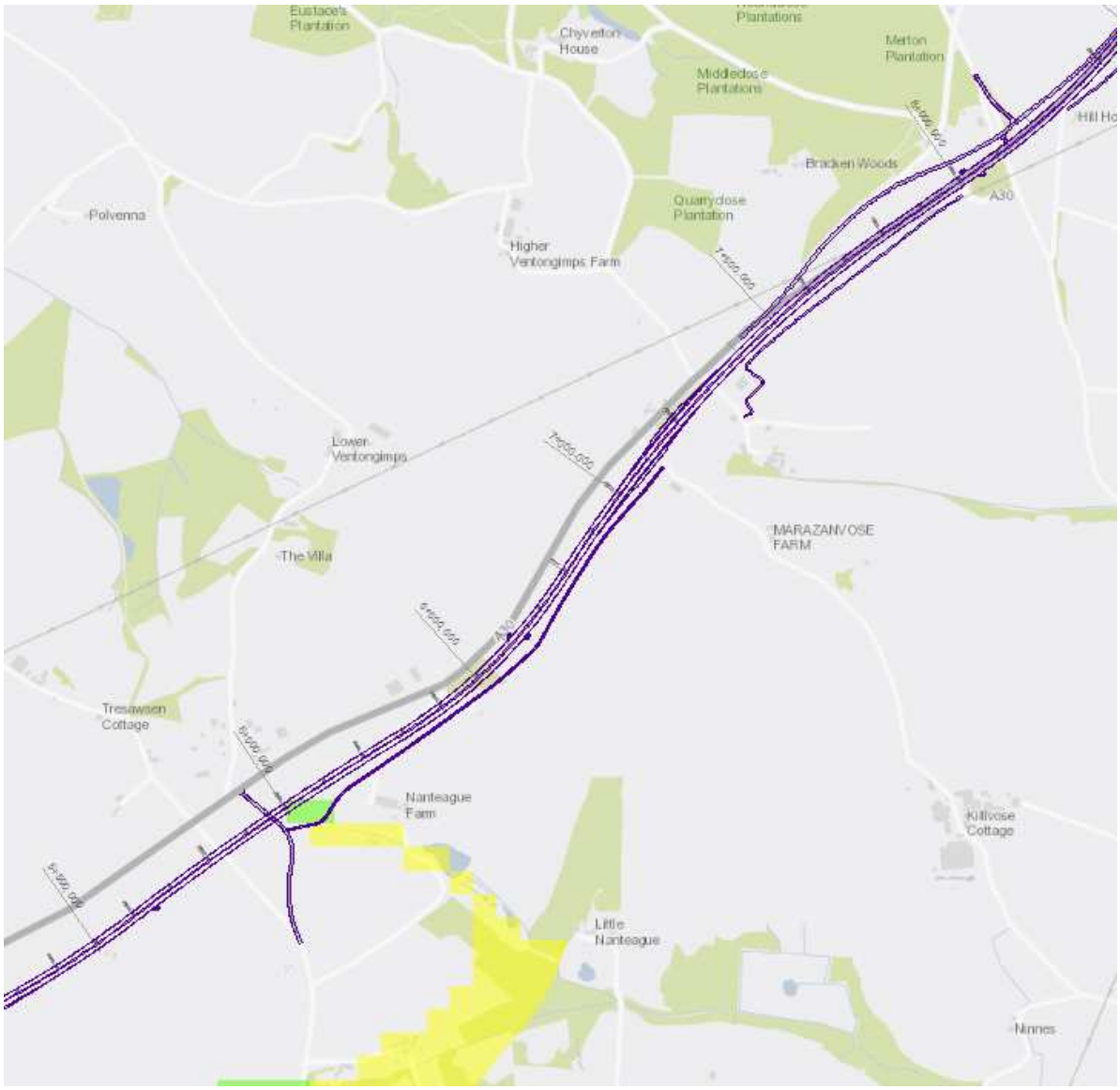

Figure 13-10 Areas at risk of groundwater flooding. Highlighted areas correspond to superficial deposits flooding. Part 3: Zelah to Tresawsen

