LANGARTH GARDEN VILLAGE ENVIRONMENTAL STATEMENT

Appendix 10.1 – Flood Risk Assessment and Surface Water Drainage Strategy

OCTOBER 2020

Incorporating

Flood Risk Assessment and Surface Water Drainage Strategy

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Executive Summary

Cornwall Council proposes to submit a hybrid application comprising a full planning permission application for the Northern Access Road and an outline planning permission application for the remainder of the Proposed Development; known as 'the masterplan' and including the Langarth Garden Village.

Arcadis has been appointed by Cornwall Council to produce an Environmental Statement for the Proposed Development. This Flood Risk Assessment and Surface Water Drainage Strategy supplements the Environmental Statement. It has been prepared by Arcadis to support the outline planning application of the Proposed Development in accordance with the National Planning Policy Framework and Local Policy requirements. A separate Flood Risk Assessment and Surface Water Drainage Strategy has also been prepared by CORMAC Solutions Ltd on behalf of Cornwall Council for the Northern Access Road as part of the full planning application.

The proposed Langarth Garden Village Development comprises of a mixed-use community incorporating up to 3,550 residential units, 200 extra care units, 50 health key worker and student accommodation units, two schools, retail, employment, community and leisure space, green infrastructure, the Northern Access Road (NAR) and alterations to the A390.

The application proposes a phased manner of development over approximately 17 years spanning 2021 - 2038.

This report provides a comprehensive assessment of flood risk from multiple sources. Evidence examined in the Flood Risk Assessment shows that the Proposed Development is at low risk of flooding from all relevant sources. The Surface Water Drainage Strategy outlines how surface water would be managed using a range of Sustainable Drainage Systems to reduce flood risk onsite and in downstream areas. The Proposed Development has been assessed for compliance with the NPPF and Local Policy. Through a detailed sequential masterplanning process, only water-compatible land uses have been situated in medium/high flood risk areas. Embedded detailed design and residual risk management would ensure that the Proposed Development remains 'safe' for its lifetime as defined by the NPPF and Local Policy, and that it would not increase flood risk elsewhere; including in the context of cumulative planning applications.

1 Introduction

Cornwall Council (CC), intends to submit an application for hybrid planning permission comprising of a full planning permission application for the Northern Access Road (NAR) and an outline planning permission application for the remainder of the Proposed Development (known as the 'masterplan' and including the Langarth Garden Village).

Arcadis has been appointed by CC in order to produce an Environmental Statement (ES) for the Proposed Development to ensure that potential impacts that could give rise to 'likely significant effects' are appropriately and proportionately addressed in the Environment Impact Assessment (EIA).

As part of the ES and EIA, this Flood Risk Assessment (FRA) and Surface Water Drainage Strategy (SWDS) has been prepared by Arcadis to support the outline planning application of the Proposed Development in accordance with the National Planning Policy Framework (NPPF), the associated Flood Risk & Coastal Change planning practice guidance (PPG) (Department for Communities and Local Government, 2019) (Ref. 10.1 and Ref. 10.2) and Local Policy. A separate FRA & SWDS has also been prepared by CORMAC Solutions Ltd on behalf of CC for the NAR as part of the full planning application. Furthermore, the relevant flood risk and surface water drainage interactions between the NAR and wider development proposals have been taken into consideration, where necessary, in this FRA & SWDS in the context for the Proposed Development.

The Scope of this study is to provide an assessment of all sources of flooding and where required, outline mitigation options. As part of this assessment, a conceptual surface water drainage strategy has been developed, incorporating Sustainable Drainage Systems (SuDS) principles and a range of measures.

The effects of residual flood risk on the development proposals are also reported, through assessment of exceedance events or failure of any proposed mitigation measures, to ensure that all aspects of flood risk and mitigation have been considered and that the Proposed Development remains 'safe' for its lifetime.

1.1 Available information

The following key sources of information have been used to inform this FRA and SWDS:

- Existing Environment Agency (EA) flood mapping (published online at https://flood-warning-information.service.gov.uk/long-term-flood-risk);
- National Planning Policy Framework;
- EA Product 4 data package;
- EA Water Framework Directive (WFD) Catchment Database Explorer;
- Cornwall Local Flood Risk Management Strategy;
- South West River Basin Management Plan;
- Data to describe hydrological catchment areas and characteristics has been drawn from the Centre for Ecology and Hydrology Flood Estimation Handbook web service;
- Cornwall Strategic Flood Risk Assessment Level 1 (SFRA);
- Data gathered during a two-phase site walkover undertaken by Arcadis in July 2019 and October 2019;
- Ground Investigation data and reports from previous planning applications and collected to inform the design of the NAR;
- Previous Flood Risk Assessments commissioned for previous planning applications at the Site;
- NAR Flood Risk Assessment and Surface Water Drainage Strategy; and
- Preliminary Ground Investigation data collected to inform this FRA&SWDS.

All reviewed information is referenced in the relevant sections and listed in Section 10.

2 Area of study and location

The Application Site (Site) is located in the central region of Cornwall, centred at National Grid Reference SW 770457. Its eastern boundary is located approximately 3km to the west of Truro city centre and extends approximately 3.6km to the west. Figure 1 shows the location of the Site and its Red Line Boundary. The Site comprises approximately 245 hectares.

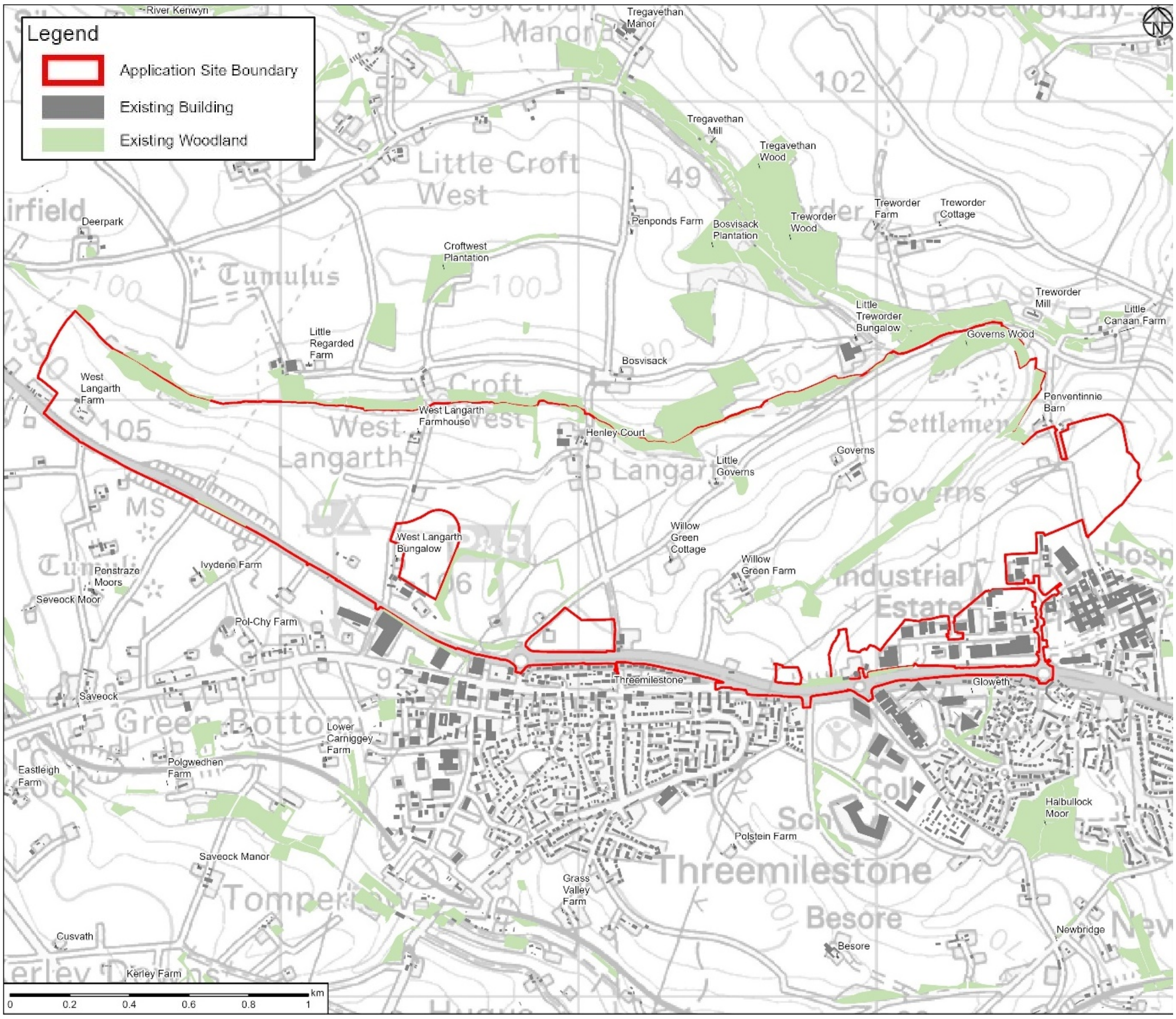


Figure 1: Site Location Map. Contains OS data © Crown Copyright and database right 2020.

The Site is bordered to the south by the A390 (included within the Site boundary), which is a dual carriageway that separates the Site from Threemilestone. Hedgerows and areas of woodland adjoined by minor watercourses bound most of the Site to the west, north and part of the east. It adjoins the Royal Cornwall Hospital and Truro Golf Club to the east and the housing estate of Gloweth to the south-east. Located within Kenwyn Parish, the eastern Site boundary abuts the parish boundary between Kenwyn and Truro. The Site encompasses over 55 agricultural fields which are mainly in arable use and includes farm buildings as shown on Figure 1.

The Site has a moderate topographic gradient, sloping downwards towards the north where an unnamed Ordinary Watercourse is aligned parallel to the Site boundary. Ground levels across the Site vary between approximately 114m and 36m above ordnance datum (AOD). A topographical survey of the Site is presented in Appendix A.

2.1 Catchment Details

Figure 2 shows the key surface water features and their drainage catchments related to the Site. The Site is principally within the River Kenwyn catchment, neighbouring the Calenick Creek catchment immediately to the south. The surface water flow within the Site is generally towards the north and north east direction.

Headwater A flows east along the northern boundary of the Site. This watercourse forms a headwater of the River Kenwyn and is spring fed. A series of small ponds are linked to the watercourse. Headwater A has two tributaries within the study area: Headwater B and Headwater C. Downstream of the Site, the watercourse joins the River Kenwyn in the vicinity of Treworder.

Headwater B flows north through the Site. The watercourse rises at Langarth Park and Ride, where two ponds are present, and then flows north for approximately 400m before entering a culvert under a track. From this culvert to the confluence with Headwater A, the watercourse flows outside of the Site.

Headwater C flows north along the eastern boundary of the Langarth Farm section of the Site. The watercourse flows north from East Langarth to join Headwater A near Langarth. Headwater D flows north-east along the western boundary of the Maiden Green section of the Site. The watercourse flows from a pond at Willow Green to join the River Kenwyn near Langarth.

The hydraulic modelling technical note in Appendix B details the key hydrological sub-catchments and the estimated flood flows for the above headwaters and the River Kenwyn. Table 1 summarises the catchment details for each watercourse.

Table 1: Receiving Watercourses and Fluvial Drainage Sub-catchments

Receiving Watercourses	Fluvial Drainage Sub-Catchments	Total Catchment Area (km^2)
Headwater A	1, 2, 3 and 5	3.60
Headwater B	2	0.32*
Headwater C	3	0.40*
Headwater D	4	0.98
River Kenwyn	1, 2, 3, 4, 5, 6 and 7	11.09

*Areas measured manually as these catchments are too small to be recognised by Flood Estimation Handbook Webservice (FEH).

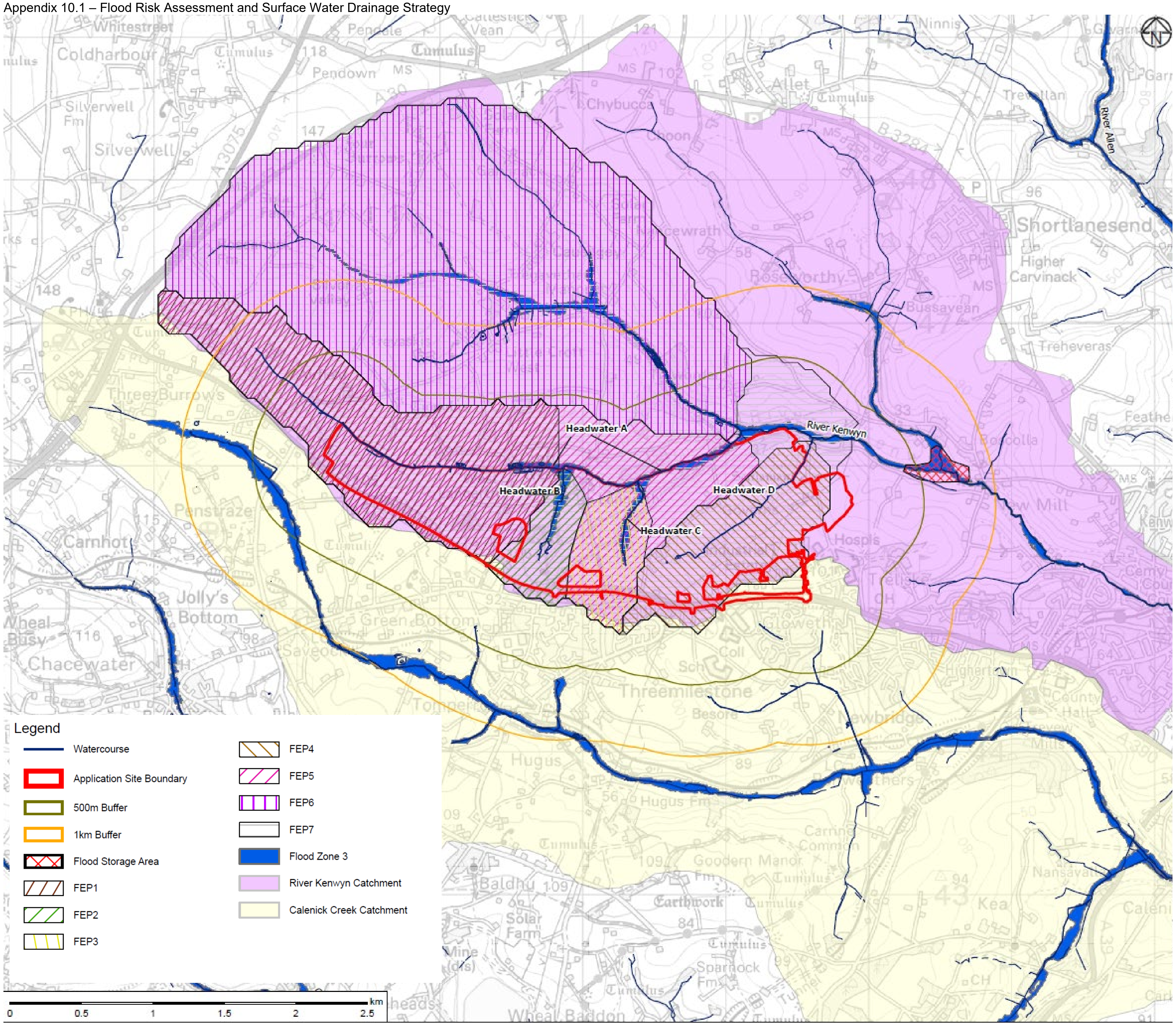


Figure 2: Key Watercourses and Drainage Sub-catchments. Contains OS data © Crown Copyright and database right 2020.

2.2 Ground conditions

2.2.1 Hydrogeology

A desk study review of the hydrogeology aquifer classification 625k data from the British Geological Survey (BGS), (Ref. 10.3) shows that the Site overlies strata of the Middle Devonian (Undifferentiated), considered to be a low productivity aquifer with small local yields from secondary fractures. The Environment Agency Aquifer Designation Map (Ref. 10.4) indicates that the Site is located on a Secondary A Aquifer. These are described as permeable strata capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.

Available data from the BGS Borehole Record Viewer (British Geological Survey (BGS) (Ref. 10.5), has also been reviewed. Borehole locations are shown in Figure 3 and the information indicates:

- One borehole is located within the Site, Ref SW74NE29, to a depth of 24.38m. The available log scan reveals a drilling date of 30/12/1953. Water was struck at 44 ft (13.4m) depth below well top, the rest-level was 40 ft (12.2m) depth below well top, and the yield was 250 gallons (1136.5 litres) per hour.
- Borehole SW74NE24 located 40m immediately southwest of the Development Site boundary penetrated to a depth of 24.38m and was drilled on 11/04/1958. Water was struck at 60 ft (18.3m) depth below well top, the rest-level was 50 ft (15.2m) depth below well top, and the yield was 350 gallons (1591.1 litres) per hour.

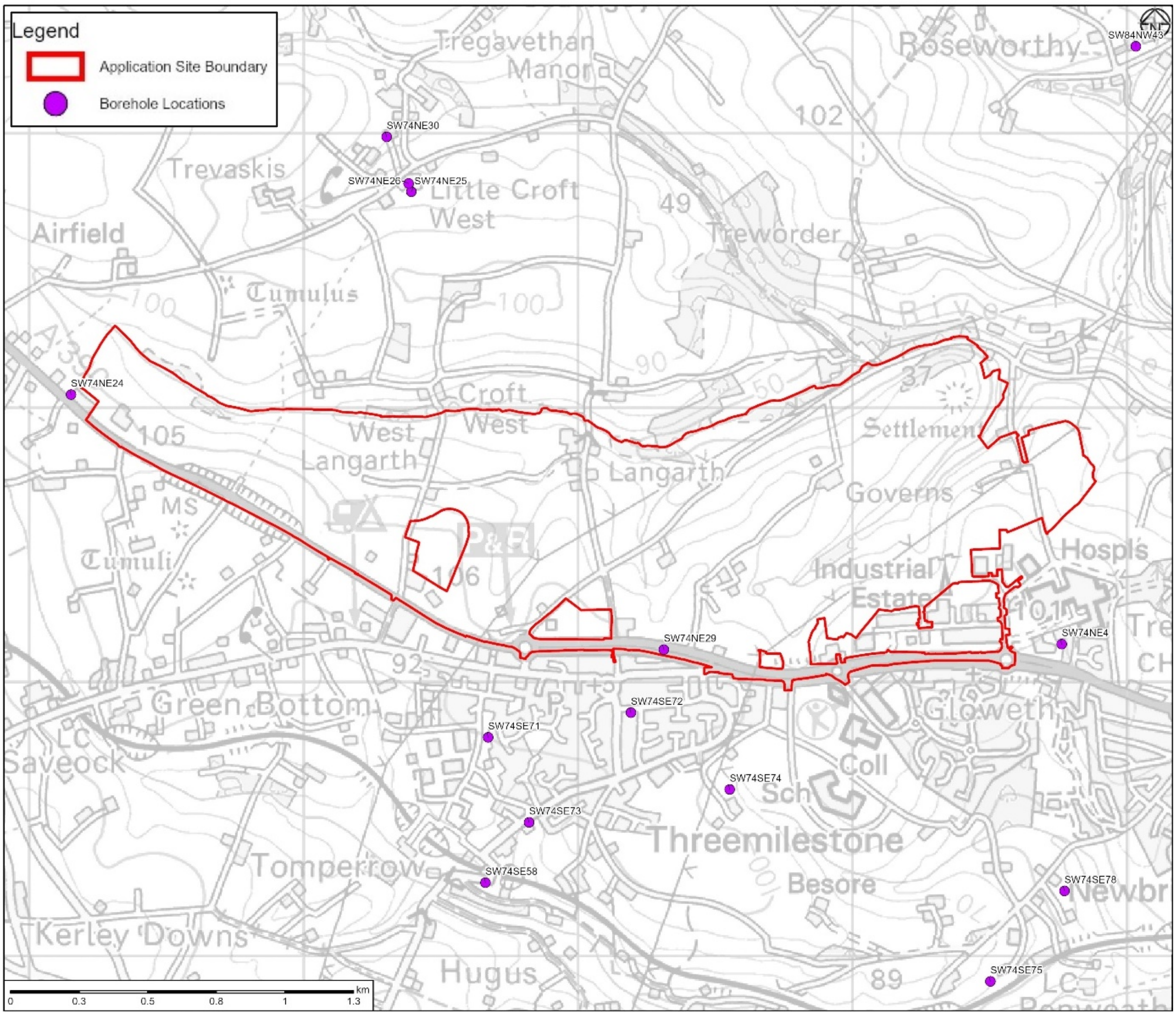


Figure 3: Borehole locations. Contains OS data © Crown Copyright and database right 2020.

