Hadlow Estates

FLOOD RISK AND DRAINAGE REVIEW - TUDELEY MASTERPLAN

Technical Note

REG19-REVIEW
JUNE 2021

CONFIDENTIAL

Hadlow Estates

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TECHNICAL NOTE (VERSION 1) CONFIDENTIAL

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Hadlow Estates

FLOOD RISK AND DRAINAGE REVIEW - TUDELEY MASTERPLAN

Technical Note

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CONTENTS

1 INTRODUCTION 1

1.1 SCOPE 1
1.2 SITE LOCATION AND SETTING 1
1.3 AIMS AND OBJECTIVES 2

2 LOCAL DEVELOPMENT PLAN WATER KEY INFORMATION 3

2.1 STRATEGIC SITES MASTERPLANING AND INFRASTRUCTURE STUDY 3
2.2 STRATEGIC FLOOD RISK ASSESSMENT (LEVEL 1 AND 2 COMBINED) 5
2.3 GREEN INFRASTRUCTURE FRAMEWORK FOR PRE-SUBMISSION LOCAL PLAN 6
2.4 DEVELOPMENT TOPICS PAPER FRAMEWORK FOR PRE-SUBMISSION LOCAL PLAN 6
2.5 STRATEGIC SITES TOPIC PAPER FRAMEWORK FOR PRE-SUBMISSION LOCAL PLAN 6

3 FLOOD RISK AND DRAINAGE 7

3.1 BASELINE CONSTRAINTS AND OPPORTUNITIES 7
3.2 KEY CONSULTATION RESPONSES 9
3.3 ADDITIONAL AVAILABLE INFORMATION 11
3.4 FLOOD RISK AND DRAINAGE FURTHER OPPORTUNITIES 12

4 SUMMARY 16

APPENDICES

APPENDIX A - WSP - WSP OPPORTUNITIES AND CONSTRAINTS TECHNICAL NOTE (21 OCT 2019)

APPENDIX B - WSP CATCHMENT SPECIFIC NATURAL FLOOD MANAGEMENT AND MITIGATION MEASURES (28 MARCH 2019)

APPENDIX C - WSP TECHNICAL MEMO – COMMENT ON DRAFT LOCAL PLAN POLICIES (10 OCT 2019)

APPENDIX D - BROOKS MURRAY GREEN SPACE DIAGRAM (14 MAY 2021)

1 INTRODUCTION

1.1 SCOPE

1.1.1. WSP has been commissioned to review previous assessments undertaken on behalf by Tudeley Promotor, Hadlow Estate, for the development proposed at Tudeley Village (Ref: CA1) and collate these into a single source of constraints / opportunities regarding flood risk.

1.1.2. WSP has also been asked to review the current flood risk and drainage information, and the evidence base contained within the Local Plan under Regulation 19. The Local Plan recommendations regarding the Tudeley scheme, have been reviewed in consideration of the wider context described in the Plan.

1.1.3. This report discusses the above points and shows that flood risk and drainage can be successfully managed as part of a proposed development of the site with appropriate master-planning and design solutions being implemented. The report identifies opportunities for the further development of the masterplan of the site taking into account policy, best practice and the available information on constraints, opportunities and expectations of the various stakeholders.

1.2 SITE LOCATION AND SETTING

1.2.1. The site is located on the Hadlow Estate near Tudeley, Tunbridge Wells, Kent (OS Grid Reference TQ 62654 45631). The current land use is predominantly agricultural, with an embanked railway line (South Eastern Main Line) traversing the site. The site is part of the Hadlow Estate, which covers a much more extensive area.

1.2.2. The site is bordered on all sides by agricultural fields and small residential developments (Tudeley, Tudeley Hale, Five Oak Green and Crockhurst Street).

1.2.3. The Alder Stream, an Environment Agency Main River, flows south to north to the east of the site. An ordinary watercourse (a tributary of the Hammer Dyke) runs along the northern border of the site and joins the River Medway approximately 2km to the northeast. To the west, another ordinary watercourse flows parallel to the site, approximately 200m away from the site boundary.