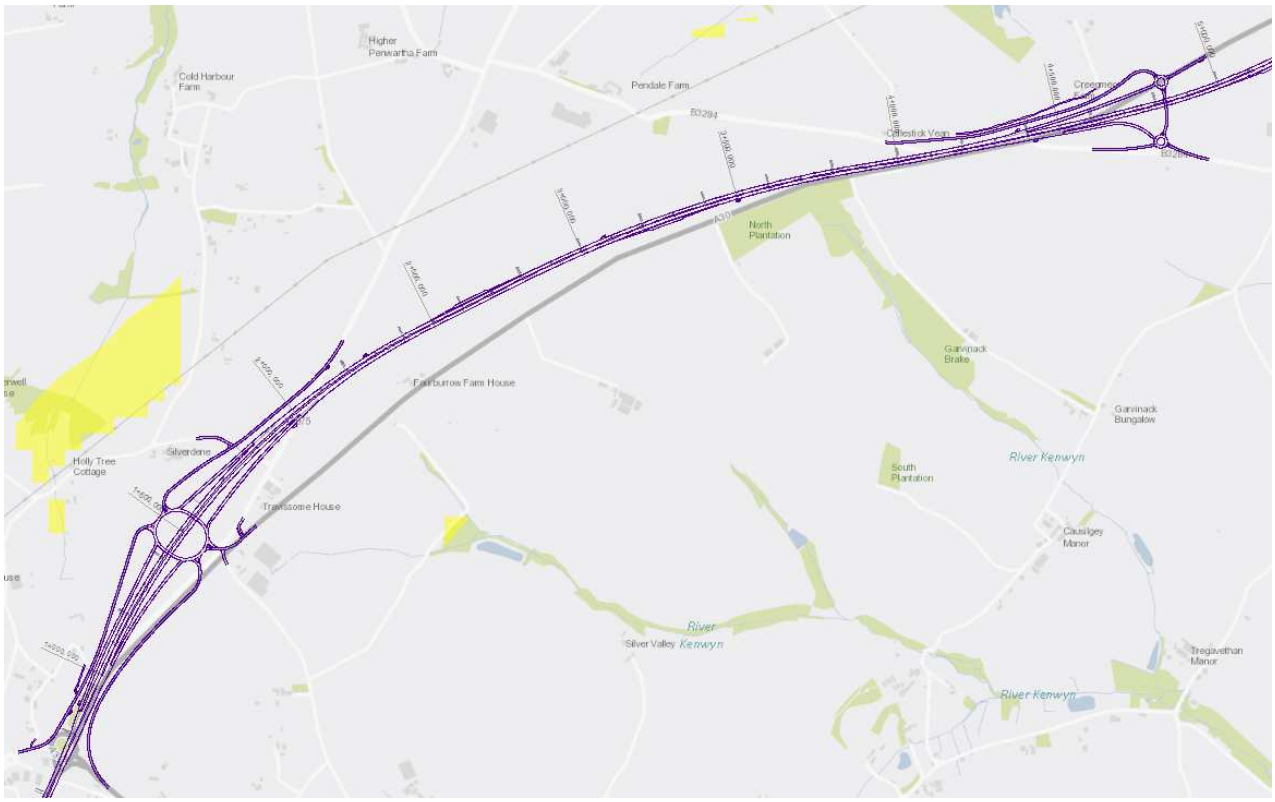

Figure 13-11 Areas at risk of groundwater flooding. Highlighted areas correspond to superficial deposits flooding. Part 4: Treswasen to Chiverton Cross

13.5.7 The areas highlighted in Figure 13-8 to Figure 13-11 correspond with the river valleys for the numerous streams close to the project site. The possible areas of concern for the project are those areas highlighted in Figure 13-9 and Figure 13-10 which occur to the south of the existing route of the A30, in the path of or close to the proposed route for the new A30 development. It should be noted that the confidence levels assigned within the BGS groundwater maps for this area are moderate.

13.5.8 At Pennycomequick the underbridge will cut into the slope and the structure will need under drainage to cater for possible high groundwater levels and possible uplift or local groundwater flooding. There is also a risk to the pond at this location which will require lining in areas with potential high groundwater.

Figure 13-12 Groundwater flood potential at Pennycomequick

Figure 13-13 Groundwater flood potential at Neanteague Farm

13.5.9 Groundwater levels have been monitored over the period of February 2017 to February 2018. Preliminary results show that groundwater levels are below ground levels. The detailed design of the underbridge, which will cut into existing ground levels however, will incorporate drainage measures to limit and control groundwater levels to below formation level of the structure.

Pluvial/Surface water

13.5.10 A number of areas close to or adjacent to the site are identified by the EA[1] as high flood risk from surface water, as illustrated in the figures below.

Figure 13-14 EA surface water flood risk map. Part 1 of 5: Carland Cross junction to Pennycomequick . Dark blue corresponds to high flood risk, light blue to low flood risk.