A suite of Groundsure reports titled TC_ARDS_24_06_2019 (Groundsure Limited, 2019) (Ref 10.6) have also been reviewed and key findings are summarised below:

- No Source Protection Zones (SPZ) and SPZ within Confined Aquifers are identified within 500m of the Site.
- Groundwater vulnerability and soil leaching across the Site itself is reported as low (L) to Intermediate (I1).

A summary of the findings of previous ground investigation reports is provided below:

The report 3218.FRA&SWDS (Stuart Michael Associates, 2011) (Ref 10.7) integrates findings from the Trial Pit Logs in CGE/6249 (CARD Geotechnics, 2010) (Ref 10.8). No groundwater was reached during intrusive investigation to 2.7m, with all trial pits dry except for TP6 where 'wet, small seepages' / 'damp' were reported at c. 1.5m – 2.7m. It is possible that the dry period prevailing at the time of drilling may have resulted in lower groundwater levels.

The Truro Northern Access Route (TNAR): Ground Investigation Report (Cormac ESL, 2019) (Ref 10.9) contains the details from the eight soakaway tests and 35 trial pits undertaken during the Phase I initial investigation. Trial pits were excavated to a maximum depth of 2.7m below ground level; groundwater was not encountered during the investigation and is considered to be present 'at depth'.

The Truro Northern Access Road (TNAR) Flood Risk Assessment & Surface Water Management Strategy (Cormac Solutions Ltd, 2020) (Ref 10.26) reports that additional trial pits have since been undertaken. Preliminary findings indicate groundwater was encountered in only one trial pit (No. 278 A) at a field boundary near to an existing pond feature. The site-specific groundwater level needs to be determined; the water ingress was estimated at ~73.3m AOD, approximately 2.6m below ground level. Groundwater monitoring systems have been installed across the masterplan Site with the intention to advise the detailed design stage. The subsequent NAR – Phase II Preliminary Sources Study Report (CORMAC ESL, 2019) which discussed the entire 3.5km of the proposed route states that groundwater is anticipated to be present at depth across the majority of the route and will be influenced by the nature of the underlying geology and site topography. Groundwater is expected at shallow depth in lower lying, valley areas of the site (NGR 177811, 045702 and NGR 178293, 045330) and areas proximal to ponds (NGR 177849, 045767 and NGR 178784, 045295). The report confirms that groundwater was not encountered in trial pits excavated during the ground investigations conducted by CARD Geotechnics in 2010 and 2015 or in trial pits excavated by the CORMAC Engineering Services Laboratory (ESL) in 2019. The report recommends that the presence and depth to groundwater should be proven by intrusive investigations and monitoring.

A further preliminary ground investigation was undertaken by CORMAC ESL in 2020 to inform this FRA & SWDS and associated masterplan development proposals. It included 44 additional soakaway trial pits at targeted locations where the previous information coverage was limited, as well as 13 boreholes across the Site, which will monitor ground water levels over a minimum period of 12 months.

COVID-19 restrictions have delayed this extra ground investigation programme but the soakaway testing and borehole installation are now complete. The factual and groundwater monitoring reports are not available at the time of writing, however the draft information available supports the same conclusions of the previous investigations discussed above. The relevant key information describing ground conditions across the Site has been used to inform the subsequent sections of this FRA & SWDS report.

2.2.2 Soils and Geology

A review of the Soilscapes Map (Cranfield Soil and Agrifood Institute, accessed 18th November 2019) (Ref. 10.10) reveals that the Site sits almost entirely on freely draining slightly acid loamy soils. Marginal areas at the southern Site boundary are covered by slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage. These are in the topographically higher southern terrain and therefore the qualities of this soil are unlikely to impede drainage. Figure 4 shows the Soilscapes Profiles for the Site.

As discussed in Section 2.2.1, the BGS borehole SW74NE29 lies within the Site, and records 0.3m of subsoil overlying 24m of 'blue and brown stone' (no precise classification given). Borehole SW74NE24 located 40m immediately southwest of the Development Site boundary records 0.3m of subsoil overlying 24m of clay. Intrusive investigations carried out by CARD Geotechnics (Ref. 10.8) for an earlier large scale residential-employment development proposal at the Site indicates that the Site is underlain by the Porthowan Formation (typically interbedded mudstone and sandstone), which has weathered to silty gravel at shallow depths.

Likely ground infiltration rates and groundwater levels within the Site are discussed further in Section 6 and Section 8, based on data gathered from the previous site investigations undertaken alongside the draft information available from the ongoing ground investigation for the masterplan Site by CORMAC ESL.

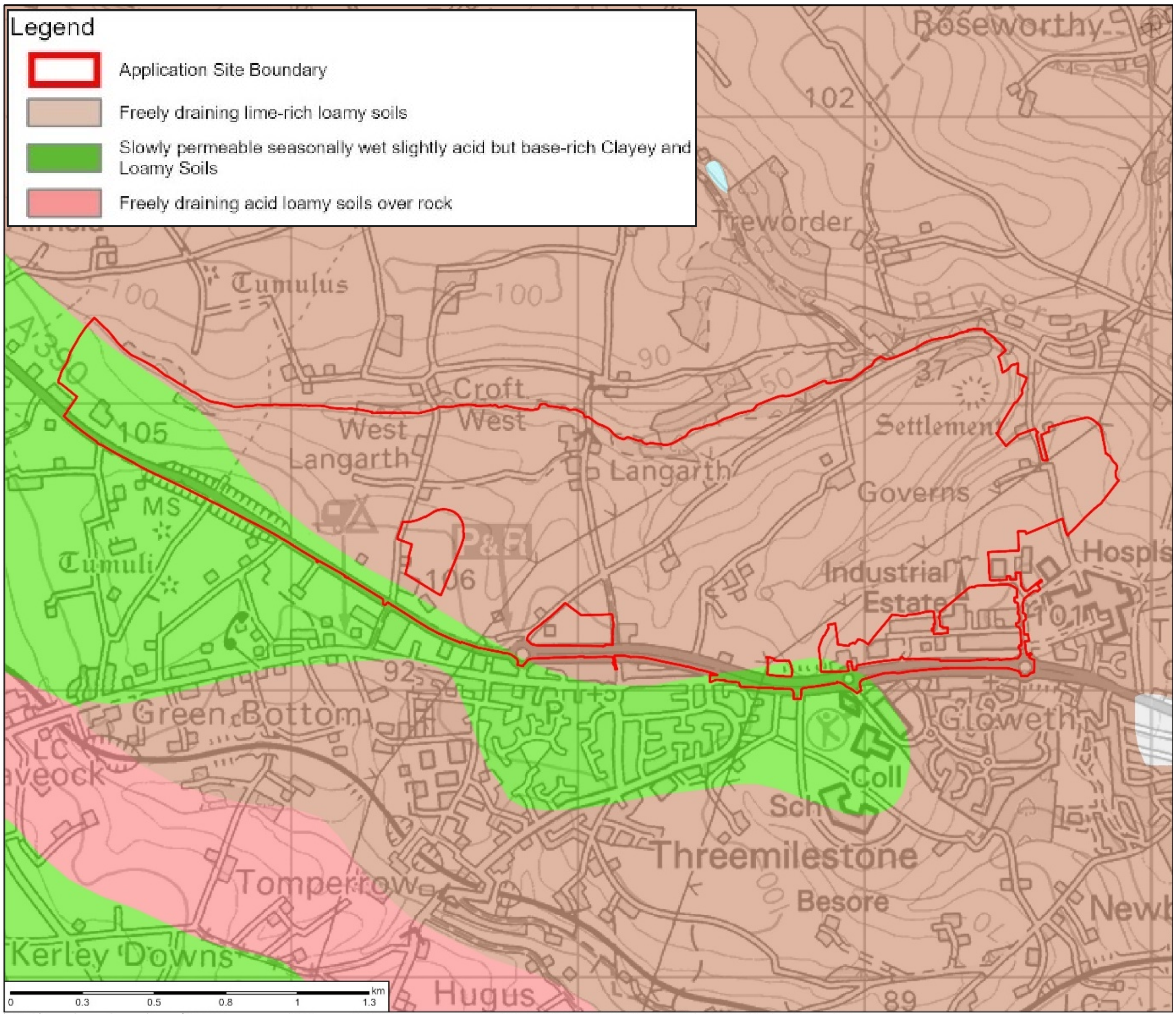


Figure 4: Soilscapes profiles (Source: Cranfield University). Contains OS data © Crown Copyright and database right 2020

3 The Proposed Development

The Proposed Development would comprise of the creation of a number of new neighbourhoods and associated infrastructure including the construction of a Northern Access Road (NAR) and community woodland proposed around the area of Governs Farm and Governs Wood. The Proposed Development has been assigned Garden Community Status, as granted by the Ministry of Housing, Communities and Local Government, and has been so-called the Langarth Garden Village. Further detail is provided in Chapter 4 of the Environment Statement.

The Proposed Development includes up to 3550 new homes and would be constructed in a phased manner spanning approximately 17 years (2021 – 2038) as described in Chapter 4. The NAR is due to be completed during phase 1 (2021 – 2024). The plots, features and infrastructure of the Proposed Development masterplan would be completed across phases 1-5 (2021 – 2038).

4 NPPF Tests

4.1 Planning context

A number of planning applications for development proposals, including residential and community uses, within the Site boundary have previously been granted consent. The Proposed Development incorporates the previously consented sites and together with the provision of the NAR creates a single integrated development. This integration intends to harmonise the process of development of the area and to provide a consistent, integrated and high-quality design which meets CC's objectives of delivering a community, not just a series of housing estates, which complies with national and local planning policy. Figure 5 shows the location of other relevant nearby planning applications considered for cumulative effects.

The planning application for the Proposed Development is a hybrid application comprising of a full planning application for the NAR and an outline planning application for the remainder of the Proposed Development (known as the masterplan), with all matters reserved.

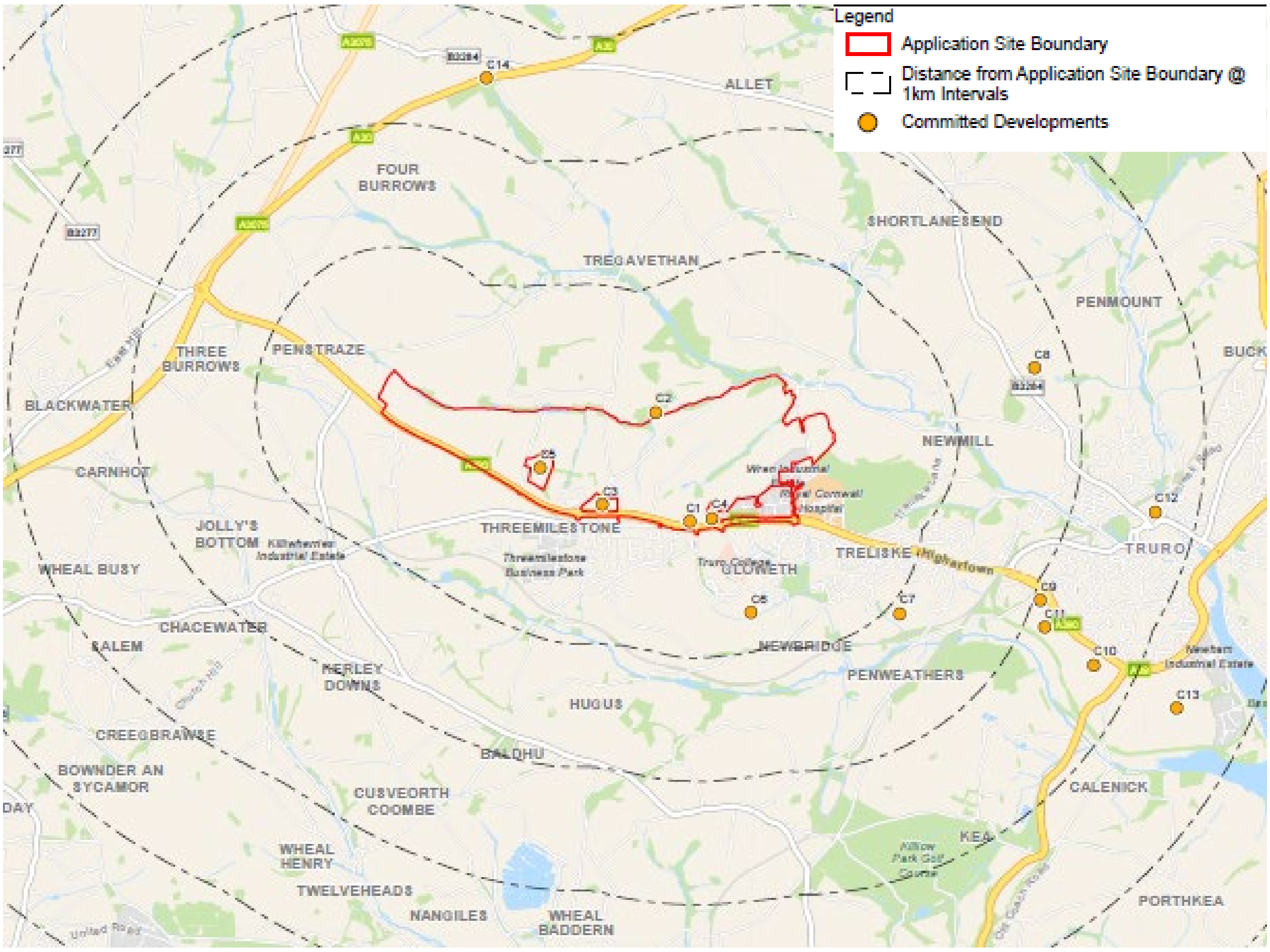


Figure 5: Relevant nearby planning applications considered for cumulative effects. Contains OS data © Crown Copyright and database right 2020

4.2 Compliance with the NPPF tests

The NPPF (Ref. 10.1) sets out the government's planning policies for England. The associated PPG (Ref. 10.2) advises planners on how to identify and address the risks associated with flooding and coastal change within the planning process. These risks are managed though a three-step process to assess, avoid and manage or mitigate flood risk, with strict tests developed to protect people and property from flooding. Suitable mitigation and adaption measures are also advised in the planning process to address the likely future impacts of climate. Further details on the NPPF are provided in Chapter 10 of the ES.

The NPPF advocates a sequential approach to situating new development, steering development away from areas at high risk of flooding if appropriate areas at lower risk of flooding are reasonably available. Developments situated in high flood risk areas must satisfy the NPPF Exception Test as a method of managing flood risk while still allowing necessary development to proceed.

Table 2 summarises the requirements of the NPPF Tests and demonstrates how these national standards are met through the Proposed Development's embedded design. Local Policy acts as a regional extension of the NPPF. These local policies may be identified by Risk Management Authorities (RMAs) under the Flooding and Water Management Act (FWMA) 2010 and are typically recorded in statutory documents such as Local Flood Risk Management Strategies. Table 3 summarises the requirements of Local Policy and demonstrates how these have been satisfied by the Proposed Development. Figure 6 and Figure 7 support these tables.

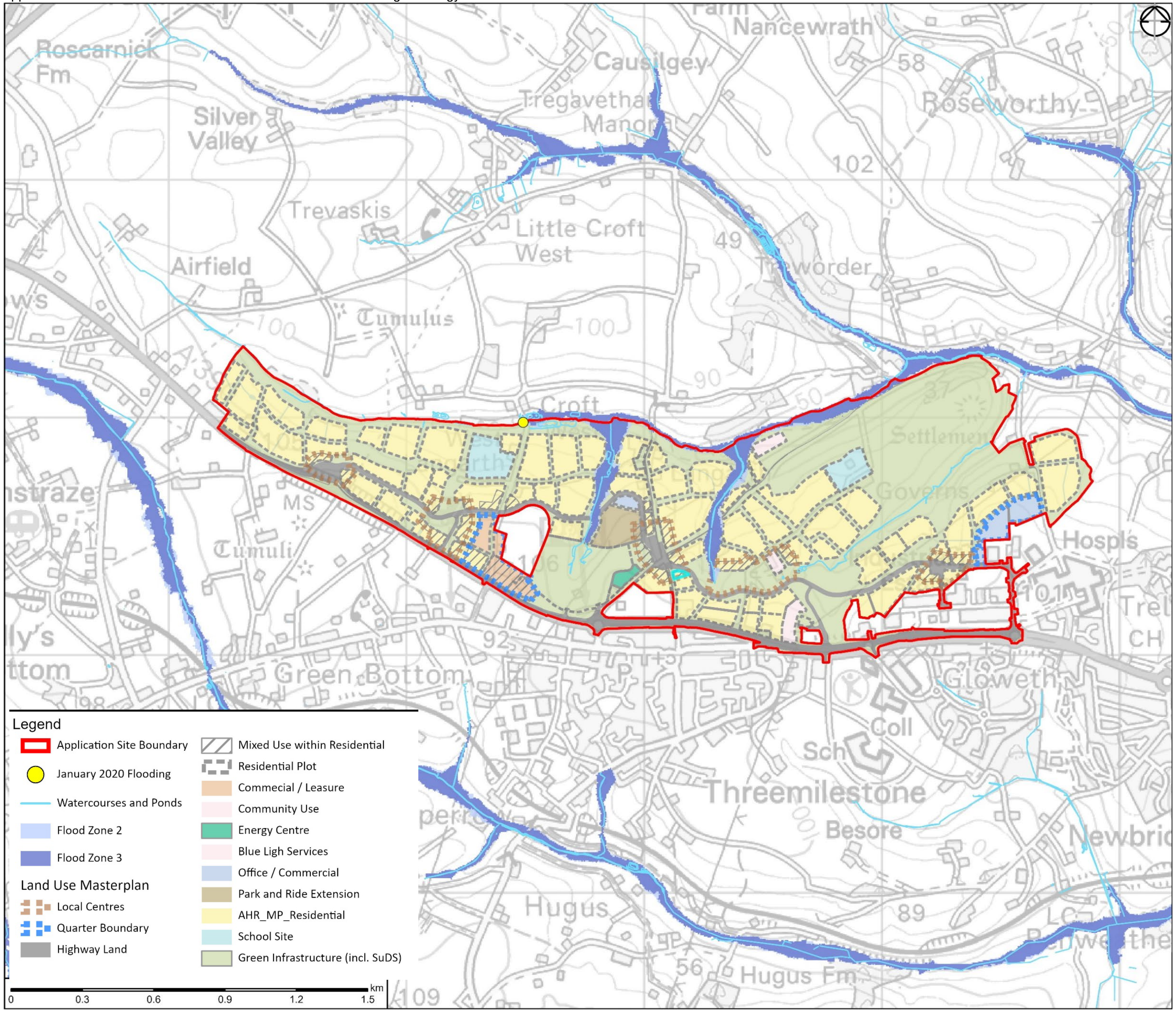


Figure 6: EA Flood Zones and bespoke modelled extents overlain on Proposed Land Use design freeze (LAN_02.1-AHR-MP-ZZ-DR-A-92-002_Proposed Land Use_P10) Contains OS data © Crown Copyright and database right 2020