1.2.4. There are four surface water flow routes traversing the site based on the strategic GOV.UK flood mapping, one of which has a catchment that extends off site. The rest of the on-site surface water flow paths appear to be locally formed within the site boundary. Three of the four surface water flow paths are located at the same location of ordinary watercourses. This is consistent with local topography and links flood risk from those watercourses rather than surface water runoff and resultant flow paths alone.

1.3 AIMS AND OBJECTIVES

1.3.1. The report aims to review previous WSP reports, additional new information and current Tunbridge Wells Borough Council Local Plan Regulation 19 consultation[1] documents regarding the proposed strategic development Tudeley Village. These reports are:

- Reg 19 – Strategic Sites Master Planning and Infrastructure Main Report (Feb 2021)
  - Appendix 2 – Tudeley Village Baseline Review (Dec 2020)
  - Appendix 5 – JBA Flood Risk Technical Note (Jan 2021)
- SFRA level 1 and 2 combined (Jul 2019).
- Green Infrastructure framework (Feb 2021)
- Reg 19 – Development Strategy topic paper (Feb 2021)
- Reg 19 – Strategic Sites topic Paper (March 2021)
- Opportunities and Constraints Technical Note by WSP Ref: 40076-OAC-001 Revision 1, dated 21 October 2019 (See Appendix A)
- Catchment Specific NFM and Mitigation Measures Plan by WSP Drawing number 40076-CON-002 Revision B dated 28 March 2019 (see Appendix B)
- Memo – Comment on Proposed Draft Local Plan Policies by WSP dated 10 October 2019 (see Appendix C)
- Green Space Diagram by Brooks Murray Architects, Ref: 126-074 Revision B dated 14 May 2021. (Appendix D)
- Flood Investigation Report, Five Oak Green on 9 February 2020 by Kent County Council[2].

[1] https://tunbridgewells.gov.uk/planning/planning-policy/local-plan/evidence (accessed 1 June 2021)
[2] https://www.kent.gov.uk/__data/assets/pdf_file/0010/118594/section-19-flood-investigation-five-oak-green.pdf (accessed 1 June 2021)

2 LOCAL DEVELOPMENT PLAN WATER KEY INFORMATION

2.1 STRATEGIC SITES MASTERPLANING AND INFRASTRUCTURE STUDY

2.1.1. Tunbridge Wells Borough Council (TWBC) commissioned three studies to support strategic sites consultation subject to Regulation 19 of the Draft Local Development Plan process. The Plan will cover the period 2016 to 2038 and aims to meet the housing need of 678 dwellings per year. The main report (by David Lock Associates – Feb 2021) highlights the approach to planning 'garden communities' within the Draft Local Plan.

2.1.2. The Tudeley Village strategic development requirements are listed as:

- 2800 dwellings (on a 170 hectare site), providing 1900 dwellings within the plan period 2020-2038 (although, since the Infrastructure Study was issued, this has been revised to providing 2100 dwellings within the plan period)
- Affordable housing
- Provision of appropriate employment within the development
- Inclusion of a range of local services and facilities appropriate to the size of the development including a six-form entry secondary school and a three-form entry primary school
- Provision of appropriate open space for leisure, recreation, informal and formal play space, sports pitches, allotments / food growing areas.

2.1.3. Since the infrastructure report was published, the masterplan has progressed and includes a primary school, a secondary school, and facilities such as allotments, tennis courts, commercial areas with the ability and flexibility to include a future railway station. There are several areas of both formal and informal open space, see Appendix D.

TUDELEY VILLAGE BASELINE REVIEW REPORT – APPENDIX 2

2.1.4. Appendix 2 is a supporting document attached to the Strategic Master Planning and Infrastructure Study. It was produced by Stantec (dated Dec 2020) to specifically review the Tudeley Village site. The objectives are listed as provision of 2800 dwellings, 2750sqm office and 8250sqm retail use, a supermarket, a three-form entry primary school, a six-form entry secondary school, a village centre and three neighbourhood centres.