[1] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

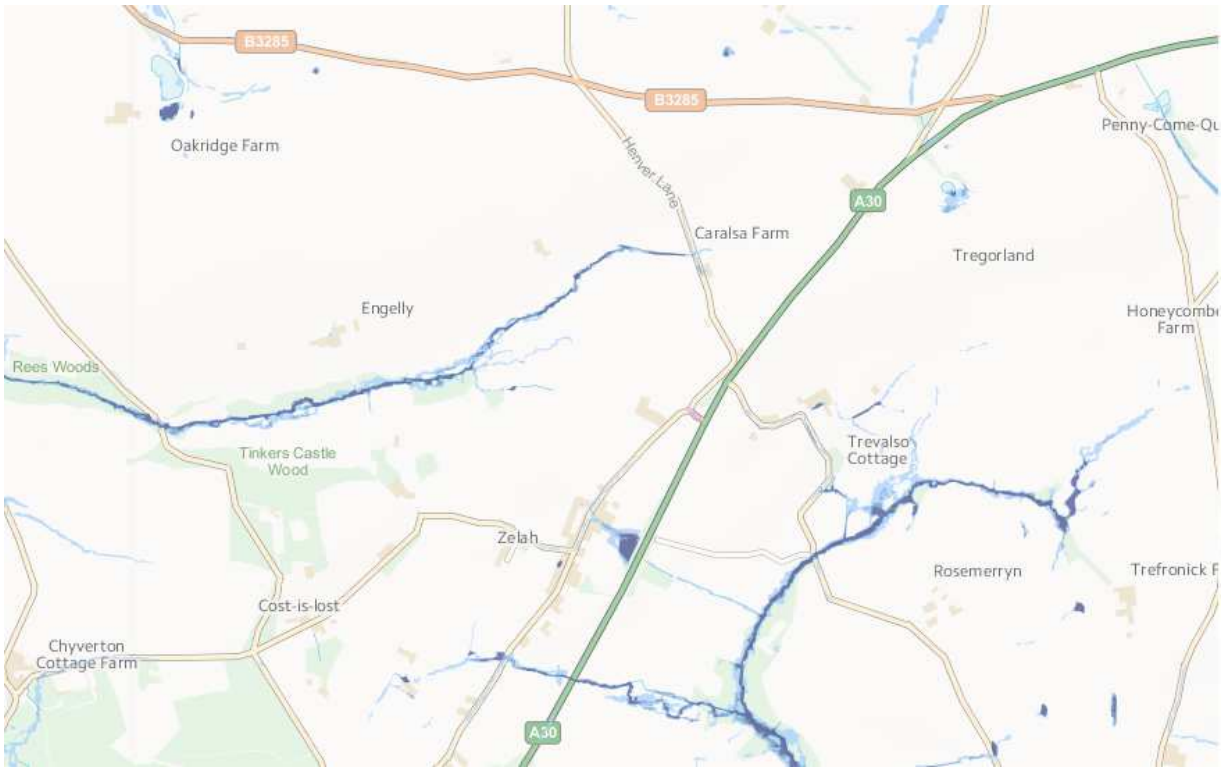

Figure 13-15 EA surface water flood risk map. Part 2 of 5: Pennycomequick to Zelah. Dark blue corresponds to high flood risk, light blue to low flood risk.

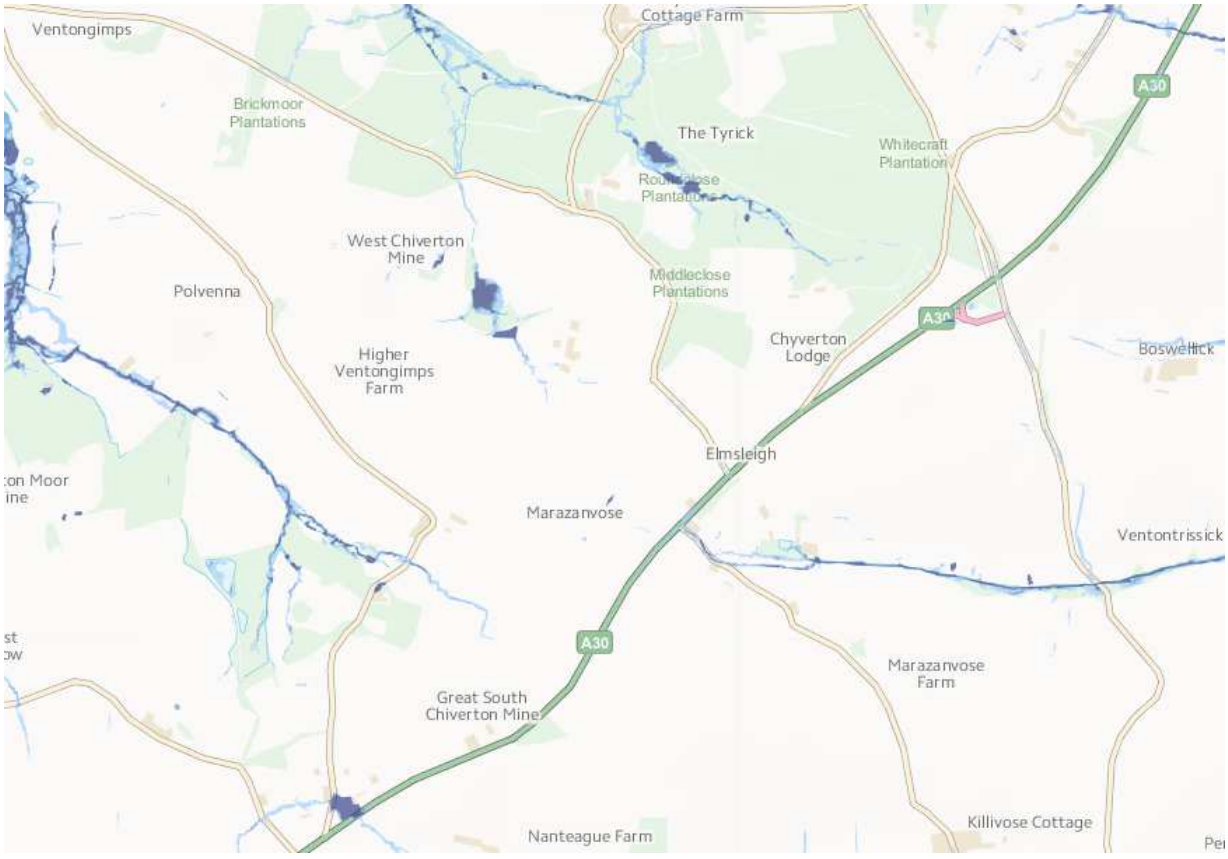

Figure 13-16 EA surface water flood risk map. Part 3 of 5: Zelah to Marazanvose. Dark blue corresponds to high flood risk, light blue to low flood risk.