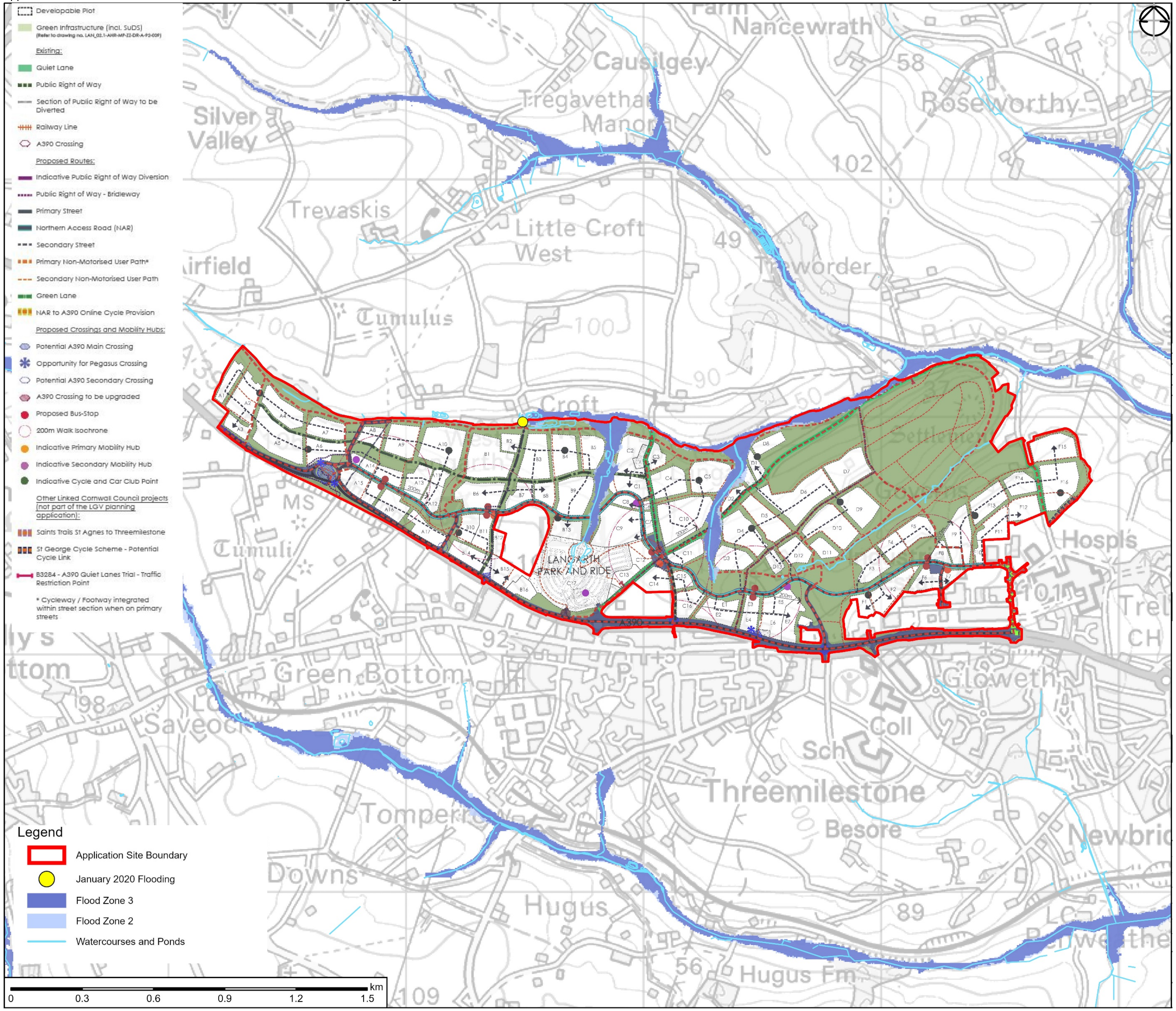


Figure 7: EA Flood Zones and bespoke modelled extents overlain on Movement and Access design freeze (LAN_02.1-AHR-MP-ZZ-DR-A-93-012_Movement and Access Parameter Plan_P10) Contains OS data © Crown Copyright and database right 2020

Table 2: NPPF Sequential and Exception Test criteria supported by embedded design.

Test	Test Requirement	Embedded Design
Sequential & Exception	Paragraph 155: Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.	The following entries in this table demonstrate how these stipulations of the Sequential and Exception Tests are met by the Proposed Development.
Sequential & Exception	Paragraph 156: Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should…take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.	To support CC's strategic policies the masterplan design, including the SuDS components, has taken account of EA and LLFA advice (as documented in Stakeholder Comments Section 8.2; Table 8).
Sequential	Paragraph 158: The aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the Proposed Development in areas with a lower risk of flooding. Paragraph 162: Where planning applications come forward on sites allocated in the development plan through the Sequential Test, applicants need not apply the Sequential Test again.	• A vast majority of the Site has previous planning permission and has been allocated for residential development within the Cornwall Local Plan (Cornwall Council, 2016) (Ref. 10.12) and Truro and Kenwyn Neighbourhood Development Plan (Truro City and Kenwyn Parish Councils, 2016) (Ref. 10.13). • The proposed mixed residential-commercial use does not represent an increase in flood vulnerability, therefore complies with the Sequential Test. • Furthermore, any additional proposed residential or commercial development areas within the Site in those areas without previous planning permission, is located entirely within the Flood Zone 1, fully meeting the Sequential Test requirements.
Sequential	Paragraph 157: All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should manage any residual risk. A sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.	• The majority of the Site is in Flood Zone 1. • Through a detailed masterplanning process, land use has been located sequentially with only water-compatible land uses situated in medium/high risk (Flood Zone 2/3) areas. This includes only water-compatible land use at the location where some minor flooding was reported in January 2020. • An appropriate Climate Change scenario has been modelled and results used to guide the embedded masterplan design (Section 5).

Test	Test Requirement	Embedded Design
		• Figure 6 and Figure 7 demonstrate the due consideration given to flood risk management embedded into the masterplan development.
Sequential	Paragraph 158: The Strategic Flood Risk Assessment will provide the basis for applying this test.	• Recommendations of the Cornwall Strategic Flood Risk Assessment (Cornwall Council 2009) (Ref 10.11) are considered in Table 3.
Exception	Paragraph 159: If it is not possible for development to be located in zones with a lower risk of flooding (taking into account wider sustainable development objectives), the Exception Test may have to be applied. The need for the Exception Test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in national planning guidance.	The Proposed Development has a mixed flood risk vulnerability classification, ranging from 'Water Compatible' (areas of open space and recreational/sports facilities), to 'Less Vulnerable' (commercial and employment space) to 'More Vulnerable' (residential use, schools and health facilities) as per NPPF guidance. The lifetime of the Proposed Development including residential use is at least 100 years. As a small portion of the Site is covered by Flood Zone 3, the 'More Vulnerable' residential classification requires the Exception Test to assess the safety of the Proposed Development over its lifetime. As stated above and demonstrated in Figure 6 and Figure 7, no 'More Vulnerable' or 'Highly Vulnerable' land uses are proposed in these small areas of Flood Zone 3 as part of the Proposed Masterplan, which require the application of Exception Test in this FRA. However, the NAR, which is classified as 'Essential Infrastructure' crosses a small area of Flood Zone 3 at the upstream reach of Headwater B. The NAR has a separate FRA & SWDS that has been prepared by Cormac Solutions, which discusses flood risk impacts, including associated Sequential Testing and Exception Testing requirements. Therefore, further reference must be made to the NAR FRA & SWDS (Ref. 10.26) in relation to the Exception Test compliance for the NAR. Nevertheless, wider sustainability benefits associated with the Proposed Development are highlighted below, including the compliance of second part of the Exception Test under Paragraph 160.
Exception	Paragraph 160: For the Exception Test to be passed it should be demonstrated that: • The development would provide wider sustainability benefits to the community that outweigh the flood risk.	**Sustainability Appraisal:** The Proposed Development provides sustainable benefits to the community that outweigh the flood risk on Site. These include: • A proportion of affordable housing to meet Local Authority aspirations; • An integrated public transport system, increased capacity of the existing Park and Ride facility and improvements to the existing A390 to improve connectivity and accessibility in a currently remote and poorly connected area;

Test	Test Requirement	Embedded Design
		• The implementation of NAR will help support and facilitate various development opportunities to the north of the A390, west of Truro. Historically outline planning consent for the 2,700 homes was obtained within the Proposed Development, which is now planned to be increased to up to 3.550 as part of this proposed masterplan; • The retention and integration of existing landscape features (hedgerows, trees, woodland and copses) wherever possible, providing 108.65 hectares of green infrastructure, SUDS infrastructure and community spaces that retain the character of the area, including a 20% net biodiversity gain.
	• The development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.	The Materplan SuDS strategy (as detailed in Section 8.5) together with the NAR SuDS strategy (as detailed in Appendix 10.3 of the Environment Statement), mitigate surface water runoff to the rates required by the LLFA lower than the existing 1% AEP greenfield rates. This not only mitigates any possible increase in surface water flooding on-site caused by the increased impermeable areas, but also attenuates any run-off to areas beyond the Proposed Development. This is important to prevent negative impacts on Truro, which is identified as a high priority community for long term flood risk management (see Section 4.3). NAR road elevation, connecting roads and finished floor levels of the new properties will be located significantly higher than the predicted flood levels in the impacted existing watercourses. The extensive SuDS network proposed for the NAR and Masterplan Site will include appropriately designed culvert crossings under the NAR, surface water swales, drainage channels as well as infiltration and attenuation basins to safely manage surface water without causing flood risk to the NAR, connecting roads and new properties within the Proposed Development.
Exception		There is the potential for developments that drain the same hydrological catchments to have a cumulative impact on flood risk and land drainage, through increased hard surfaces, increased runoff, modification of watercourses and loss of floodplain storage. A cumulative risk can be posed to existing developments by multiple proposed developments. A list of planning applications considered cumulative in terms of flood risk management is provided in ES Chapter 10 and shown in Figure 5. To achieve consent, the cumulative applications would need to pass the NPPF Sequential and Exception Tests for flood risk. They would demonstrably not increase flood risk

Test	Test Requirement	Embedded Design
		elsewhere, e.g. by achieving greenfield runoff rates. Each application would self-negate its flood risk. Cumulative effects on flood risk and land drainage are therefore not anticipated.
Sequential & Exception	Paragraph 163: Where appropriate, applications should be supported by a site-specific flood-risk assessment.	This report constitutes a site-specific FRA and SWDS for the Masterplan Site, evaluating flood risk from all relevant sources, supplemented by bespoke modelling of fluvial flood risk to the Proposed Development. This modelling is confirmed by the EA as appropriate for the purpose of outline application masterplanning (Table 8). As highlighted before, Appendix 10.3 of the Environment Statement includes a site-specific FRA & SWDS for the NAR.
Sequential & Exception	Paragraph 163: Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the Sequential and Exception Tests, as applicable) it can be demonstrated that:	
	• Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location	The masterplanning process has not placed the 'More Vulnerable' residential components in conflict with the EA modelled Flood Zones 2 or 3. The bespoke hydraulic modelling (Section 7) has indicates that the current EA mapping of Flood Zones 2 & 3 over-estimates the 1% and 0.1%AEP flood extents to which the masterplan has been designed, creating a greater buffer of safety for the residential plots.
	• The development is appropriately flood resistant and resilient	The bespoke hydraulic modelling (Section 7) indicates that the topography of the site, the nature of which is largely retained in the masterplanning, naturally restricts the fluvial flood extents to be largely within the banks of existing channels. Drainage routes/flow paths will be retained as blue and green corridors without any built development, forming a key part of the proposed drainage strategy.
	• It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate	A SuDS strategy has been embedded into the masterplan design. The SuDS strategy is detailed in Section 8.
	• Any residual risk can be safely managed	Residual risk management is discussed as part of this FRA in Section 7.5. Due to the low flood risk within the Proposed Development, it is considered that residual risk can be safely managed, and that no site-specific emergency plan is required.
	• Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.	Figure 7 demonstrates how safe access/egress is embedded into the masterplan.

Test	Test Requirement	Embedded Design
		The NAR and A390 improvements would serve to improve access/egress to the general area, further to the benefit of the emergency services and existing emergency plans. The NAR is designed to cross Headwater B where Flood Zones 2 & 3 indicate out-of-bank flooding, but Arcadis' bespoke flood extents are predicted to be largely in-channel. Any potential impeded access/egress to the Proposed Development caused by flooding at this location would be mitigated by embedded design. Arcadis' bespoke modelling has generated hydraulic data to inform such embedded design. A large 1.8m high by 2.4m wide box culvert with a 0.5m wide mammal ledge and a low flow channel would be designed in accordance with best practice to avoid any localised hydraulic flow throttling effects. Further consideration is discussed in the Residual Risk Management Section 7.5. The NAR also benefits from its own bespoke FRA, provided in Appendix 10.3 of the Environmental Impact Assessment. Proposed secondary roads would remain flood-free, ensuring access/egress to every residential plot. In terms of pedestrian access, the Flood Risk Assessment (Section 7) has identified the areas of risk described below. The detailed design would address these specific risks accordingly: - a cycleway / footpath would cross Headwaters B & C near their confluences with Headwater A where out-of-bank flooding is predicted. - a cycleway / footpath would cross the location where flooding was reported in January 2020; predicted by modelling to originate from surcharge of a culvert on Headwater A. - A cycleway / footpath would trend parallel with Headwater B and may experience flooding where surcharge of a culvert is predicted. - An existing lane would be retained as a cycleway / footpath crossing Headwater C at a culvert where out-of-bank flooding is predicted. The masterplan ensures that the abovementioned four routes do not constitute the sole access/egress route for any plot; and alternative means of access/egress would be available to all plots through the embedded design. Therefore, within the Proposed Development itself, no access/egress would be impeded by flooding. Sensitive watercourse design is embedded into the masterplan. Section 7.5 discusses further recommendations to mitigate residual risk.

4.3 Compliance with Local Planning Policy

Table 3: Local Policy criteria supported by embedded design.

Policy Document	Policy Requirement	Embedded Design
Cornwall Local Flood Risk Management Strategy (Cornwall Council, 2014) (Ref. 10.15)	A statutory report under the FWMA 2010. Published as Parts 1, 2 and 3. It considers the main sources of flood risk in the region and outlines activities and strategies that Cornwall County Council can implement, in their role as the LLFA, to manage long-term-flood risk. There are no Site-specific policies in Part 1. The Preliminary Flood Risk Assessment Report (Cornwall Council, 2011) (Ref 10.16) (undertaken to inform the Local Flood Risk Management Strategy) identified Truro as being the highest priority of 28 identified communities for undertaking Part 2. Part 2: Local Flood Risk Management Profiles are work in progress, with one not yet being available for Truro.	To support the Sequential Test and Exception Test, an FRA & SWDS have been undertaken to safeguard nearby vulnerable localities such as Truro from any increase in flood risk posed by the Proposed Development. The review of historic flood events for Truro found the two 1988 events were estimated as having 1% to 2% Annual Exceedance Probability (AEP) by a UK leading hydrological institution. The proposed SuDS strategy is designed to safely store water up to the 1% AEP plus 40% Climate Change critical event, rather than discharging uncontrolled flow downstream where it could contribute to increased flooding elsewhere. The SuDS strategy has demonstrable capacity to mitigate surface water flooding on-site and also negate any increase in flood risk elsewhere (including the nearby vulnerable area of Truro further downstream) as it limits the peak runoff rates to the 10% AEP greenfield rate.
Cornwall Strategic Flood Risk Assessment (Ref. 10.11)	The Cornwall Strategic Flood Risk Assessment is currently at its Level 1 assessment phase. Level 1 comprises the 'Cornwall SFRA Level 1' report and an interactive mapping platform. Level 1 Appendix E contains a 'Developer Information Pack', which issues guidance on Sequential and Exception Tests. This guidance defines the term 'safe' which must be satisfied to pass the Exception Test: • Floors in single storey buildings of 'more vulnerable' development should remain dry during a 0.1% AEP fluvial flood; • Multi-storey buildings should provide a safe route to a floor level above flooding for all people, including those with restricted mobility, accessible and acceptable to the emergency services;	The masterplanning process has not placed the 'More Vulnerable' residential components in conflict with the EA modelled Flood Zones 2 or 3; therefore floors can be expected to remain dry during a 0.1% AEP flood event. Arcadis' bespoke hydraulic modelling includes climate change scenarios and therefore provides data to advise on floor levels and masterplan design for the current outline planning application stage. Exception Test is not applicable for the Masterplan Site and only relevant for the NAR design. Access/egress is discussed in detail in Table 2 and the Residual Risk Management Section 7.5.

Policy Document	Policy Requirement	Embedded Design
	• Access/egress routes should aim to remain flood free during a 0.1% AEP fluvial flood, and emergency services should be able to access buildings to rescue and evacuate people; and • Floor levels should be set at least 300 mm above precisely, or 600 mm above less precisely computed future flood levels.	
Cornwall Local Plan (Ref. 10.12).	Referenced by CC in development management decisions in Cornwall for planning applications up to 2030. Policy 26: Development proposals should contribute to increased flood resilience, account for climate change and development vulnerability, and safeguard land for functional flood storage. Policy 26: Development proposals of more than 10 dwellings or exceeding 0.5 ha should provide a long-term water management plan.	Through a detailed masterplanning process, land use has been located sequentially with only the water-compatible land uses situated in medium/high risk areas. Bespoke hydraulic modelling accounts for climate change to current Government Standards. Residual Risk Management recommendations and SuDS strategy plans are provided within the FRA / SWDS.
Truro and Kenwyn Neighbourhood Development Plan (Cornwall Council, 2016) (Ref. 10.13)	Referenced by CC in development management decisions in the Truro and Kenwyn areas for planning applications up to 2030. Policy E1: focuses on sustainable development; minimising the effects of development on the environment and taking into account the effects of climate change. New development in Truro and Kenwyn will be approved where it can be demonstrated that the proposal is sustainable. Policy E2: focuses on sustainable drainage; new developments will be permitted where they provide sustainable urban drainage and incorporate water recycling features that minimise the impact of development upon the drainage regime of the river catchment. This is to include maximum use of SuDS, minimal loss of green space to hard surfacing, and no increased flood risk.	A detailed SuDS strategy has been designed and integrated into the masterplan. The SuDS strategy provides sustainable attenuation of surface water run-off to negate any increased flood risk elsewhere. Application of the Sequential & Exception Tests assess the sustainability of the Proposed Development. Loss of green space to hard surface is minimised with retention of community woodland and 108.65 hectares of green infrastructure and SUDS infrastructure. Drainage routes/flow paths are retained as blue and green corridors without any built development. Incorporation of existing natural waterbodies, nature-based systems and green buffers forms a key part of the proposed SuDS and landscape design.
West Cornwall Catchment Flood Management Plan (Environment Agency, 2012) (Ref. 10.14)	Gives an overview of flood risk in the West Cornwall catchment and sets out the EA's preferred plan for sustainable flood risk management over the next 50 to 100 years.	Due to the precise location of the Site, Policies 4 & 6 are not relevant to this FRA/SWDS.