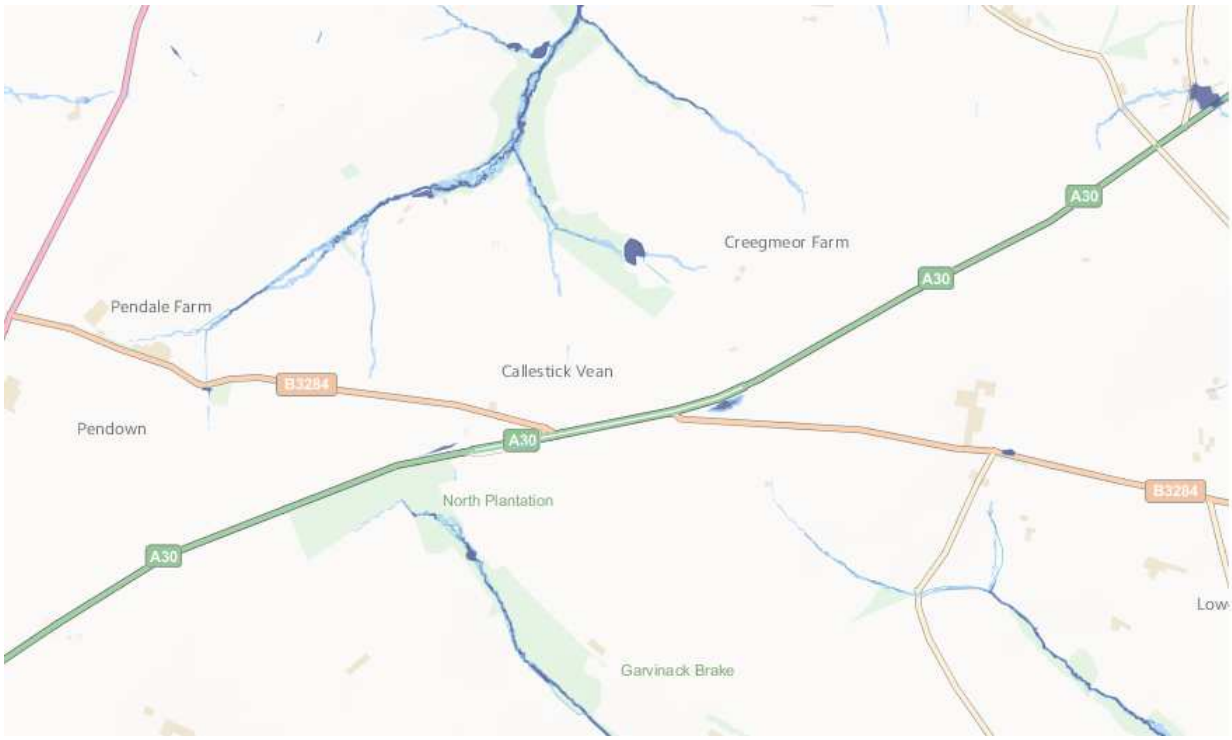

Figure 13-17 EA surface water flood risk map. Part 4 of 5: Marazanvose to Fourburow Farm House. Dark blue corresponds to high flood risk, light blue to low flood risk.

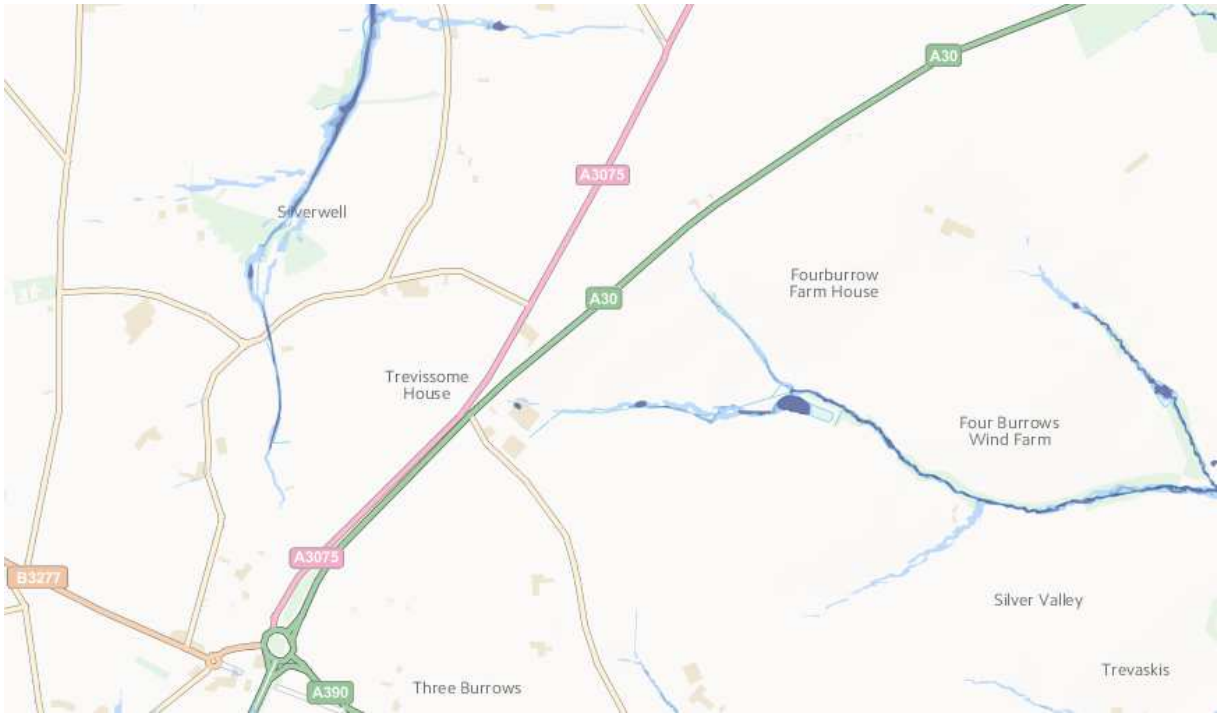

Figure 13-18 EA surface water flood risk map. Part 5 of 5: Fourburow Farm House to Chiverton Cross. Dark blue corresponds to high flood risk, light blue to low flood risk.

13.5.11 The majority of the highway corridor is designated as very low risk of flooding from surface water.

13.5.12 The areas at risk of pluvial flooding have been identified as indicated in Table 13-1:

Table 13-1 Areas at High, Medium and Low risk of pluvial flooding

High Risk	Medium Risk	Low Risk
The area on the southern outskirts of Zelah and the area in centre of Zelah where branches of the River Allen pass beneath the A30 road (Figure 5-15)	The junction of the B3285 and A30	Section of the road south of the Tresawsen area
The area at Tresawsen (Figure 5-16	The Chyverton Lodge junction	The junction of the B3284 and A30
	In the areas surrounding Marazanvose	

High risk

13.5.13 Areas of high risk have been identified at Zelah and in the Tresawsen area. At Zelah, the risk is due to low elevations in the existing topography. There are two culverts which may not be accounted for in the EA surface water maps. Therefore, the flood risk may be lower at this location. Culverts will be provided in the proposed scheme at these locations to minimise the risk of surface water flooding.

Figure 13-19 Area identified as high risk of surface water flooding close to Zelah. Dark blue corresponds to areas of high flood risk.

13.5.14 In the area around Tresawsen, the EA map shows a high risk of surface water flooding at a low point of the existing topography, which is likely to become a flow

path in a large rainfall event. A culvert will be provided at this location to minimise the risk of surface water flooding.

Figure 13-20 Area identified as high risk of surface water flooding at Tresawsen. Dark blue corresponds to areas of high flood risk.

Medium risk

13.5.15 Areas of medium pluvial flood risk have been identified at locations as identified in Table 13-1.

13.5.16 There is medium risk at the junction between the A30 road and B3285. The OS map indicates that there is a culvert underneath the B3285 road which may not be accounted for in the EA surface water flood risk maps. Therefore, the pluvial flood risk may be lower or completely mitigated at this location.

13.5.17 At Chyverton Lodge bypass, the EA flood risk map indicates a medium risk of surface water flooding. This is likely to arise from surface water runoff from the field being constrained by the existing A30 earthworks. Cut off ditches will be provided on the proposed scheme in such instances to convey the flow to an adjacent watercourse.

13.5.18 In the areas surrounding Marazanvose, there is a medium to low risk of surface water flooding at low points in topography along the existing side road. This road will be removed by the scheme and a positive drainage scheme will be provided under the proposed design.

Low risk

13.5.19 Low surface water flood risk has been identified on a section of the road south of the Tresawsen area. This is most likely surface flow that accumulates on the side of the road. The proposed location of the new dual-carriageway at this location is approximately 70m south from the existing A30, therefore this risk is mitigated.

13.5.20 The junction of the B3284 and A30 is shown at low risk of surface water flooding. The drainage design will incorporate measures to accommodate local surface water and convey any runoff from the surrounding areas back into the cutoff ditches which would tie into watercourses.

Reservoirs and other artificial sources

13.5.21 There is no risk of flooding from reservoirs or other artificial sources

13.6 Climate change

Introduction

13.6.1 The EA has produced climate change allowances[2] as the government's expert on flood risk. These allowances are predictions of anticipated change for:

- Peak river flow
- Peal rainfall intensity
- Sea level rise
- Offshore wind speed and extreme wave height

13.6.2 The range of allowances is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it. The central allowance is based on the 50th percentile, higher central is based on the 70th percentile and upper end is based on the 90th percentile

Allowances

13.6.3 The A30 scheme falls in South West river basin district. The peak river flow allowances for 2020s, 2050s and 2080s (with 1961-1990 as baseline) are outlined below.

Table 13-2 Peak river flow allowances for South West river basin

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	25%	40%	85%
Higher central	20%	30%	40%
Central	10%	20%	30%

Table 13-3 Peak rainfall intensity allowances for South West river basin

[2] Environment Agency, 3 Feb 2017, Flood risk assessments: climate change allowances. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

13.6.4 Cornwall Council have indicated that the design should be based on the higher central estimate up to the end of the century, a value of 40%.

13.7 Possible impacts on 3rd party flood risks from the site

Stream interference

13.7.1 Several watercourses/streams cross the route of the proposed scheme. Flows in these watercourses will be maintained within their catchment through culverts where possible. No EA designated main river crossings are required for the proposed scheme.