Policy Document	Policy Requirement	Embedded Design
	Policies 4 & 6 are specific to the study area; and include recommendations to incorporate wetlands and disused china clay pits into attenuation and storage.	

4.4 Compliance Assessment

With respect to the Sequential and Exception Tests, it is concluded that:

- Through a detailed masterplanning process, land use has been located sequentially with only water-compatible land uses situated in medium/high risk areas and as such it is considered that the Proposed Development passes the Sequential Test;
- The Proposed Development will remain ‘safe’ as defined by the NPPF and Local Policy and will not increase flood risk elsewhere, including in the context of cumulative planning applications; and
- Both the Sustainability and Lifetime Safety elements of the Exception Test required for development to be allocated or permitted are satisfied. As such, it is considered that the Proposed Development passes the Exception Test.

5 Climate change

Climate change is a key consideration in assessing flood risk. Whilst there is uncertainty as to the future effects of climate change, UK Government forecasts predict increases in peak fluvial flows and rainstorm intensities, therefore introducing flood risk to areas previously unaffected.

The NPPF (Ref. 10.1) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. Climate change allowances for considering flood risk across the Proposed Development's design lifetime are taken from the PPG (Ref. 10.2). These are estimated as banded upper and lower ranges of expected change in rainfall intensities and peak river flows. Table 4 shows the specific guidance recommendations for FRAs located in the South West River Basin District. Table 5 shows the national guidance recommendations for projecting rainfall intensities.

The Proposed Development is expected to have a design life of 100 years. To embed climate change resilience into the development, the following uplifts in rainfall intensities and fluvial flood flow peaks have been adopted:

- For peak fluvial flows: a climate change scenario of 1% AEP storm + 85% CC
- For surface water drainage: a climate change scenario of 1% AEP storm + 40% CC.

Table 4: Peak river flows increase for the South West RBD (Adapted from Table 1 of Ref. 10.2.)

Peak River Flow Allowance Category	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	85%
Higher Central	40%
Central	30%

Table 5: National rainfall intensity increase (Adapted from Table 2 of Ref. 10.2.)

Peak Rainfall Allowance Category	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	40%
Central	20%

6 Potential Sources of Flooding

6.1 Overview

In line with best practice, this section of the FRA considers flood risk from the range of possible sources listed in Table 6.

Table 6: Sources of Flooding

Source of Flooding	Description
1. Flooding from rivers (Fluvial)	Floodwater originating from a nearby watercourse when the amount of water exceeds the channel capacity of that watercourse
2. Flooding from land (Surface Water)	Flooding caused by intense rainfall exceeding the available infiltration and/or drainage capacity of the ground
3. Flooding from groundwater	Flooding caused when groundwater levels rise above ground level following prolonged rainfall
4. Flooding from the sea (Coastal)	High tides, storm surges and wave action, often acting in combination, flooding low-lying coastal land
5 Flooding from sewers	Flooding originating from surface water, foul or combined drainage systems, typically caused by limited capacity or blockages
6 Flooding from reservoirs, canals and other artificial sources	Failure of infrastructure that retains or transmits water or controls its flow.

6.2 Fluvial

The Flood Risk Map for Planning (Environment Agency, accessed 18th November 2019) (Ref. 10.17) (see Figure 8) indicates that the Site is not at risk of flooding from the EA main rivers and that the vast majority of the Site is located on land designated in low risk Flood Zone 1 (land having less than 0.1% annual probability of flooding). There are however limited areas of medium risk Flood Zone 2 (land having between 1% and 0.1% annual probability of flooding) and high risk Flood Zone 3 (land having ≥1% annual probability of flooding). These areas generally follow the route and profile of the existing ordinary watercourses within the Site and along the northern Site boundary.

The SFRA Level 1 (Ref 10.11) also refers to the EA Flood Risk Map for Planning in order to identify flood zones associated with ordinary watercourses.

A review of fluvial flooding records was undertaken to ascertain if historic fluvial flooding has affected the Site. This review entailed a search of:

- The ‘Recorded Flood Outlines’ dataset (Environment Agency, Dec 2019) (Ref 10.18);
- The bespoke Product 4 data package ENQ19/DCIS/132003 (Environment Agency, 2019) (Ref 10.19);
- Published studies of Truro by the Institute of Hydrology / UK Centre for Ecology & Hydrology;
- Local Policies produced by CC (listed in Section 4.3);
- Flood Risk Assessments commissioned for previous planning applications at the Site; and
- Anecdotal data collected from local residents.

A single anecdotal report of flooding on Site in January 2020 was provided by a local resident. The flooding occurred upstream of the road bridge at West Langarth Farmhouse on Headwater A (River 9 Station 2589). Its indicative location is shown on Figure 8, and following a site inspection, the cause of this event is concluded to be a partially blocked/ collapsed culvert. No properties were impacted by this flooding incident.

The EA Product 4 data package (Ref. 10.19) was received for the 1km study buffer. It indicates a localised recorded flood outline at the tributary confluence point immediately northeast of the Site boundary, and a further flood outline downstream at New Mills. Further interrogation of this data using the Environment Agency 'Recorded Flood Outlines' dataset (Ref 10.18) reveals the date of the flooding incidents to be 1993 and 1994. The source of flooding is reported to be 'Main River' and the causes to be 'obstruction/blockage – bridge' and 'channel capacity exceeded (no raised defences)'.

As a significant local population downstream of the Proposed Development, the flood history of Truro is given special consideration here. The LLFA highlighted in their Scoping Opinion comments (Cornwall Council, 2019) (Ref. 10.20) a history of flooding at Truro, associated with development of the catchment. A detailed review of the Environment Agency 'Recorded Flood Outlines' dataset (Ref 10.18) has been undertaken, supported by independent hydrological research by the UK Centre for Hydrology & Ecology. Eighteen flood outlines are recorded for Truro, with dates spanning 1924 to 2018. Approximately half of the recorded outlines represent the 1988 floods. In January 1988, Truro experienced severe flooding, followed by a second flood event of greater magnitude in October 1988. The return period of the January event was initially estimated as 1 in 350 years, using methodology that focused on the restricted gauge data that was only available for 20 years previous (1968 – 1988) (Ref. 10.27). The second flood prompted a new investigation by the Institute of Hydrology in 1989, who re-analysed and re-assessed the 2 events (Ref. 10.27). In addition to the gauged data, the Institute of Hydrology used historical flood information. The Institute concluded that the return periods of the two events were 1 in 50 and 1 in 100 years respectively (1% to 2% AEP). Acreman & Horrocks published further on their methodology in 1990 (Ref. 10.28), which has since been cited by the Centre of Ecology (2001) (Ref. 10.29) as demonstration of how analysis that includes historic floods gives greater confidence in the assessment of flood frequency. Indeed, due consideration of historical flood events is now a key component of all Flood Risk Assessments, including this report for the Proposed Development.

A flood storage area (FSA) exists downstream of the Site, to attenuate flood flows in the River Kenwyn. The increased urbanisation of the contributing catchment as a result of the Proposed Development could potentially affect the performance of the FSA and an initial study has been commissioned to assess this risk, in consultation with the EA. The results and recommendations of this initial study will be reported as an addendum to this FRA.

Further detailed study of fluvial flood risk has been undertaken as part of this FRA. Bespoke site-specific hydraulic modelling has been undertaken for the ordinary watercourses within the Site, to provide flood mapping coverage where unavailable on the EA Flood Risk Map for Planning (Ref. 10.17) and to form the basis for any further masterplan refinements at sensitive locations such as river crossings, as per the consultee advice received in Table 8.

The modelling methodology and results are discussed in Section 7.

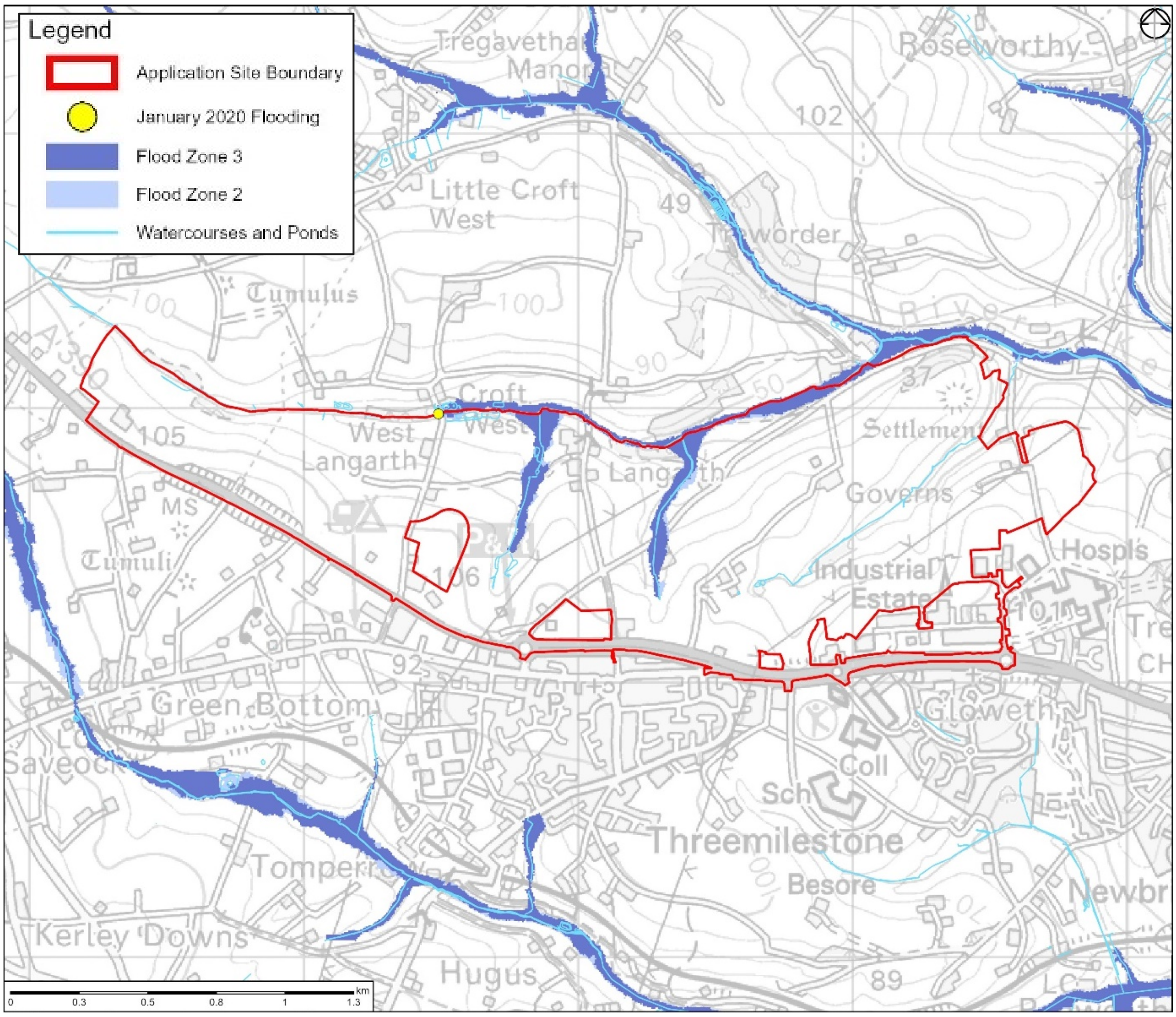


Figure 8: EA Flood Map for Planning © EA, 2019. Indicative location of January 2020 flooding shown. Contains OS data © Crown Copyright and database right 2020.

6.3 Surface water

Flooding from the land (often known as surface water flooding) occurs when extreme rainfall exceeds the infiltration or drainage capacity of the ground surface. This form of flooding can pose both flood risk to a site, from surface water run-on from off-site areas, and an increased flood risk to adjacent sites, where Proposed Development affects the existing rainfall runoff regime.

As a largely greenfield site, rainfall runoff patterns are governed by topography, soil type and the nature of the overlying surfaces. A review of the Soilscapes map (Ref. 10.10) reveals that the Site sits almost entirely on freely draining slightly acid loamy soils.

Information on surface water flooding has been gathered from the risk of flooding from surface water dataset published by the EA. An extract from the online mapping for the study area is provided in Figure 9. Large areas are defined as having 'very low' surface water flood risk (less than 1 in 1000 annual probability rainfall event), with other areas at low, (between a 1 in 1000 and 1 in 100 annual probability rainfall event) risk. The map also indicates limited areas of medium (between a 1 in 100 and 1 in 30 annual probability rainfall event) and high (greater than a 1 in 30 annual probability rainfall event) risk, mostly following the profiles of the ordinary watercourses within and along the northern Site boundary. These represent drainage routes/flow paths, which will be retained where possible as blue and green corridors without any built development, forming a key part of the proposed drainage strategy.

A review of surface water flooding records was undertaken to ascertain whether historic surface water flooding has been reported for the Site. This review entailed a search of the data sources listed in Section 1.1 and did not identify any records of historic surface water flooding. It is therefore considered that the risk of flooding from surface water is **low**.

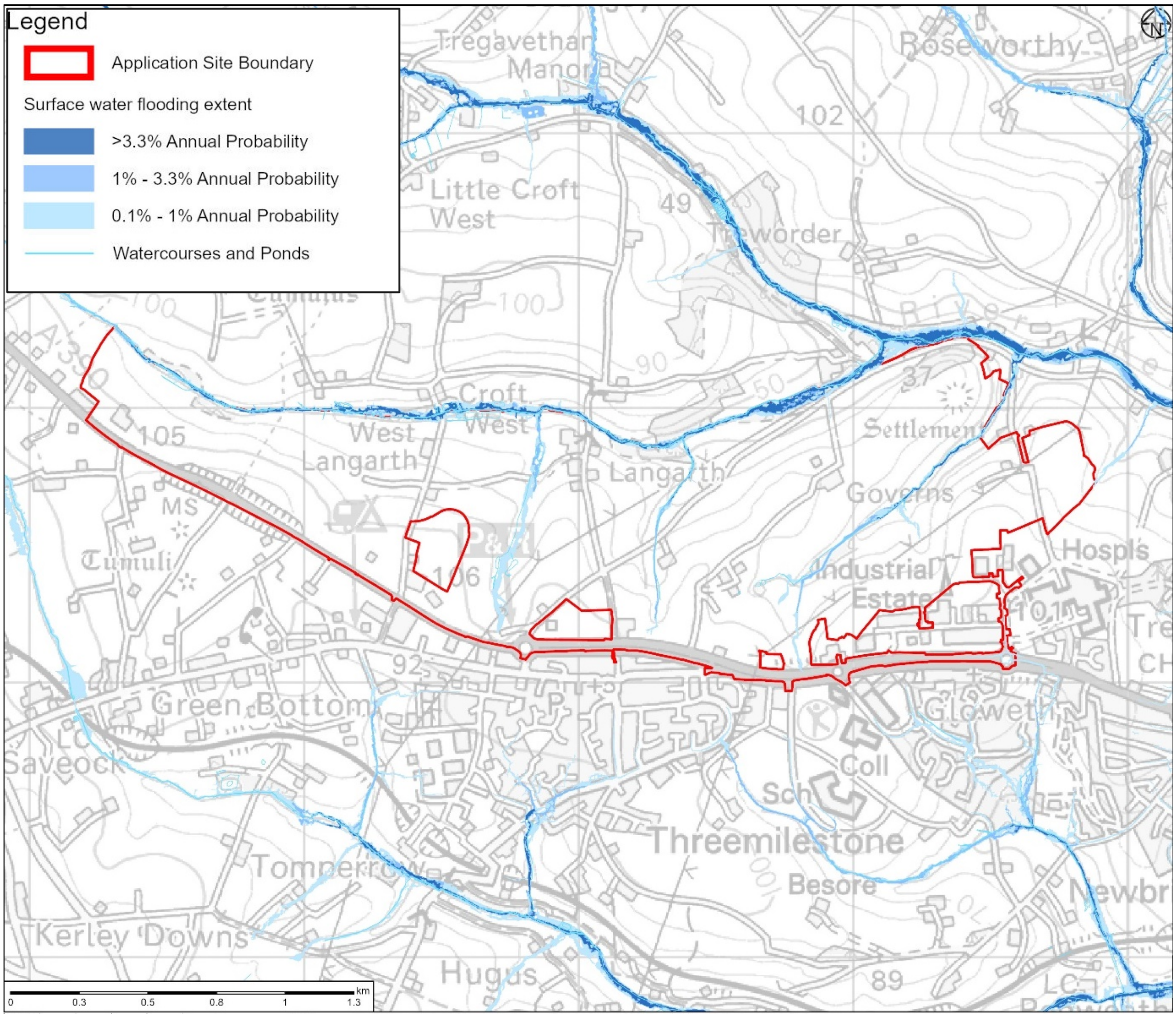


Figure 9: Risk of Flooding from Surface Water Map © EA, 2019. Contains OS data © Crown Copyright and database right 2020.

6.4 Groundwater

Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water issuing from springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying, where the water table is more likely to be at shallow depth.

The SFRA Level 1 (Ref. 10.11) reports that groundwater flooding is of low prevalence due to Cornwall having only minor aquifers. This is supported by the Arcadis desk study review of baseline aquifer potential. The exceptions to this are areas where extensive mine drainage systems exist underground, where blockages can lead to water breakouts at the surface. The Site has been subject to a desktop study review and site walkover to determine mine shaft risk; this is presented in Chapter 8: Ground Conditions and Contaminated Land.

As summarised in Section 2, near surface groundwater has generally not been encountered by previous ground investigation of the Site in higher ground and this is also supported by available BGS borehole records.

Recently completed ground investigation has identified groundwater at depths of between 1.1m and 2.6m at trail pits located along the northern drainage valley associated with Headwater A, and a groundwater strike was also observed at 0.8m depth at a single trial pit (TP434) near a spring along Headwater D. Thirteen boreholes have been installed as part of this ground investigation and the locations of these trial pits and boreholes are shown in Appendix C. The groundwater strikes observed in trial pits and boreholes are summarised in Table 7. This clearly confirms the presence of shallow groundwater levels with Headwater A and Headwater B.

Table 7 Observed Groundwater Strikes

Trial Pit /Borehole Location	Observed Groundwater Strike Depth (m BGL)	Headwater Location
TP401	2.0	Headwater A
TP404	1.6	Headwater A
TP415	1.1	Headwater A & B
TP421	2.2	Headwater A & B
TP428	2.6	Headwater A
TP434	0.8	Headwater D
BH401	12.0	Not near any watercourse
BH402	1.0	Headwater A
BH403	-	Not near any watercourse
BH404	2.0	Headwater A
BH405	-	Not near any watercourse
BH406	1.0	Headwater A
BH407	2.1	Headwater A & B
BH408	1.2	Headwater B
BH409	6.0	Headwater C
BH410	1.2	Headwater A
BH411	-	Headwater D
BH412	10.4	Not near any watercourse
BH413	4.4	Headwater A

It is therefore considered that the risk of flooding to the Proposed Development from groundwater is **low** as no new properties are proposed in close proximity to the existing drainage valleys. However, groundwater is still a key consideration when designing SuDS drainage located near to these features. The groundwater monitoring programme at the 13 borehole locations will provide further information to inform the detailed design of SuDS features. Section 8 discusses this in further detail.