13.7.2 The proposed cross drainage culverts will be designed to convey the 100 year event plus a 40% allowance for climate change. A freeboard of 300mm or a quarter of the diameter, whichever is greater will be provided. The culverts may require a 150mm embedment for environmental purposes.

13.7.3 The required introduction of new culverts for the many streams which are to be crossed by the new A30 route may lead to the introduction of choke points into these watercourses. These may become blocked by debris or sediment. Due to the low flow rate of these streams this is believed to be of low probability. To further mitigate this issue, all culverts are to be sized based on flood conditions. The culverts will be designed in accordance with the requirements of the DMRB, CIRIA Report 689, and Cornwall Council Drainage requirements.

13.7.4 Where the catchment area draining to the cross drainage culvert is not readily defined, the minimum culvert diameter will be 1200mm in accordance with the DMRB. Culvert design will be in accordance with HA107/04. Culvert crossings will be coordinated with the environmental mitigation measures to rationalise/ combine crossing points. Culverts may be upsized to accommodate environmental requirements if necessary.

13.7.5 Table 13-4 indicates the proposed cross drainage solutions. Culvert sizes will be confirmed following detailed design.

Table 13-4 Proposed cross drainage

Approximate Chainage	Solution	
6+050	Proposed culvert to account for existing watercourse.	1.2m
8+900	Proposed culvert to account for existing watercourse and associated existing culvert on A30.	2.4m [box]

Approximate Chainage	Solution	
9+250	Proposed culvert to account for existing watercourse and associated existing culvert on A30.	2.4m [box]
11+050	Proposed culvert to account for existing watercourse.	1.2m
13+600	Proposed culvert to account for existing culvert on A30	1.2m

Surface water management

13.7.6 The current proposal is for highway drainage to be implemented which would allow the infiltration of surface water runoff from the proposed development[3]. Initial infiltration rates from eight tested locations indicate a wide range of infiltration values between $2.29x10^{-3}$ m/s and $1.63x10^{-4}$ m/s. It is currently inconclusive if infiltration would be successful as groundwater was encountered only 2m below ground level in various locations along the alignment[4]. Groundwater will be monitored until February 2018 and the design proposal will be further informed. Discharge to adjacent watercourses has been considered as an alternative option.

13.7.7 The drainage system will be designed in accordance with the requirements of the Design Manual for Roads and Bridges (DMRB) and will incorporate the Cornwall Council drainage requirements where applicable. Table 13-5 highlights the design specifications for different event periods.

Table 13-5 Drainage design approach for different event return periods

Event	Approach
1 in 1 year	Highway drainage will be designed to ensure there is no surcharging
1 in 5 year	Highway drainage will be designed to ensure there is no surface water flooding
1 in 100 year	Attenuation ponds/ infiltration basins to accommodate the event with an allowance for climate change (40%)

13.7.8 Where infiltration is not possible, in order to mitigate the impact of the road on the existing watercourses, the surface water runoff will be attenuated to a Greenfield Runoff Rate (GRR). This was determined through a hydrological assessment using the Institute of Hydrology 124 method as agreed by Cornwall Council.

Table 13-6 Greenfield runoff rates for different event return periods

Return Period (years)	Greenfield Runoff Rate (GRR) l/s/ha
1	2.8
2	3.2
5	4.4
30	6.8

[3]HA551502-ARP-HDG-SW-RP-CD000002 - A30 Chiverton to Carland Cross Drainage Strategy
[4] WSP Draft Ground Investigation Report, received 2017-08-24

Return Period (years)	Greenfield Runoff Rate (GRR) l/s/ha
100	8.6

13.7.9 Discharge would be controlled by a flow control device immediately downstream of each pond. The type of flow control device would be confirmed during detailed design.

13.7.10 The proposed outfalls and attenuation storage volumes are shown in Table 13-7 and Table 13-8. The information is based on preliminary design and may change subject to detailed design. The volumes have been calculated on the basis of no infiltration, as infiltration values at the pond locations are currently unknown.

13.7.11 The volumes shown below are subject to change as the design is being updated to account for all the drainage elements.

Table 13-7 Proposed Attenuation Pond Volumes under Highways England Responsibility

Approximate Mainline Chainage (m)	Attenuation Pond Outfall Reference	Storage Volume Required (m3)	Cornwall Council Critical Drainage Area?
0+500	A	2100	Y
1+500	B	2200	Y
2+000	C	4250	N
4+100	D	7050	N
6+000	E	4250	N
7+100	F	6000	N
8+900	G	7600	N
10+900	H	3400	N
11+900	I	3300	N
13+300	J	780	N
13+500	K	575	N
14+200	L	4200	N

Table 13-8 Proposed Attenuation Pond Volumes under Cornwall Council Responsibility

Approximate Mainline Chainage (m)	Attenuation Pond Outfall Reference	Storage Volume Required (m3)	Cornwall Council Critical Drainage Area?
1+600	1	2900	Y
4+100	2	1200	N
4+600	3	200	N
6+000	4	50	N
8+000	5	800	N
9+700	6	40	N
11+000	7	50	N
13+200	8	1000	N

13.7.12 Access tracks will be provided to the ponds for maintenance. The tracks will be 3m wide (including room for turning where necessary) and constructed from unbound material.