6.5 Artificial sources

The Site does not lie within an area at risk of flooding from reservoirs. The EA Long Term Flood Risk Map (Ref. 10.21) shows the maximum area that might be flooded if large reservoirs were to fail and release the water they hold. The nearest extent of such predicted reservoir flooding is located 1km east of the Site towards Truro.

It is therefore considered that the risk of flooding from artificial sources is **low**.

6.6 Sewers

The local sewer network is maintained by South West Water Limited. The SFRA Level 1 (Ref. 10.11) provides a summary of South West Water's policy on flooding, including their opposing of development proposals using combined sewers and new highway drainage connections to foul or combined sewers.

The SFRA gives no specific information on the sewer type (combined or public foul) local to the Site, however utility records available to Arcadis show that a network of combined sewers serves Threemilestone and the adjacent section of the A390. These partially cross the southern boundary of the Site.

The Truro and Threemilestone Surface Water Drainage Strategy (Cornwall Council, 2008) (Ref. 10.22) was compiled in two phases, the first collated and analysed existing sewerage infrastructure. Phase 2 provided proposals for the strategic implementation of SuDS. Stage 1 was GIS-based and is not available for review. Stage 2 contains a section specific to Langarth, which gives no specific sewer infrastructure recommendations.

Due to the predominantly agricultural nature of the existing land use, the baseline risk of flooding from sewer networks is considered to be low. The sewer network to serve the Proposed Development is being sustainably designed, to comply with the Cornwall Council and South West Water's surface water management policies and to ensure there is a low risk of sewer flooding post-development.

It is therefore considered that the risk of flooding from sewers is **low**.

6.7 Conclusions

It is considered that the Proposed Development is at **low risk** of flooding from the majority of sources, with the primary risks to the Site arising from fluvial and surface water flooding. The mitigation measures proposed to ensure the development is safe for its lifetime are outlined in the following sections. Groundwater is also a key consideration for the design of new SuDS features and any infrastructure near to the existing drainage valleys.

7 Fluvial Flood Risk Modelling

7.1 Overview

This section outlines the hydraulic modelling methodology used to assess fluvial flood risk across the Site.

The current Environment Agency (EA) flood mapping for the headwaters through flow through and border the Site is based on broad scale national mapping (JFLOW), which is not suitable for informing site-specific assessments. Bespoke hydraulic modelling was therefore undertaken to refine the flood outlines and to provide data where EA mapping has none.

Further detail on the hydraulic modelling is provided in the form of a Technical Note (Appendix B) including a Flood Estimation Handbook (FEH) Calculation Record.

7.2 Design Flood Estimation

Flows were estimated using both the FEH Statistical and ReFH2 methods. Given the availability of gauged data records from a gauging station located on the River Kenwyn, the FEH Statistical method was preferred. In accordance with standard guidance, the FEH Statistical method was not applied at Flow Estimation Points (FEP) 2 and 3 because their catchment areas are less than 0.5km2; the final flood peaks for these FEPs were derived using ReFH2 and the plot-scale equations. Flood peaks from the FEH Statistical method (including the Hybrid method) were adopted for all other FEPs. The resultant peak flows for the modelled flood events are presented in Table 8.

Table 8: Peak flows for all modelled AEP events at each FEP.

Site Code	Flood peak (m^3/s) for the following AEP Events		
	1%	**1% +85% CC**	**0.1%**
FEP1	3.15	5.83	6.10
FEP2	0.58	1.07	1.04
FEP3	0.62	1.15	1.15
FEP4	1.54	2.85	2.98
FEP5	4.73	8.75	9.09
FEP6	6.20	11.47	11.89
FEP7	11.17	20.66	21.19

7.3 Hydraulic Modelling

A 1D-only approach to modelling the headwaters was adopted as the lateral spread of flows is constrained by the valley sides and the resulting floodplain storage is minimal. HEC-RAS version 5.0.7 was chosen as the hydraulic modelling software due to its ability to resolve relatively small flows in steep watercourses.

A 1D hydraulic model of Headwaters A, B, C and D was built and hydraulic structures on the watercourses (such as culverts and fords) were incorporated based using topographic survey data and site inspection observations. The watercourses are characteristic of upper catchment channels in that they are steep (3-5% slopes), heavily vegetated and relatively small (1-2m wide and 0.5–1m deep). Headwaters B, C and D were modelled in their entire length. Due to access permission issues, Headwater A was modelled from its upstream extent to NGR 178024, 45958. The remaining length is covered by JFLOW modelling. Further detail is given in Appendix B.

Model sensitivity tests were undertaken to provide confidence in the uncalibrated model results. Standard sensitivity testing of roughness (±20%), flow (±20%) and the downstream boundary was carried out. Results of the sensitivity testing indicate that the model is not overly sensitive to reasonable changes in standard modelling parameters. Therefore, the model results are considered robust and suitable for use in this study.

7.4 Risk Assessment

Baseline flood risk was modelled for the 3 AEP events in . The modelled water levels were used to generate flood outlines, for comparison with the EA's JFLOW outputs. The major constraint on flood extent for all headwaters is concluded to be the steep topography of the flow paths. Figure 10 – Figure 13 show the EA mapping overlain by Arcadis' modelled flood extents. As highlighted in Section 7.3, Headwater A was only modelled from its upstream extent to NGR 178024, 45958 due to access permission issues and the remaining length is covered by JFLOW modelling.

Headwater A

The model predicts peak flows in Headwater A to largely remain within the channel for all modelled events (Figure 10). The road bridge at River Station 2589 (immediately north of West Langarth Farm) causes the widest flood extents within the modelled reach due to the lack of capacity within the culvert that carries the watercourse beneath the road. This is consistent with where flooding was reported in January 2020. It suggests that this is the most at-risk location along the modelled length of Headwater A as well as adding a degree of validation to the results of the model. The embedded design to mitigate risk at this location is discussed in Section 4.

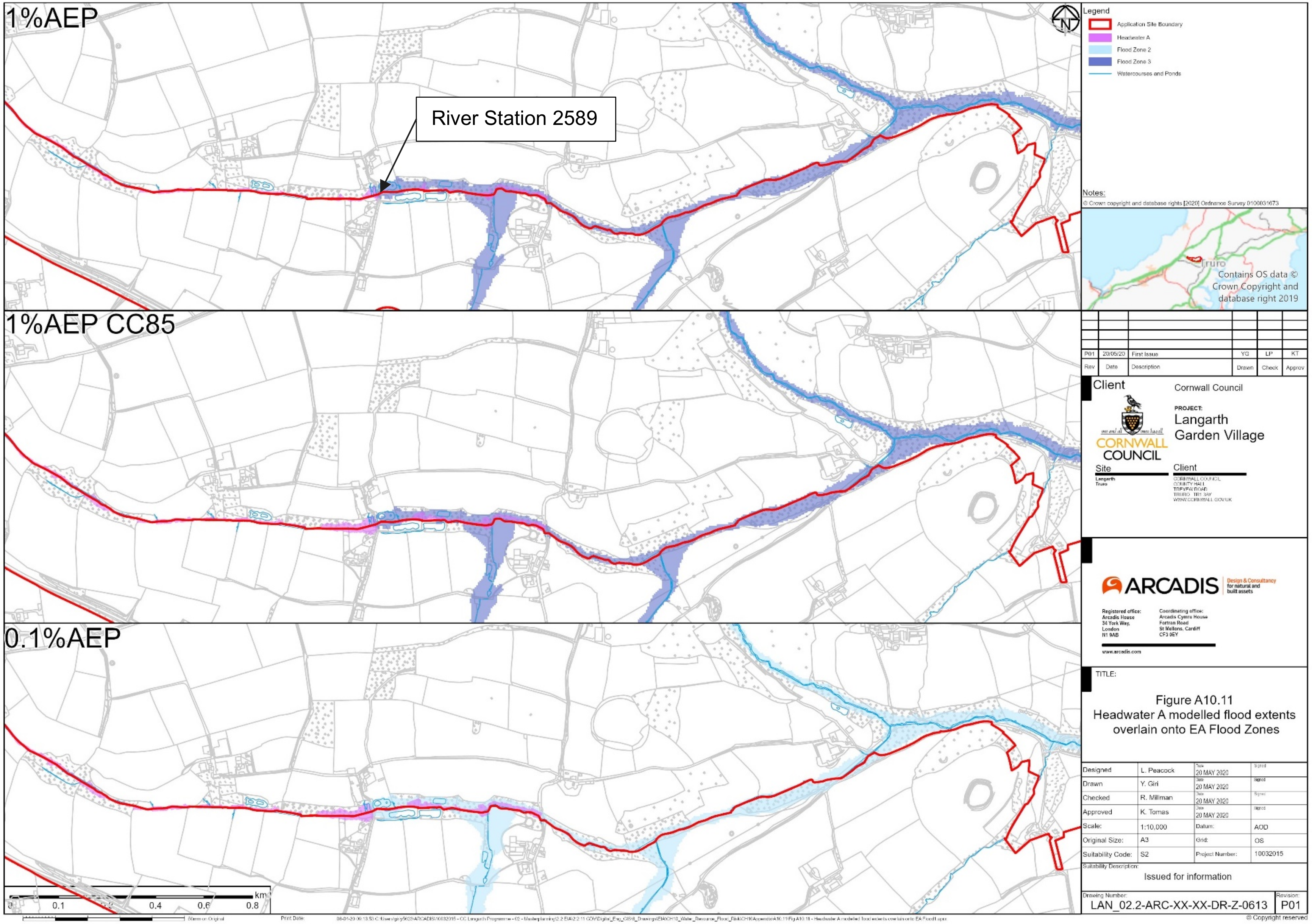


Figure 10: Headwater A modelled flood extents overlain onto EA Flood Zones. Contains OS data © Crown Copyright and database right 2020

Headwater B

The model predicts peak flows to largely remain in channel for all events modelled (Figure 11). The culvert structure under the access track (River Station 215) does not have capacity to convey the modelled flows and water is predicted to overtop the access track spilling over the left bank before re-entering the watercourse. Downstream of the access track are two ponds. One is a very small online pond and the other a larger offline pond. The capacity of the online pond outlet (River station 264) is exceeded and water weirs out of the pond and back into channel. The offline pond is not modelled but is assumed to become connected to the floodplain during larger flood events and is mapped as being part of the flood extent. The embedded design to mitigate risk at this location is discussed in Section 4.

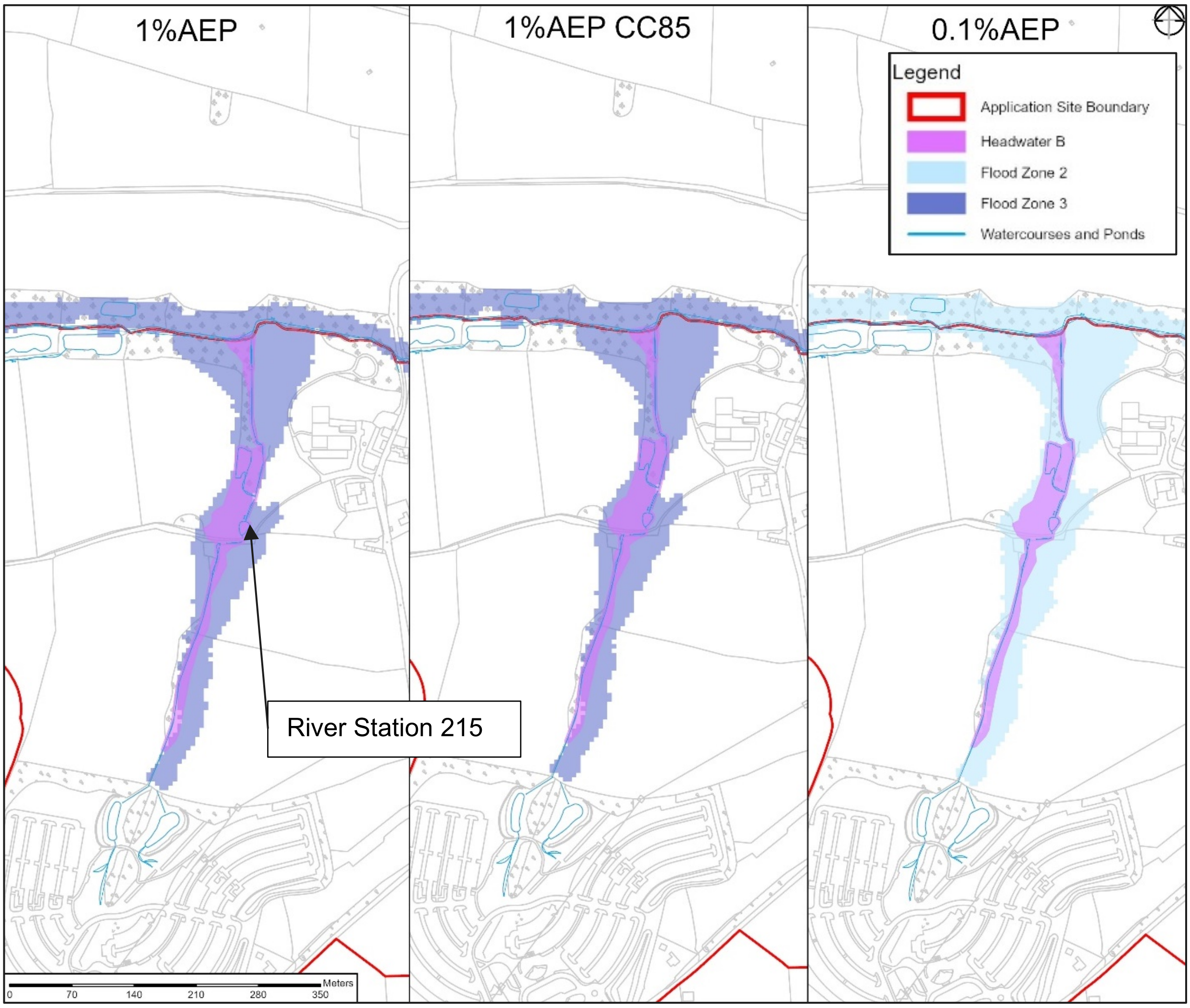


Figure 11: Headwater B modelled flood extents overlain onto EA Flood Zones. Contains OS data © Crown Copyright and database right 2020

Headwater C

The model predicts flows in Headwater C to remain largely in channel with flood widths less than 6m (Figure 12). The culvert structure under the road (River station 415) does not have capacity to convey the flow for the events modelled and water is therefore predicted to overtop the road before flowing back into the channel downstream. The embedded design to mitigate risk at this location is discussed in Section 4.

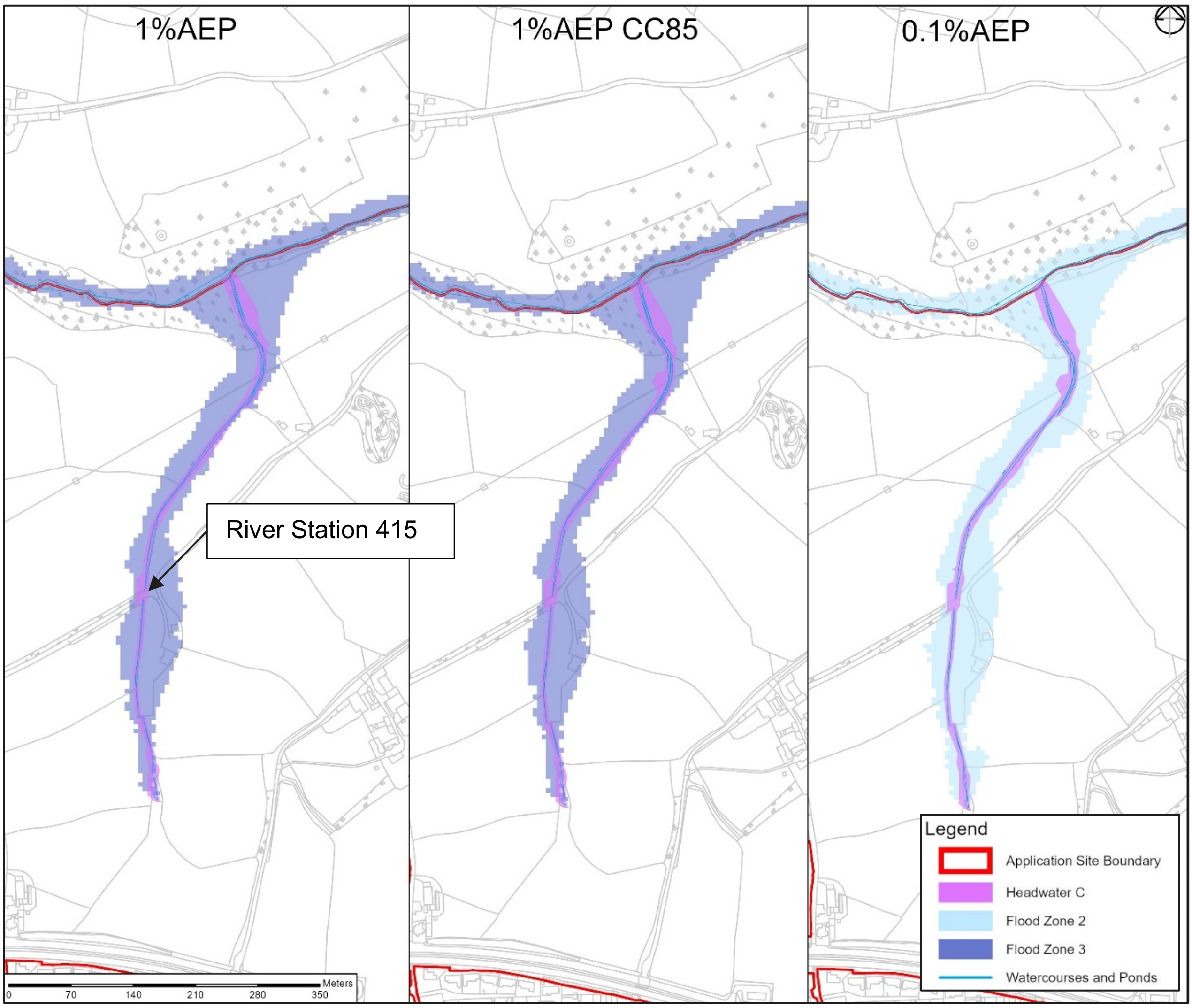


Figure 12: Headwater C modelled flood extents overlain onto EA Flood Zones. Contains OS data © Crown Copyright and database right 2020

Headwater D

For Headwater D, the model indicates that peak flood flows will be constrained by the topography with lateral flood extents typically less than 20m wide (Figure 13). There is some uncertainty on the location of the meandering channel between surveyed sections and the approach taken to mapping flood extents is considered to be conservative. The model predicts the capacity of the two culverts at the downstream model extent to be exceeded for all modelled events. This results in water flowing over the roads and then back into the channel downstream. These culverts are beyond the Proposed Development Site and no surcharge to the Proposed Development is predicted.

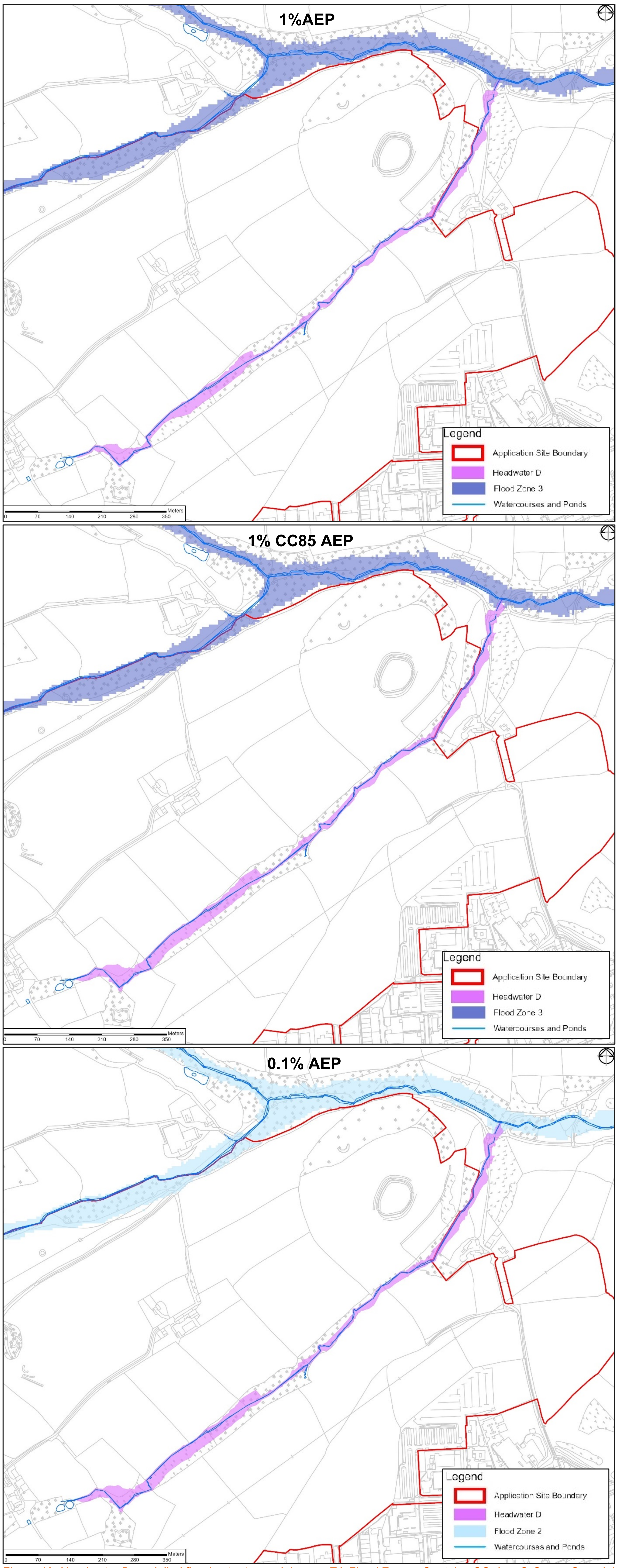


Figure 13: Headwater D modelled flood extents overlain onto EA Flood Zones. Contains OS data © Crown Copyright and database right 2020

7.5 Residual Risk Management

The Proposed Development benefits from a range of embedded design that negates the need for extensive residual flood risk management measures. Section 4 determines that as such, the Proposed Development satisfies the NPPF Sequential and Exception Tests. Embedded design contributes to keeping the Proposed Development 'safe' over its lifetime and prevents increased flood risk elsewhere. A brief summary of the embedded design discussed in Section 4 is provided below:

- Through a detailed masterplanning process, land use has been located sequentially with only water-compatible land uses situated in medium/high risk areas. This is demonstrated in Figure 6.
- The SuDS strategy (detailed in Section 8) mitigates surface water runoff to the rates required by the LLFA. Drainage routes/flow paths will be retained as blue and green corridors without any built development. This not only mitigates surface water flooding on-site, but also mitigates the risk posed to existing settlements and negates risk in the context of cumulative planning applications.
- Where swales from the Proposed Development SuDS are proposed to convey flows under the NAR, the number of crossings limits feeding catchment size and should reduce the severity of a failure at any singular location.
- Arcadis' bespoke modelling has generated hydraulic data to inform culvert design at the NAR crossing of Headwater B. The proposed culvert (2.5m W x 1.8m H) is oversized to allow for maintenance access. This culvert would be designed in accordance with best practice to avoid localised hydraulic effects that could result in flooding of the NAR at this location impeding access/egress to the Proposed Development.

Residual flood risk may remain in the form of:

- A severe flood event that exceeds the flood risk design standard
- Blockage of a modified watercourse causing an overtopping event, i.e. at a bridge or culvert.

Additional residual risk management in the form of sensitive watercourse crossing design is recommended for the NAR culvert and other proposed crossings (see Section 4 and Figure 7). This should consider:

- The bespoke modelling, which may be further refined at the reserved matters stage to inform watercourse crossing detailed designs, including submission of the models to the EA for approval.
- Preparation of ordinary watercourse consent applications under the Land Drainage Act 1991 for submission to CC, as the LLFA, for any works impacting on the flow conveyance of minor watercourses on the Site. These applications should demonstrate that the design of watercourses crossings would cause no increase in flood risk either upstream or downstream, access to the river network for future maintenance would not be prejudiced; and works would be carried out in such a way as to avoid constrictions to flow and other such impacts on hydromorphology.
- A risk assessment of culvert/pipe headwalls should be undertaken at detailed design to define appropriate measures to prevent unauthorised access to culverts or pipes crossing the NAR.

During the lifetime of the Proposed Development the culverts should be subject to a suitable maintenance regime. This will need to be agreed between the RMAs responsible for adopting the drainage networks. Adoption duties are set out in the FWMA 2010 (Section 32 & Schedule 3). It is currently envisaged that a 3rd party will adopt the SuDS (Section 8.5.5). The Highways Authority has the duty to adopt the drainage from the NAR as a publicly maintained road. The drainage network serving the NAR and the Proposed Development has been suitably split to allow separation of responsibility, with an aspiration that this will enhance maintenance.

8 Surface Water Drainage Strategy

8.1 Existing Site Drainage

Most of the Site footprint is arable and horticultural land which provides a large area for natural infiltration into the soil. As explained in Section 2.1, the Site has six natural fluvial sub-catchments that ultimately drain to the River Kenwyn.

As shown in Figure 14, the Site falls within two Critical Drainage Areas (CDA); primarily the "Truro - Kenwyn, Allen & Tregolls Road" CDA. A small portion of the Site in the south-eastern corner, comprising the A390 and Penventinnie Lane, falls within the "Truro - River Tinney" CDA where no site works or drainage alterations are involved. The proposed drainage strategy will only discharge to the Kenwyn catchment and, therefore, only the requirements of this CDA are considered.

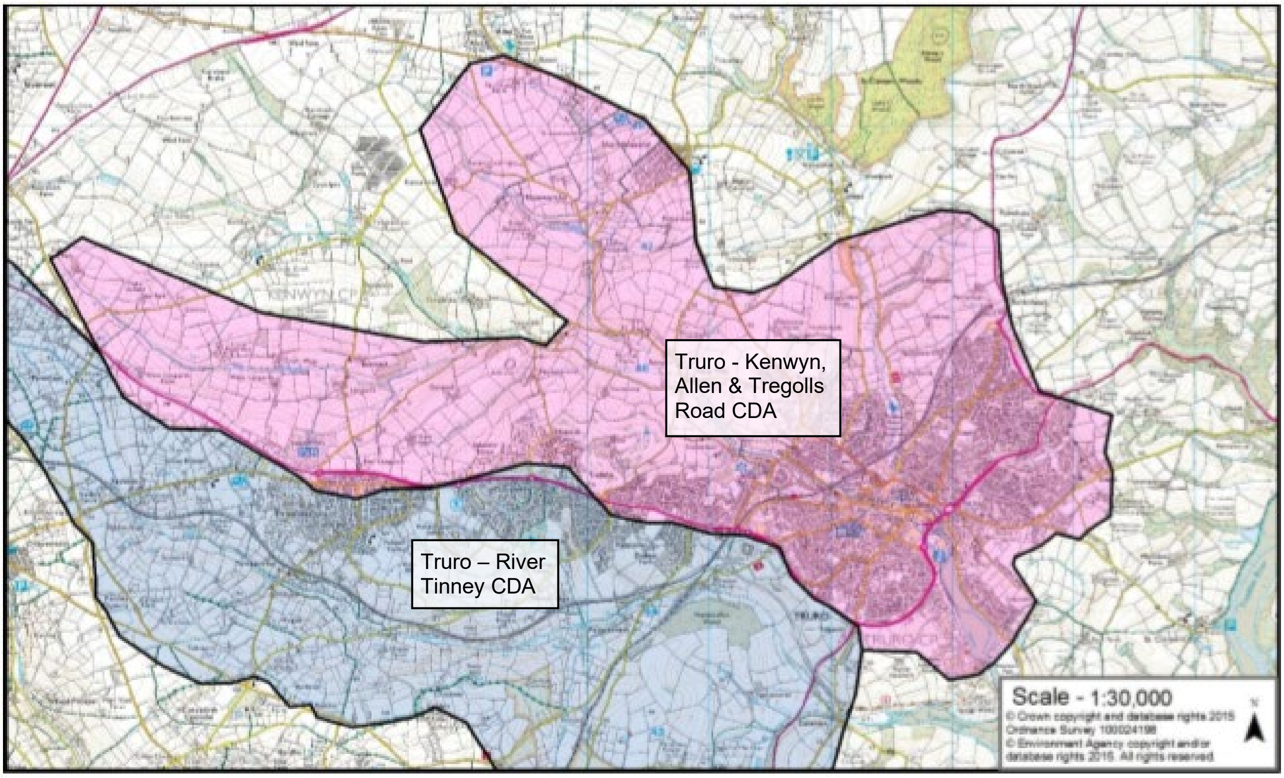


Figure 14: Truro - Kenwyn, Allen, Tregolls Rd Critical Drainage Area Contains OS data © Crown Copyright and database right 2020

In line with the Flood Risk Assessment and Surface Water Management Strategy (Ref 10.26), it has been considered that the proposed Truro NAR Road Drainage System will fully accommodate the runoff from the NAR (i.e. for the 1 in 100 annual probability event with 40% climate change allowance) and there is no need to provide additional attenuation storage within the proposed strategic SuDS strategy. As such the impermeable areas and drainage requirements for the NAR have been excluded from the below.

8.2 Stakeholder Comments

The EA, the Lead Local Flood Authority (LLFA) and other key stakeholders have been consulted in order to identify design requirements for the application site in regard to flood risk and surface water management. A summary of the responses received regarding surface water management is provided below in Table 9.

Table 9: Summary of consultation responses

Consultee	Date of Response	Consultee Comments	Project Response
CC	11/10/19	Pollution prevention, changes to water chemistry, flood risk, surface water drainage, and Sustainable Drainage Systems (SUDS) should be considered and assessed, in addition to potential changes to the geomorphology of watercourses. A surface water drainage strategy should be included that explains how surface water will be managed in order to reduce flood risk and pollution.	These aspects are all included in the scope of the Surface Water Drainage Strategy, which presents a strategy for the management of surface water runoff from the Proposed Development.
LLFA	11/10/2019	Detailed response received. Highlighted that the Site is located in two Critical Drainage Areas (CDA) and set out drainage standards/requirements to manage both runoff rates/volumes and protect water quality, in each CDA. Flood Risk Assessments and Drainage Strategies must be provided for each phase of development and fit within an overarching strategy for the Site as a whole. Infiltration should be used were ground conditions permit and percolation tests must be undertaken to test if infiltration is viable.	This SWDS has been prepared to address these comments.
LLFA	02/12/2019	Surface water drainage from the Truro Northern Access Relief Road and other adopted roads should ideally be kept separate from the site-wide SuDS drainage system. Further infiltration testing and groundwater level monitoring will be required to inform the proposed SuDS strategy. A series of SuDS measures (i.e. source control, site control and regional control) will be required across the site. Opportunities to incorporate the small onsite watercourses as part of the SuDS strategy should be maximised, subject to the level of actual flood risk. Hydraulic modelling and flood mapping outputs should be first agreed with the EA and LLFA. 300mm freeboard should be considered for all attenuation SuDS features whereas freeboard can vary from 100mm to 0mm for the conveyance SuDS measures, subject to the detailed design/ catchment needs.	A SWDS has been prepared in line with the advice provided. Hydraulic modelling and flood mapping outputs have been reviewed and accepted by the EA.
EA	04/05/2020	Arcadis' bespoke modelling & technical note is appropriate for the purpose of the master-planning of this area. If development is required within areas at risk or around the watercourses (bridge structures, strategic SUDS) the modelling may need to be updated to reflect site specific modelling requirements.	We envisage that where this is required it could follow at the reserved matters stage and that the current flood modelling is suitable for supporting the outline planning application.

Consultee	Date of Response	Consultee Comments	Project Response
EA	31/08/2020	Concerns have been recently raised on the potential effect of the Proposed Development on the performance and safety of the New Mills Dam and River Kenwyn Flood Storage Area. These concerns have been raised following a recent assessment by the EA of Truro's strategic flood protection assets which include New Mills Dam.	A study has been commissioned to assess the potential effects of the Proposed Development on the performance of the River Kenwyn Flood Storage Area and the safety of the associated New Mills Dam. The results of this study will be submitted as an addendum to this FRA.

8.3 Greenfield Runoff and Volume calculations

Greenfield runoff rates were estimated for each principal natural drainage sub-catchment using the IH124 method, as per the LLFA advice received. The Revitalised Flood Hydrograph (ReFH2) method was used, using the Flood Estimation Handbook (FEH) Catchment Descriptors, to estimate the greenfield runoff volumes for the six-hour storm. Figure 15 below shows the locations of these sub-catchments.

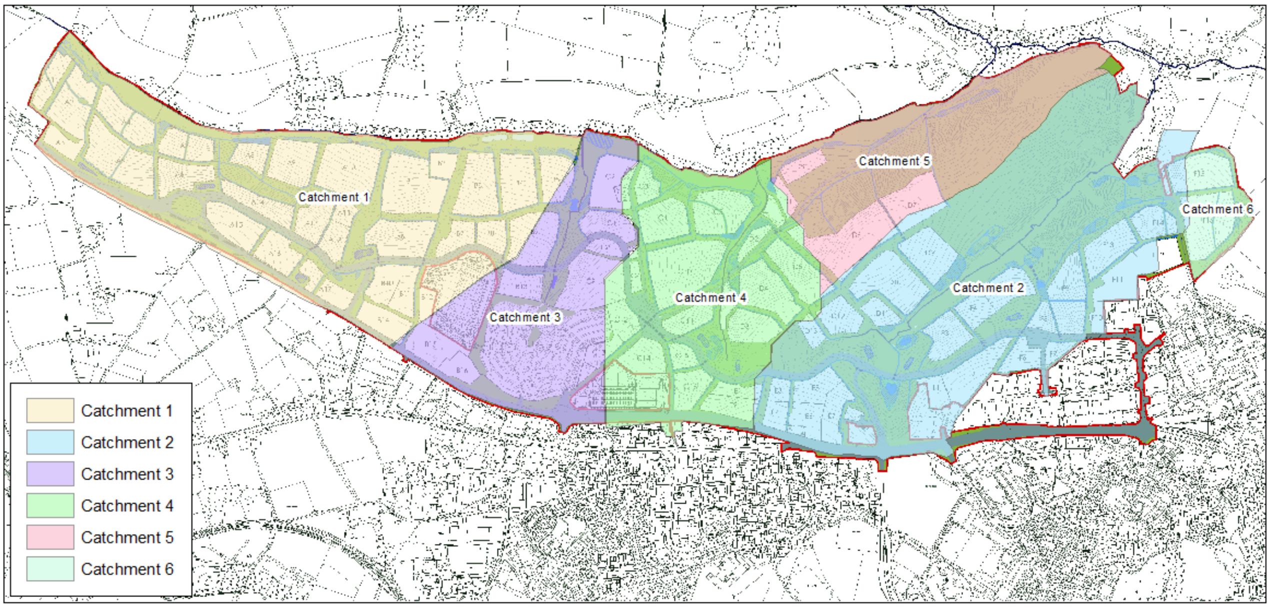


Figure 15: Plan showing the location of drainage zones. Contains OS data © Crown Copyright and database right 2020

A summary of the estimated peak greenfield runoff rates and the volumes for each sub-catchment are summarised below in Table 10 and Table 11, respectively.

Table 10: IH124 greenfield peak runoff rates (l/s/ha)

Annual Probability	Catchment 1	Catchment 2	Catchment 3	Catchment 4	Catchment 5	Catchment 6
1 in 1	2.4	2.3	2.6	2.5	2.5	3.0
1 in 2	2.7	2.6	2.9	2.8	2.9	3.4
1 in 5	3.8	3.6	4.0	3.9	4.0	4.8
1 in 10	4.6	4.4	4.9	4.7	4.8	5.8
1 in 30	6.1	5.8	6.5	6.3	6.4	7.7
1 in 50	6.5	6.2	7.0	6.7	6.9	8.2
1 in 100	7.4	7.1	8.0	7.7	7.9	9.4

Table 11: Greenfield runoff volumes (m3)

Annual Probability	Catchment 1	Catchment 2	Catchment 3	Catchment 4	Catchment 5	Catchment 6
1 in 1	2,788	2,732	1,131	1,458	1,022	221
1 in 2	3,144	3,087	1,281	1,651	1,155	250
1 in 5	4,394	4,334	1,793	2,316	1,623	351
1 in 10	5,393	5,338	2,210	2,852	1,996	431
1 in 30	7,398	7,340	3,040	3,928	2,754	594
1 in 50	8,647	8,578	3,554	4,592	3,222	694
1 in 100	10,743	10,692	4,432	5,731	4,025	866

8.4 Infiltration Potential

Groundsure reports and previous ground investigations (Section 2.2.2) indicate the following geology descriptions within the existing site (Table 12). It also shows that the bedrock geology is classified as a Secondary A Aquifer.

Table 12: Geology descriptions

Geology	Lex Code	Description	Rock Type
Superficial Ground and Drift Geology	ALV-XCZSV	Alluvium	Clay, Silt, Sand and Gravel
Bedrock and Solid Geology	POAN-MDSD	Porthtowan Formation	Mudstone and Sandstone

Cranfield University's Soilscapes maps (Ref. 10.10, see Section 2.2) also show that the Site sits almost entirely on freely draining slightly acid and loamy soils, which support the use of infiltration-based SuDS measures. Marginal areas at the southern Site boundary are covered by slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage.

Infiltration rate data has been sourced from available site investigations for previous planning applications as well as that commissioned for the masterplan. These are listed as follows:

- The Stuart Michael Associates report (Ref. 10.7) integrates findings from the Trial Pit Logs undertaken by CARD Geotechnics (Ref. 10.8). Soakaway testing was undertaken within the Porthowan Formation at its weathered shallower depths; the results indicating a likely permeability range of 1 x 10^{-5} m/s to 7.5 x 10^{-4} m/s.
- The Truro Northern Access Route (TNAR): Ground Investigation Report (Ref. 10.9) contains details from the eight soakaway tests and thirty-five trial pits undertaken during investigation. Soakaway tests recorded highly permeable ground, with infiltration rates ranging between 8.3 x 10^{-5} m/s to 3.51 x 10^{-4} m/s.
- Soakaway tests commissioned to inform the masterplan and undertaken by Cormac covered 27 trial pits and found that infiltration rates varied from 1.01 x 10^{-5} to 3.62 x 10^{-03}.