13.7.13 Where the existing carriageway is to be widened, a new drainage system will be provided, if required, as a result of the proposed works. However, the restricted flow at the outfalls will include the 1 in 1 year return period flows from the existing carriageway as well as the Greenfield Runoff Rate from the widened section. This has been confirmed with Cornwall Council.

13.7.14 Attenuation ponds/infiltration basins will have a maximum storage depth of 1.5m with 0.3m freeboard to the top of the pond. Side slopes will be 1:3 with one side 1:5 for better access and to allow mammal escape from the pond. Permanent water depth of 0.15m will be provided where required. The design will be in accordance with the requirements of HA103/06.

13.7.15 Pavement edge drainage details have been selected in line with the recommended solutions flow chart in DMRB HD33/16.

13.7.16 In cuttings, surface runoff will be drained to grass lined combined surface water/groundwater filter drains in the verge in accordance with Manual of Contract Documents for Highway Works (MCHW) – Highway Construction Detail (HCD) B1 Type 1A.

13.7.17 On embankments, the surface water runoff will be drained via surface water channels in accordance with MCHW – HCD B14 Type A.

13.7.18 Where kerbs are required, surface water runoff will be drained via gully outlets to carrier pipes in accordance with HCD B9 Type 21A.

13.7.19 Lined cut-off ditches at the top of cuttings and unlined cut-off ditches at bottom of embankments will intercept natural runoff. If the natural topography falls away from the alignment, cut-off ditches will not generally be provided other than to mitigate local flood risk.

13.7.20 Fin drains will be used in accordance with HCD F18 on embankments. When the highway is in cutting, the use of grass lined filter drains will also drain the subsurface of the pavement along with the surface water runoff.

13.7.21 Watercourse details such as water levels, bed levels and section details at culvert and drainage outfall locations are currently unknown. These details will need to be confirmed at a detailed design stage and may affect the current design proposals.

13.7.22 There will be a need to connect new drainage into the existing highway network. Approval will be required from Cornwall Council. The existing drainage network details are currently unknown and will need to be confirmed.

Critical drainage areas

13.7.23 The existing road does not fall into Cornwall's Critical Drainage Areas (CDA), except at Chiverton Cross, which is located in the Truro – River Tinney CDA. However, it should be noted that the scheme eventually drains into the Truro – Kenwyn, Allen, Tinney and Tregolls Road CDA.

13.7.24 Where the proposed surface water network discharges directly into the Truro - River Tinney CDA, the runoff rate will mimic the Greenfield Runoff Rate (GRR) up

to a maximum 1 in 1 year rate. Elsewhere the proposed discharge shall mimic the greenfield performance[5].

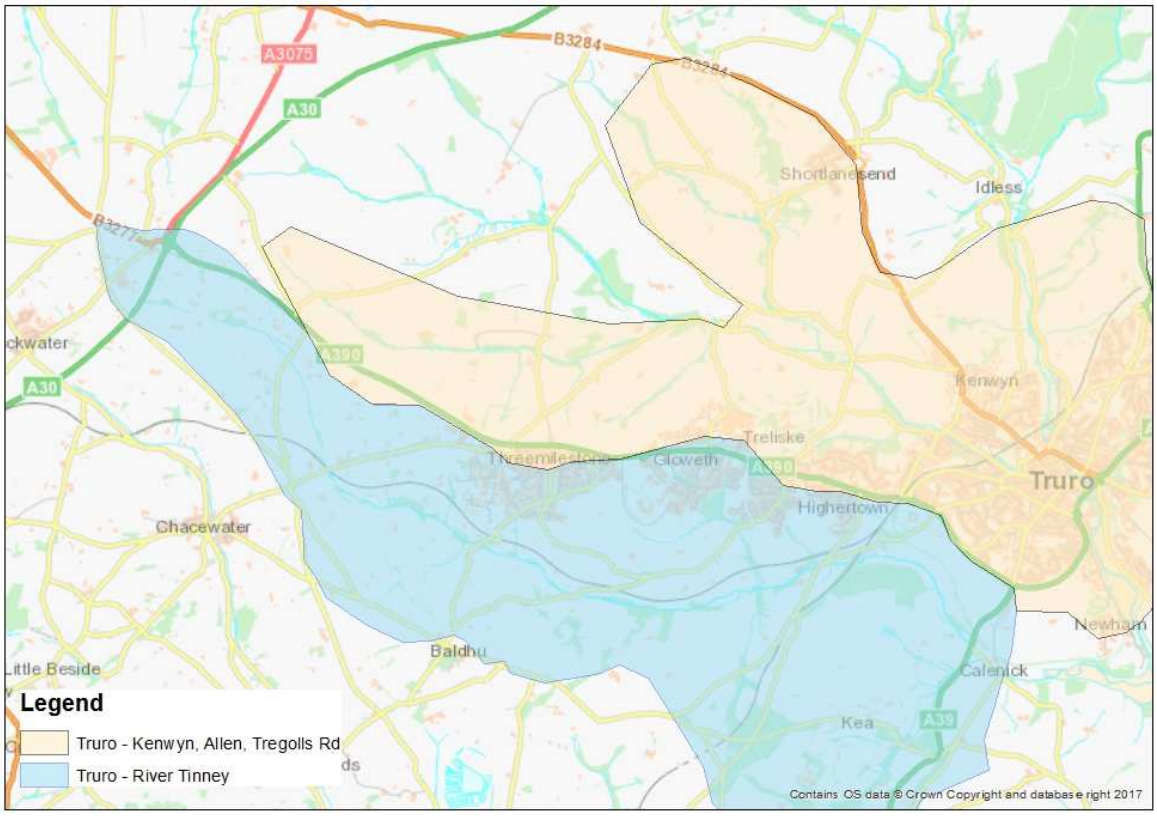

Figure 13-21 Critical Drainage Area (broad view)