The Proposed Development plots have been grouped into 18 drainage zones based on the phasing and topographical constraints as shown in Figure 16. These drainage zones are located in one of the five proposed overall drainage catchments (i.e. A, B, C, D and E), which SuDS features will be located within to drain and attenuate surface water from the planned development.

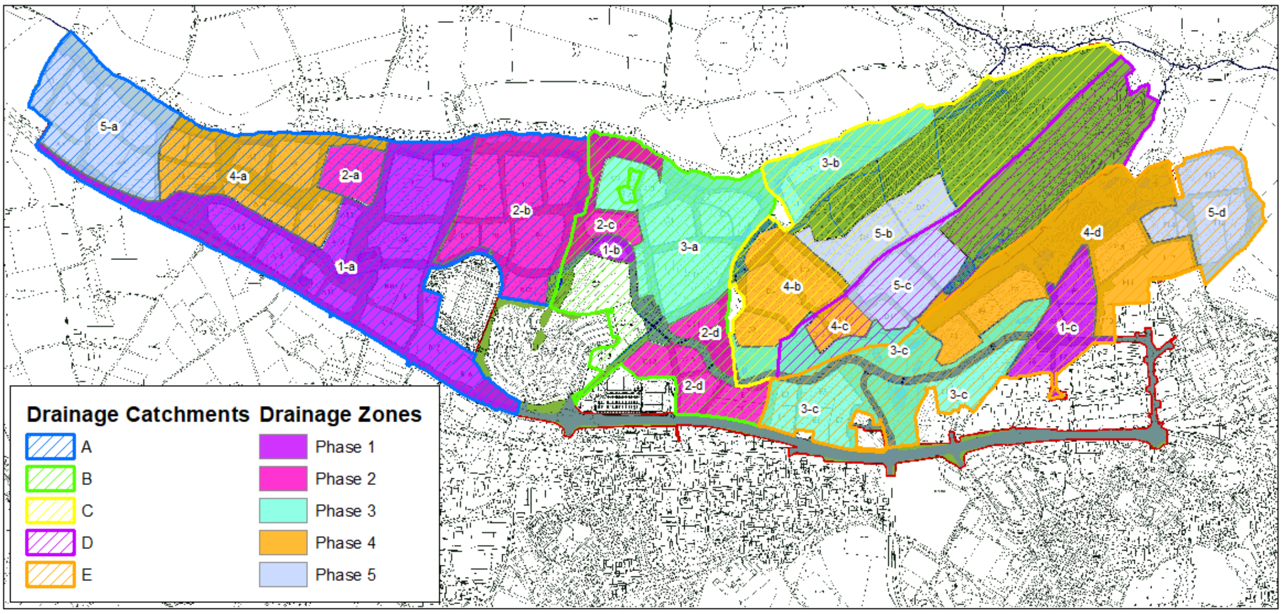


Figure 16: Plan showing the location of drainage zones. Contains OS data © Crown Copyright and database right 2020

The average infiltration rates for each drainage zone are summarised in Table 13 below and have been used in estimating the size of SuDS features.

Table 13: Summary of infiltration rates

Drainage Zone	Average Infiltration Rate (m/s)	Average Infiltration Rate (m/hr)	Drainage Zone	Average Infiltration Rate (m/s)	Average Infiltration Rate (m/hr)
1-a	2.87×10^{-04}	1.03	4-a	1.04×10^{-03}	3.73
1-b	3.34×10^{-04}	1.20	4-b	8.06×10^{-05}	0.29
1-c	6.70×10^{-05}	0.24	4-c	4.66×10^{-05}	0.17
2-a	5.38×10^{-05}	0.19	4-d	1.62×10^{-04}	0.58
2-b	1.28×10^{-04}	0.46	5-a	9.72×10^{-05}	0.35
2-c	3.34×10^{-04}	1.20	5-b	3.25×10^{-05}	0.12
2-d	8.96×10^{-05}	0.32	5-c	3.11×10^{-05}	0.11
3-a	3.34×10^{-04}	1.20	5-d	1.87×10^{-04}	0.67
3-b	5.02×10^{-04}	1.81			
3-c	5.13×10^{-05}	0.18			

This confirms that there are good infiltration rates across the Site and that infiltration-based SuDS features would be suitable. However, further percolation tests (in accordance with the procedures set out in BRE Digest 365 or CIRIA 156) must be completed prior to the detailed design to provide adequate coverage of the Site to allow an assessment to be made. These tests should be undertaken in the locations and at the effective depth of potential soakaways or infiltration-based SuDS features.

In order to minimise the risk of pollution entering groundwater and to ensure that infiltration features operate as intended the invert level of all infiltration features will need to be located more than 1m above the peak groundwater level. Borehole monitoring is currently underway for a period of 12 months across the Site to establish the peak groundwater level which will be used to inform the design of infiltration features at the reserved matters stage.

At the time of writing the results of this monitoring are not available, due to wet conditions on site preventing access for heavy machinery and restrictions in place in relation to COVID-19 in the first half of 2020. However, some trial pits did record groundwater ingress at shallow depths (less than 2 metres below ground level). These were most notable in the lower-lying areas of the site, confirming infiltration-based SuDS should be avoided in these areas.

In addition, a mining risk assessment report prepared by Cormac (reference 64672 CN2000026) identifies a number of historic mining features located to the south of drainage zones 4-c and 5-c. The report recommends that infiltration features should not be located in these areas to avoid mobilising potential contamination within the historic workings.

8.5 Preliminary Sustainable Drainage (SuDS) Strategy

In line with the LLFA and the NPPF requirements the Proposed Development would utilise SuDS as summarised in the following sections in order to manage surface water across the site. SuDS aim to replicate natural drainage mechanisms where possible and have multiple benefits including, but not limited to, water quality, flood risk, amenity and biodiversity.

Early consideration of surface water management provides the opportunity to use SuDS that respond to the local context and character, enriching both the natural and built environment. By fully integrating the management of surface water with the wider development objectives and by considering all space as potentially multifunctional, surface water management systems can be used to enhance development viability through the delivery of the design criteria. This can result in a number of benefits as defined in the SuDS Manual (Ref. 10.24):

- An alternative supply of water resources, to improve water security;
- Higher value amenity, recreation and education facilities within public open space;

- Improved habitats and biodiversity;
- Improved climate resilience;
- Reduced pressure on sewerage infrastructure and reduced surface water flooding;
- A mechanism for enhancing and defining the quality, character and visual aesthetics of both the built environment and green/ open space;
- A surface water management system that can be easily and cost-effectively maintained; and
- Flood risk reduction or betterment.

8.5.1 Design Criteria and Methodology

The proposed preliminary design criteria have been set out below. The detailed surface water strategy and design proposals should be further developed (as part of the current masterplan development and future detailed planning application process), in accordance with the following design criteria:

- CIRIA SuDS Manual (Ref. 10.24) best practice along with local guidance requirements;
- Defra Non-statutory technical standards for SuDS (Ref. 10.25);
- The surface water management principles (see Appendix D);
- The opportunities, constraints and challenges identified by the site and development characterisation; and
- Key stakeholder requirements, including the EA and the LLFA.

In line with SuDS principles the destination for surface water runoff that is not collected for use should be prioritised in the following order:

- Infiltration
- Discharge to surface waters
- Discharge to surface water sewer, highway drain or another drainage system
- Discharge to a combined sewer.

As highlighted above, the available infiltration data shows the potential for the use of infiltration-based SuDS features on higher ground but there are limitations on their use in lower lying areas of the site due to shallow ground water. Therefore, infiltration should be maximised across the Proposed Development where feasible. However, it is unlikely that infiltration SuDS alone is sufficient to fully manage the runoff within the site as the steep topography of the site means that large infiltration basins will be difficult to accommodate on the higher ground. Therefore, allowable discharge rates from each drainage catchment, the strategic SuDS attenuation storage requirements and key discharge points are defined and set out below to provide a fully inter-linked and integrated SuDS system within the landscape proposals.

Surface water runoff will be managed on the site in order to meet the following standards:

- Surface water drainage systems sized to cater for the 1 in 100 annual probability critical duration event plus a minimum allowance of 40% for climate change.
- Flow rates leaving the developed site must not exceed the 1 in 10 annual probability greenfield runoff rate in accordance with the requirements of the CDA.
- Overland flood flow routes will be considered at the detailed design phase.

At this outline planning stage, it is not possible to be definitive about certain aspects of the design, such as areas of impermeable surface, or the exact capacity of SuDS features. Therefore, a number of assumptions have been made in order to develop a strategy suitable for supporting the proposed masterplan, these are detailed in the following sections.

8.5.2 Drainage Catchments

The proposed masterplan would be developed over a number of phases and the site naturally falls within distinct catchments. Therefore, the SuDS Strategy proposals have been divided into five overall drainage catchments that reflect the topographical constraints of the site, the development plots are then grouped into 18 drainage zones within the drainage catchments to account for the phased nature of the development. Sufficient storage will be provided within each drainage catchment for each phase of development. In some cases, strategic SuDS features could be constructed ahead of the required development phasing to reduce the need to re-construct or extend features after they have been established.

It should be noted that the proposed NAR has been excluded from this drainage strategy as Cormac have designed a separate SuDS system for this (Ref 10.26). Furthermore, plots C9 and C12 (extension to the Park & Ride) have been excluded as it is understood that a drainage strategy has been prepared separately for this. Plot C13 is proposed to be an energy centre for the Langarth Garden Village and a separate drainage strategy has been prepared in support of the detailed planning application for that plot.

An assumption about the percentage impermeable area of each development plot has been made based on proposed land use and development density. For residential plots, the impermeable area is assumed based on the proposed density as set out in Table 14, an additional 10% is added on to allow for urban creep over the lifetime of the development. For other proposed land uses (e.g. primary schools, employment, extra care, etc.) the impermeable area is assumed to be between 80-90% of the plot area.

The available infiltration testing for the Site demonstrates that soakaways and other infiltration-based SuDS techniques would be a feasible solution. Therefore, it is proposed that each dwelling would be served by a private soakaway and driveways would be formed from permeable paving, which can also connect to the same private soakaway As such, dwelling roofs and driveways can be removed from the estimated impermeable area for the purpose of estimating required strategic SuDS storage estimates.

The average roof area of a dwelling is assumed to be 40m^2 and a driveway of 25m^2, which means that the total impermeable area served by each private soakaway is 65m^2. Therefore, the impermeable area for each development plot will be estimated as the product of the plot area and assumed impermeability minus the estimated area draining to private soakaways, as further illustrated in Table 14 below.

Table 14: Dwelling density and impermeable area

Density (Dwellings per hectare)	Assumed Impermeable Area	Urban Creep	Driveways / Roofs (to local soakaways)	Net Impermeable Area
20	40%	+10%	-13%	37%
30	50%	+10%	-20%	40%
35	55%	+10%	-23%	42%
40	60%	+10%	-26%	44%
45	65%	+10%	-29%	46%
>50	70%	+10%	-33%	47%

The LLFA has stated that the IH124 method is preferred for establishing the greenfield runoff rates and these have been calculated for the natural catchments and presented in Section 8.3. The maximum allowable discharge rates have been calculated based on the product of estimated impermeable area and 1 in 10 annual probability specific runoff; these are summarised in Table 15.

Table 15: Summary of impermeable area draining to strategic storage and maximum allowable peak discharge rates

Drainage Zone	Impermeable Area (ha)	Maximum Allowable Discharge Rate (l/s)	Drainage Zone	Impermeable Area (ha)	Maximum Allowable Discharge Rate (l/s)
1-a	9.51	43.9	3-c	3.26	14.2
1-b	0.38	1.9	4-a	3.25	14.8
1-c	1.73	7.5	4-b	2.44	11.5
2-a	1.15	5.3	4-c	0.89	3.9
2-b	4.34	20.3	4-d	4.55	17.6
2-c	0.50	2.5	5-a	3.22	14.7
2-d	2.39	11.3	5-b	3.15	15.3
3-a	4.18	19.8	5-c	1.75	7.6
3-b	0.22	1.1	5-d	2.14	11.7

Note: The calculations have been performed for each plot and aggregated for each drainage zone.

8.5.3 Estimation of Attenuation Volume

The industry standard modelling package, Micro Drainage, has been used to make a preliminary estimate of the storage required within the development to attenuate the post-development runoff to the maximum allowable discharge rates set out in Table 15 for each drainage zone.

Catchment data for the area was extracted from FEH Web Service and the Micro Drainage Quick Storage Estimate (QSE) tool was used to determine the storage requirements for each drainage zone with a 40% uplift in storm intensity to address the climate change allowance.

The following key parameters were used:

- Rainfall: FEH Depth-Duration Frequency model 1 in 30 and 1 in 100 annual probability summer and winter storms;
- Impermeable Area: as summarised in Table 15;
- Volumetric Runoff Coefficient: set to 0.95;
- Greenfield Discharge Rate (l/s): as summarised in Table 11;
- Infiltration Rate (m/hr): 50% of the infiltration rates summarised in Table 13 to account for areas where infiltration may not be feasible due to shallow groundwater,
- Factor of Safety: set to 5.0; and
- Climate Change Allowance: +40%.

Table 16 provides a summary of the estimated storage requirements for each drainage zone for the 1 in 30 and 1 in 100 annual probability storms. The average storage requirement has been calculated and is used in determining the size of SuDS features.

Table 16: Estimated storage requirements for 1 in 30 and 1 in 100 annual probability storm with 40% climate change allowance.

Drainage Catchment	1 in 30 storm + 40% CC Attenuation Volume (m^3)			1 in 100 storm + 40% CC Attenuation Volume (m^3)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
1-a	1,525	5,430	3,478	2,055	7,436	4,746
1-b	57	208	133	76	285	181
1-c	487	1,372	930	659	1,872	1,266
2-a	342	945	644	463	1,284	874
2-b	979	3,032	2,006	1,321	4,134	2,728
2-c	75	274	175	101	375	238
2-d	608	1,780	1,194	824	2,435	1,630
3-a	625	2,292	1,459	842	3,138	1,990
3-b	27	108	68	36	147	92
3-c	998	2,709	1,854	1,351	3,680	2,516
4-a	257	1,307	782	344	1,753	1,049
4-b	636	1,846	1,241	859	2,523	1,691
4-c	281	753	517	381	1,022	702
4-d	943	3,020	1,982	1,271	4,132	2,702
5-a	791	2,374	1,583	1,071	3,234	2,153
5-b	1,057	2,739	1,898	1,443	3,742	2,593
5-c	591	1,542	1,067	806	2,096	1,451
5-d	412	1,338	875	556	1,841	1,199

8.5.4 Proposed SuDS Features and Locations

The required storage capacity estimated above can be provided by various interlinked SuDS components within the development parcels and in the drainage catchments across the site as described below, whilst maximising ground infiltration as far as practicable and allowing for exceedance flows.

There is significant potential to incorporate SuDS storage (incl. natural flood management measures) within the existing small local watercourses and their floodplain (i.e. Headwaters B, C and D) if they can be enhanced as part of the Proposed Development. This is particularly relevant as the local drainage catchments associated with these existing small watercourses are mainly limited to the application site. Therefore, these watercourses primarily receive surface water discharge from the Proposed Development and they could be enhanced and incorporated within a holistic and an integrated surface water drainage strategy to maximise the potential flood risk reduction and wider environmental benefits.

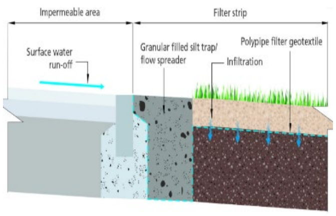
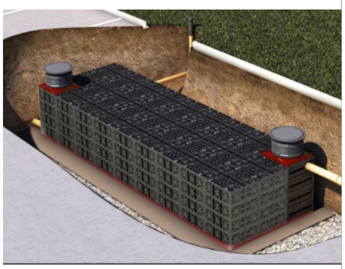
The location of SuDS features will need to take into consideration tree root protection zones and buffer zones to hedgerows to prevent root damage from construction and localised increases in ground water levels. As most of the streams follow hedgerows the proposed SuDS features have been located away from the watercourses. As the masterplan is developed, opportunities to integrate the SuDS features with the existing watercourses should be sought.

As well as components located in the main development character areas, larger scale strategic components are likely to be required outside of these areas, within the strategic green space, to provide the necessary infiltration and long-term attenuation storage for larger storm events. These would be in place prior to the commencement of development construction for each phase as appropriate, along with the necessary treatment stages to address water quality and silt management needs.

Consideration of potential SuDS features and their application are presented in Table 17, which needs further consideration as the design principles and design codes are being developed for the individual development parcels, subject to their site constraints and opportunities.

Table 17: SuDS components and application

SuDS Component		Description and Function	Benefits Provided*	Application			
				Residential Parcels	Employment Parcels	Primary Access Roads	Green Infrastructure
Green Roofs		A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	Attenuation, Water Treatment, Biodiversity, Education, Amenity, Microclimate, (Open Space, Water Reuse, Character)		✓		
Soakaways / Infiltration Trenches		Where infiltration is suitable, soakaways allow water to infiltrate into the ground and can be used to drain roofs, roads and other paved areas. At a plot level, soakaways can be set into household gardens.	Attenuation, Water Treatment, Infiltration, (Biodiversity, Amenity)	✓	✓	✓	✓
Permeable Paving		Permeable paving allows surface water to soak through to storage media below. From there it can either infiltrate into the ground where ground conditions are favourable or be discharged down the SuDS train. Permeable paving can be located along non-adoptable roads and in parking areas.	Attenuation, Water Treatment, (Infiltration, Water Re-Use)	✓	✓		

SuDS Component		Description and Function	Benefits Provided*	Application			
				Residential Parcels	Employment Parcels	Primary Access Roads	Green Infrastructure
Filter Strips		Filter strips are grassed or planted areas that runoff can run across to promote infiltration and cleansing. Filter strips can be located alongside roads and typically require less space that swales.	Water Treatment, Infiltration, (Attenuation, Open Space)		✓	✓	
Swales		Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration. Swales can exist alongside roads and within blue/green corridors.	Attenuation, Water Treatment, Biodiversity, Education, Amenity, Microclimate (Open Space, Infiltration, Character),	✓	✓	✓	✓
Bioretention Areas		A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to pipework and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens and can be in any urban environment.	Attenuation, Water Treatment, Biodiversity, Education, Amenity, Microclimate, (Infiltration),	✓	✓	✓	✓
Underground Storage		Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	Attenuation, (Infiltration)		✓		✓

SuDS Component		Description and Function	Benefits Provided*	Application			
				Residential Parcels	Employment Parcels	Primary Access Roads	Green Infrastructure
Infiltration and Detention Basins		Infiltration and detention basins are usually dry but during heavy storms they can be wet. Basins can provide infiltration and storage and can be located in areas of open space. Due to them also being 'wet' they can be designed to provide multi-functionality.	Attenuation, Water Treatment, Biodiversity, Education, Amenity, Open Space, Character, Microclimate, (Infiltration),				✓
Wetlands/ Ponds		Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	Attenuation, Water Treatment, Biodiversity, Education, Amenity, Open Space, Character, Microclimate, (Infiltration),		✓		✓

The strategic SuDS features that will form part of the Green Infrastructure for the masterplan consist of a network of swales and basins to convey, infiltrate and store surface water before discharging to local watercourses at the agreed 1 in 10 annual probability greenfield rate. To estimate the volume of storage achievable within these strategic SuDS features and inform the concept design several assumptions must be made.

Swales are assumed to have an average depth of 0.5m, a base width of 0.5m and a maximum side slope of 1 in 3. The design water depth for the swales is proposed to be 0.4m to provide a 0.1m freeboard. Where swales are running across the slope (i.e. close to parallel with contour lines) it is assumed that the swales will be able to maximise the storage available and the volume would be equal to the product of the cross-sectional area and the length of the swale.

Where swales run down a slope (i.e. roughly perpendicular to contour lines) it will be necessary to include check dams within the design to slow and store water within them. It is proposed that check dams be constructed at intervals equivalent to every 0.4m of fall in ground elevation along the length of the swale. As such, it will be assumed that only 30% of the maximum storage volume available in these swales will be available as effective attenuation storage.

Given the steep topography of the Site, the construction of basins capable of storing water will require significant earthworks to accommodate them. This will be minimised where practical, by locating basins in areas with relatively shallow gradients; however, some earthworks will still be required, and therefore, it is necessary to consider their impact on the masterplan and available storage volume estimates.

It has been assumed that the earthworks to create each SuDS basin would be accommodated within the footprint shown on the SuDS Strategy Plan (Appendix E).

As such, the storage volume would be reduced depending on the topography at each basin location and in order to provide initial estimates for the concept design it is assumed that the potential storage volume would be equal to the product of the area and an average depth of 0.8 m, reduced by 50% to allow for the required earthworks. This is based on initial checks done at a few selected locations using a maximum side slope of 1 in 3 for the earth works to form the basins. This check identified that where the basins are narrower than 15m a 'loss' greater than 50% could occur and to account for this the loss was increased to 80% for narrow basins as a precautionary approach.

In practice, it is likely that the basins could achieve greater volumes of storage as the earthworks could be accommodated within the cut and fill required to develop the remainder of the site; however, this approach provides a conservative estimate of the storage provided by the basins suitable for informing the masterplan.

The proposed location and connectivity of the strategic open SuDS features is shown in Appendix E.

Table 18 provides a summary of the total volume of storage provided by the offline swales and basins compared with the average required volume for 1 in 100 annual probability storm inclusive of a 40% allowance for climate change. This has been broken down by the proposed drainage catchments and phasing to assess the availability of storage for each phase of the development. Furthermore, it summarises the total volume estimates for each drainage catchment and phase as well as for the entire development.

Table 18: Summary of storage provided by strategic offline open SuDS features (m^3)/ per development phase

Phase	1		2		3		4		5		***TOTAL***	
Catchment	Needed	Provided	Needed	Provided	Needed	Provided	Needed	Provided	Needed	Provided	***Needed***	***Provided***
A	4746	2671	3601	3845	0	0	1049	1737	2153	2234	***11548***	***10486***
B	181	0	1868	2267	1990	2372	0	0	0	0	***4038***	***4639***
C	0	0	0	0	92	1410	1691	1828	2593	1343	***4375***	***4582***
D	0	0	0	0	0	0	702	314	1451	3221	***2153***	***3535***
E	1266	1693	0	0	2516	2826	2702	2331	1199	1608	***7681***	***8458***
TOTAL	***6192***	***4364***	***5469***	***6112***	***4597***	***6609***	***6143***	***6210***	***7395***	***8406***	***29794***	***31700***

This demonstrates that sufficient strategic attenuation storage can be provided in open SuDS features within the masterplan for the majority of catchments and phases of development with a few exceptions as highlighted below:

- Phase 1 of catchment A has a deficit of 2,075 m^3. Options for locating additional basins have been explored however there are pressures to include other land uses in this area. As such it is proposed to accommodate this volume of storage within the playing fields of the proposed school (Plot B1). It is considered that the majority of this storage could be provided below ground in a geo-cellular crate system in conjunction with additional storage provided by allowing the playing fields to become inundated during very extreme storms to reduce costs (e.g. in events exceeding the 1 in 30 annual probability storm).
- Phase 1 of catchment B has a deficit of 181 m^3 in relation to plot C8, which is proposed for employment and mixed use. It is currently proposed to provide an on-plot solution through the

combined use of bio-retention area, permeable paving and soakaways. Alternatively, the immediately downstream drainage zone 2-c in Phase 2 of catchment B has a surplus storage, which can be utilised if some SuDS features can be brought forward to serve plot C8.

- Phase 5 of catchment C and phase 4 of catchment E both report deficits; however, early phases provide a surplus of storage that would be more than sufficient to account for this.
- Phase 4 of catchment D has a deficit of 388 m^3. This is due to potential risks in relation to historic mining features in this area and the subsequent exclusion of the use SuDS basins here until further investigations are undertaken. Therefore, on-plot storage solutions will need to be investigated at detailed design or there is the potential to create some online storage features within Headwater D that could deliver other benefits. Alternatively, there is a storage surplus in the immediately downstream Phase 5 drainage zone (5-c) in Catchment D, which can be utilised to address the shortfall in Phase 4 as the SuDS basins that serve 5-c are actually located in phase 3 green infrastructure in any case.

Table 18 also demonstrates that the development as a whole can provide more storage in offline open SuDS features than what is needed. It should be noted that extra online SuDS storage can be provided within Headwater B, C and D if required subject to further consultations with LLFA and EA during the reserved matters stages.

8.5.5 Implementation and maintenance

The SuDS strategy will be designed and implemented so that each phase of the development can provide sufficient storage for the surface water that will be generated from that particular phase (or earlier phases), as well as working as a wider SuDS network across the phases once the development has been completed. This creates a localised and self-sufficient surface water drainage strategy for each phase, as well as an interconnected larger network.

Indicative Phasing Plans and supporting plans are submitted with the Outline Planning Application, demonstrating how the strategic SuDS network will be implemented across Langarth Garden Village Development integrated within Green Infrastructure. More detail on the detailed design and implementation of blue-green infrastructure for each phase will be provided as part of reserved matters; however, the information submitted with this document aims to demonstrate that it is feasible to reduce runoff rates to the 1 in 10 year greenfield rate within the masterplan.

The surface water management strategy and its construction sequence will also ensure that any potential construction impacts, such as dealing with runoff from bare, compacted or muddy surfaces including haul roads associated with off-site infrastructure works are accounted for and therefore present a limited flood risk to the construction site. In addition, a Construction and Environment Management Plan will be prepared and approved by the LLFA before commencement of works on site in order to prevent silt from entering the strategic SuDS features.

Table 18 and the subsequent discussion demonstrates that the current masterplan has sufficient SuDS space as a whole to accommodate the design events, including 40% allowance for climate change.

In terms of maintenance, the strategic SuDS components will need to be adopted by a body that can maintain the different components so that they function as they were originally designed to. It is currently envisaged the strategic SuDS and green infrastructure will be adopted by a Community Land Trust with an elected body. Any drainage features within the adopted roads within the development parcels can be adopted by Cornwall Council as the Highway Authority. The maintenance regime and activities would follow those set out in the CIRIA SuDS Manual (Ref. 10.24) and further details along with confirmation of responsibility would be provided as part of the reserved matters application.

8.5.6 Water Quality

In order to control potential pollution risks from the Proposed Development it will be necessary to consider how the SuDS can be used to treat runoff prior to discharge to the natural watercourses on site. The SuDS Manual recommends the use of a series of SuDS features in what is termed a ‘management train’. The number of features required is dependent on the associated land use, potential source of pollution and the ability of each feature to provide adequate treatment.

The development runoff (i.e. except for some existing green areas and roads) will pass through both swales and basins within the strategic SuDS network prior to discharge. Check dams and small wetland areas within the swales can also act as silt traps and isolate any accidental minor pollution incidents. However, additional features should be accommodated within the development parcels where possible to capture and treat the majority of pollution first so that the strategic SuDS network is only required to provide a final polish to water quality. Therefore, it is recommended that runoff from all development plots pass through at least one, but ideally two treatment stages before discharging to the strategic network. These could be in the form of permeable paving, grass filter strips, bio-retention areas or filter trenches. Land uses that could provide an elevated risk of pollution should provide additional treatments stages.

8.5.7 Other Considerations

The NAR will drain to a separate drainage system that has been designed by Cormac (please refer to EDG01665-CSL-HDG-00MZ-RP-CD 0002 for details). However, there will be other access roads within the masterplan that will be adopted by Cornwall Council. It is proposed for these to drain to the strategic SuDS network and the impermeable surface has been accounted for in the attenuation calculations in this document. It is noted that easements will need to be agreed to facilitate the discharge of surface runoff from the adopted highways to the strategic SuDS network.

As noted earlier in the report, there are significant opportunities for the development of Natural Flood Management (also known as Working with Natural Processes) measures within the existing watercourses and floodplain on site. These could include the construction of woody debris dams, wildlife ponds that could act as additional attenuation ponds, riparian woodland planting and the creation of wetland habitat. These could enhance the reduction in flood risk offered by the currently proposed strategic SuDS scheme (i.e. reduction of peak flows to 1 in 10 year greenfield runoff rates) and provide significant benefits to water quality, biodiversity and public amenity. It is recommended that further options for their inclusion are considered as part of the reserved matters stage.

An initial study has been commissioned to assess the potential effects of the Proposed Development on the performance of the River Kenwyn Flood Storage Area and the safety of the associated New Mills Dam. The results of this study will be submitted as an addendum to this FRA.

9 Summary and Conclusions

Arcadis has prepared a Flood Risk Assessment and Surface Water Drainage Strategy to inform the masterplanning and Environmental Impact Assessment of the Proposed Development of “Langarth Garden Village” and the Northern Access Road (NAR). The Site is located in the central region of Cornwall, approximately 3km to the west of Truro and comprises approximately 245 hectares.

The Proposed Development has a mixed flood risk vulnerability classification, ranging from ‘Water Compatible’ to ‘More Vulnerable’ as per NPPF guidance. The lifetime of the Proposed Development including residential use is at least 100 years.

Flood risk from all sources has been assessed, with reference to published data sources, site specific ground investigation data and bespoke fluvial flood modelling.

The assessment concludes:

- **Fluvial:** The Site is predominantly located in Flood Zone 1, with minor extents of Flood Zones 2 & 3 topographically limited to the channel valleys of the studied headwaters. Bespoke site-specific hydraulic modelling has demonstrated that EA Flood Zone 2 and Flood Zone 3 overestimate the extents of fluvial flood risk across the Site.
- **Surface Water:** The majority of the Site has ‘very low’ to ‘low’ surface water flood risk, with limited areas of ‘medium’ and ‘high’ risk mostly following the profiles of the studied Headwaters.
- **Groundwater:** The Cornwall SFRA reports that groundwater flooding is of low prevalence due to Cornwall having only minor aquifers. Groundwater has not been encountered by previous Ground Investigation of the Site and the NAR. GI data suggest the water table sits below 2.7m.
- **Artificial & Sewer:** The Site does not lie within an area at risk of flooding from reservoirs. The sewer network to serve the Proposed Development is being sustainably designed, to comply with Cornwall Council and South West Water’s surface water management policies and to ensure there is a low risk of sewer flooding post-development.

The NPPF Sequential and Exception Tests have been applied. It is concluded that through a detailed masterplanning process, land use has been located sequentially with only water-compatible land uses situated in medium/high risk areas and as such it is considered that the Proposed Development passes the Sequential Test under NPPF and Local Policy requirements. It has also been demonstrated that the requirements of the NPPF Test are fulfilled by the Proposed Development.

A SuDS strategy has been designed to mitigate surface water discharges to the 1 in 10 greenfield runoff rates, as required by the LLFA. Runoff generated during storm events up to the 1% AEP plus 40% Climate Change critical event would be stored on site, rather than discharging downstream where it could contribute to flooding elsewhere. This design capacity is greater than storms that caused the Truro 1988 historical flood events, and also accounts for future climate change. The SuDS strategy has therefore demonstrable capacity to mitigate surface water flooding on-site and also negate any increase in flood risk elsewhere, including the nearby vulnerable area of Truro. This measure satisfies the NPPF requirement to assess the impacts of planning applications on local areas susceptible to flooding.

Other embedded measures to negate flood risk elsewhere have been designed to national and local policy requirements. These standards are also expected to be met by all relevant nearby 3rd party planning applications in order to obtain their own consents. It is therefore expected that each planning application will effectively self-mitigate any flood risk it poses, to negate any cumulative risk. This measure satisfies the NPPF requirement to assess the cumulative impacts of planning applications on local flood risk.

The FRA and SWDS support the potential for the Development to remain ‘safe’ as defined by the NPPF and Local Policy for its lifetime, and to not increase flood risk elsewhere, including in the context of cumulative planning applications.

The bespoke hydraulic modelling results indicate that there will be no obstruction to access/egress routes within the residential plots of the masterplan during a flood event. No vulnerable development will be located in areas where the bespoke modelling indicates that access could be impeded during a flood.

The development of the NAR in association with the Proposed Development will serve to improve overall access/egress to the area, further to the benefit of the emergency services. The embedded design of the NAR crossing at Headwater B, supported by a comprehensive residual risk management plan, will mitigate flood risk and not compromise safe access/egress to the Proposed Development.

Due to the low flood risk within the Proposed Development, it is considered that residual risk can be safely managed, and that no emergency plan is required to be produced as part of the Exception Test.

Both the Sustainability and Lifetime Safety elements of the Exception Test required for development to be allocated or permitted are satisfied. As such, it is considered that the Proposed Development passes the Exception Test under NPPF and Local Policy requirements.

10 References

Ref. 10.1 National Planning Policy Framework (Ministry of Housing, Communities & Local Government, Feb 2019)

Ref. 10.2 Planning Policy Guidance (PPG) (Ministry of Housing, Communities & Local Government, Dec 2019)

Ref. 10.3 BGS hydrogeology 625k (British Geological Survey (BGS), accessed 18th November 2019)

Ref. 10.4 Aquifer Designation Map (Environment Agency, accessed 18th November 2019)

Ref. 10.5 BGS Borehole Record Viewer (British Geological Survey (BGS), accessed 18th November 2019)

Ref. 10.6 TC_ARDS_24_06_2019_Enviro_1;

TC_ARDS_24_06_2019_Enviro_2;

TC_ARDS_24_06_2019_Enviro_3;

TC_ARDS_24_06_2019_GEO_1; and

TC_ARDS_24_06_2019_GEO_2

(Groundsure Limited, 2019)

Ref. 10.7 3218.FRA&SWDS (Stuart Michael Associates, 2011)

Ref. 10.8 CGE/6249 (CARD Geotechnics, 2010)

Ref. 10.9 The Truro Northern Access Route (TNAR): Ground Investigation Report (Cormac Solutions Ltd, 2019)

Ref. 10.10 Soilscapes Map (Cranfield Soil and Agrifood Institute, accessed 18th November 2019)

Ref. 10.11 Cornwall Strategic Flood Risk Assessment Level 1 (Cornwall Council, 2009)

Ref. 10.12 Cornwall Local Plan (Cornwall Council, 2016)

Ref. 10.13 Truro and Kenwyn Neighbourhood Development Plan (Cornwall Council, 2016)

Ref. 10.14 West Cornwall Catchment Flood Management Plan (Environment Agency, 2012)

Ref. 10.15 Cornwall Local Flood Risk Management Strategy (Cornwall Council, 2014)

Ref. 10.16 The Preliminary Flood Risk Assessment Report (Cornwall Council, 2011)

Ref. 10.17 Flood Risk Map for Planning (Environment Agency, accessed 18th November 2019)

Ref. 10.18 Recorded Flood Outlines (Environment Agency, Dec 2019)

Ref. 10.19 ENQ19/DCIS/132003 (Environment Agency, 2019)

Ref. 10.20 PA19-07610 Scoping Opinion (Cornwall Council, 2019)

Ref. 10.21 Long Term Flood Risk Map (Environment Agency, accessed 18th November 2019)

Ref. 10.22 Truro and Threemilestone Surface Water Drainage Strategy (Cornwall Council, 2008)

Ref. 10.23 Truro Northern Access Road (TNAR) Surface Water Management Strategy Design development Interim Update (Cormac Solutions, August 2019)

Ref. 10.24 The SuDS Manual (CIRIA, 2015)

Ref. 10.25 Non-statutory technical standards for SuDS (Defra, 2015)

Ref. 10.26 Truro Northern Access Road (TNAR) Flood Risk Assessment & Surface Water Management Strategy EDG01665-CSL-HDG-00MZ-RP-CD 0002 (Cormac Solutions, June 2020)

Ref. 10.27 Hydrological analysis of the Truro floods of January and October 1988. Hydrological Data UK 1988, Institute of Hydrology, Wallingford, 1989, 27-33. (Acreman, M.C. 1989)

Ref. 10.28 Flood frequency analysis for the 1988 Truro floods. J. Inst. Water & Environ. Manage., 4, 62-69. (Acreman, M.C. & Horrocks, R.J. 1990)

Ref. 10.29 The use of historical data in flood frequency estimation. Report to MAF. Centre for Ecology and Hydrology: Wallingford. (Bayliss AC, Reed DW. 2001)

APPENDIX A

Topographic Survey

APPENDIX B

Hydraulic Modelling Technical Note including FEH Calculation Record

APPENDIX C

Ground Investigation Plan and CORMAC report

APPENDIX D

Surface Water Management Design Principles

Design Principle	Design Criteria Delivery
Water Quantity	a. Reduce the risk of flooding from surface and foul water and its contribution to fluvial flooding. b. Provision of a surface water management strategy that works with the natural drainage of the site, retaining surface water within the site and manage the risk of flooding during severe storms. c. Surface water not collected for use to be discharged per the following discharge hierarchy; to ground, to a surface water body, a surface water sewer, to a combined sewer. d. Protect people and property within the area of study from flooding and does not create any additional flood risk outside the development. e. Ensure that all surface water is retained within the SuDS components for no flooding for events up to the 1 in 30 annual rainfall event and contained within appropriate exceedance routes and storage areas up to the critical 1 in 100 annual rainfall event, with appropriate freeboard within the drainage measures and floor levels set above surface water or fluvial levels inclusive of climate change and urban creep allowances. f. Runoff rates should match greenfield runoff rates for all events up to the climate change adjusted 1 in 100 annual rainfall event. g. Development to not have an adverse impact on drinking water resources. h. Existing ordinary watercourses should be identified and accommodated and preferably retained.
Water Quality	a. Surface water discharges should not adversely impact the water quality of the receiving water bodies, both during construction and when operational. b. The first 5mm of any rainfall event should be accommodated and disposed of on-site, rather than being discharged to any receiving watercourse or surface water sewer. c. Industrial areas will have appropriate pollution control operation processes in place to minimise the risk of serious pollution events occurring. d. Provide treatment of surface water runoff to meet the requirements of local and national standards. e. Ensure that the impact of periodic extended wet and dry periods do not invalidate treatment performance. f. Ensure that where infiltration is proposed that a sufficient treatment train is in place to ensure no pollution contamination.
Amenity	a. Respect and enhance hey historic features of conservation interest. b. Integrate car parking, recreational and amenity space, identified green corridors and public open space areas with the surface water management system. c. Use water to support vegetation to enhance civic space, the road environment and public open space.

Design Principle	Design Criteria Delivery
	d. Keep sides sloped to accessible water features, swales and detention basins shallow, easily accessible and easy to maintain. e. Ensure the safest access as far as reasonably practical for learning and community engagement activities.
Habitat and Biodiversity	a. To conserve and enhance biodiversity and avoid a net loss of biodiversity. b. Contribute to habitat connectivity through the provision of blue/green corridors. c. Contribute to the connectivity and enhancement to and of the SSSI and AONB that are located close to the site. d. Increase the resilience and the self-sustainability of the ecosystems.

APPENDIX E

SuDS Strategy Plan

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