[5] HA551502-ARP-HDG-SW-RP-CD000002 - A30 Chiverton to Carland Cross Drainage Strategy

Figure 13-22 Critical Drainage Area (detailed view)

13.8 Residual risks

Permanent works

13.8.1 Several risks to permanent works have been identified and discussed below.

- There is a risk to permanent works that might arise if the event magnitude is greater than designed for, particularly if climate change estimates are greater than the anticipated 40% advised for the scheme.
- There is a risk to permanent works if climate change is greater than designed for in particular with regard to attenuation pond freeboard. It is intended that storms with the higher estimates of extreme climate change are run through the proposed drainage network and attenuation ponds to check that there is no overtopping of earth embankments or other vulnerable structures.
- There is a risk to permanent works in small catchments with high flood risk (mainly groundwater); the resilience of the structures to convey surface water needs to be reviewed to ensure they do not get overwhelmed.

Construction phase

13.8.2 The contractor's design for surface water management during the construction phase is expected to include temporary measures to ensure sheet runoff and silt generation is managed before discharge to downstream water courses. A draft buildability plan from the outline design stage is provided by the preferred contractor, Skanska.

13.9 Conclusion and Recommendations

13.9.1 Highways England are proposing works to upgrade the A30 between the Carland Cross junction and Chiverton Cross junction involving building a new dual carriageway 7.9 miles long. This report provides an overview of the flood risk to and from the site.

13.9.2 The risk of flooding to the proposed new alignment as a whole is considered to be very low, the main risk to the scheme being localised pluvial and groundwater flooding as highlighted in Sections 13.5.6 and 13.5.10. Several areas at high risk of pluvial flooding were identified. These areas may constitute a risk during the construction phase, but are not believed to present a risk to the completed scheme due to a combination of the elevation of the proposed dual carriageway above the surrounding landscape and the recommended drainage measures.

13.9.3 The risk of flooding from the site is minimal. Several watercourses and streams cross the route of the proposed scheme, however there is no major river crossing. A number of culverts have been proposed to maintain the flow paths of these small watercourses. The culverts will be designed to convey a 1 in 100 year flow including a 40% increase in flow to account for the predicted effects of climate change. The minimum culvert diameter is 1200mm with a freeboard of 300mm or a quarter of diameter (whichever provides the greater freeboard).

13.9.4 The preferred option for mitigating flood risk is for highway drainage to be implemented which would allow infiltration of surface runoff from the development. Initial infiltration results were inconclusive, therefore whether infiltration would be successful is uncertain. Groundwater is being monitored from February 2017 to February 2018 which will inform the drainage design. Discharge to adjacent watercourses was investigated as an alternative. Cornwall Council drainage requirements were applied where applicable.

13.9.5 Where infiltration is not possible, the surface water runoff will be attenuated to a GRR. A number of outfall and attenuation storage ponds have been proposed under Highways England and Cornwall Council responsibility. The ponds will have a maximum storage depth of 1.5m with 0.3m freeboard to the top of the pond with a permanent water depth of 0.15m as required. In cuttings the surface water will be drained to grass lined combined surface water/groundwater filter drains in the verge. On embankments the surface water runoff will be drained via surface water channels. The surface water runoff will be drained via gully outlets where kerbs are required. Lined cut-off ditches at the top of cuttings and unlined cut-off ditches at bottom of embankments will intercept natural runoff.

13.9.6 At Chiverton Cross, the existing road falls within Truro - River Tinney CDA. The runoff will mimic the greenfield performance up to a max 1 in 1 year rate where the proposed surface water network discharges directly into the CDA. Elsewhere the proposed discharge (for new impermeable areas) shall mimic the greenfield performance.

13.9.7 Several risks have been identified to the permanent works and during the construction phase. If climate change is greater than the recommended allowance, there might be risks to the permanent works including to the design if there is insufficient freeboard provided to prevent overtopping.

13.9.8 The construction plan for the surface water management during construction phase will be developed by the contractor and is expected to include temporary measures to manage potential runoff or silt generation before discharge.

13.9.9 Overall, the measures proposed to control and attenuate surface water drainage discharges from the new works and the modifications to the existing A30 carriageway will ensure that third party flood risks upstream and downstream are not exacerbated, and indeed are marginally improved over the design life of the proposal, including current allowances for climate change impacts.

Abbreviations List

Abbreviation	Full word/phrase
Abbreviation	Full word/phrase
Abbreviation	Full word/phrase

Glossary

Word	Explanation/description
Word	Explanation/description
Word	Explanation/description

References

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