2.1.5. This report provides a baseline review. Chapter 4 reviews the baseline ecology and Chapter 5 reviews baseline flood risk. It is based on publicly available information before the provision of a masterplan layout.

2.1.6. Opportunities are highlighted for the masterplan to create new ecological habitats with multifunctional benefits of SuDS, restoration of watercourse and contribution to improvements of biodiversity within the site boundary.

2.1.7. It is recognised that the majority of the site is within Flood Zone 1 of the Environment Agency (EA) River and Coastal Flood Map. Flood Zone 1 is a low probability of fluvial flooding [less than 0.1% annual exceedance probability (AEP)]. The site is located a short distance to the south of the River Medway. Some northern and north eastern parts, a small proportion of the overall site, are within Flood Zones 2 and 3a, with an area of Flood Zone 3b located between the site and the River Medway. The Alder Stream runs to the east of the site, with adjacent areas of Flood Zones 2, 3a

and 3b. Moreover, there are other small ordinary watercourses, surface water flooding and groundwater flooding within the site to consider.

2.1.8. The main observations for the masterplan process in the Baseline Review report are:

- Layout should be designed to limit or avoid obstruction of flood pathways.
- Modifications to watercourses should be avoided unless providing ecological and / or environmental benefit such as reducing flood risk.
- Agreement is required to secure flood risk management measures
- Strategic approach to managing flood risk and drainage rates is important, with regard to cumulative impacts.
- New infrastructure such as bridges should be planned to be clear span without the impinging on Flood Zone 3.
- Surface water runoff from the development itself should be managed and integrated into green infrastructure, to allow for multifunctional benefits – particularly;
  - Shallow side slope landscaping, for long term storage of water
  - Amenity and play areas can be designed to store water underground for frequent flood events but above ground in extreme rainfall events when they are less likely to be used.
  - Adoption and maintenance of each drainage area to be understood at an early stage.
  - Communication of the functions of these areas to residents is critical.
- SuDS (vegetated features) have the potential to provide numerous planning policy objectives such as climate resilience (flooding), habitat connectivity, environmental net gain, amenity and educational value.
- SuDS to be placed outside the fluvial flood zones, to allow storage of water during floods. Making use of strategic topographic low spots within a masterplan area, connectivity of swales and potential discharge locations. Surface conveyance routes should retain existing flow routes e.g. ordinary watercourse which can become blue green corridors through the development.
- Small rainfall events should be managed through source control, green roofs, rain gardens, swales, permeable paving.
- Surface water discharge rates should be agreed at an early stage in the master-planning / planning process with the appropriate body (KCC and / or EA).
- Rainwater harvesting should be incorporated wherever possible.
- Urban creep and climate change should be accounted for in the initial storage size of SuDS to inform the masterplan.

2.1.9. The report highlights that there are few initial geotechnical or geo-environmental constraints, except for possible high groundwater levels in parts of the site.

2.1.10. The report concludes that '**there are no insurmountable constraints and risks that have been identified that would prevent development at Tudeley Village**'.

TECHNICAL NOTE – MASTERPLAN DEVELOPMENT MODELLING AT PADDOCK WOOD - APPENDIX 5

2.1.11. Appendix 5 is a supporting document which only relates to fluvial flood risk and flood modelling undertaken at Paddock Wood. This technical note has been used to support the masterplan layout for Paddock Wood and has no information that is relevant to the watercourses or catchments that are upstream of Tudeley Village site.

2.2 STRATEGIC FLOOD RISK ASSESSMENT (LEVEL 1 AND 2 COMBINED)

2.2.1. The combined level 1 and level 2 Strategic Flood Risk Assessment (SFRA) (JBA, July 2019), summarises the flood risks within the Tunbridge Wells Borough Council area. It assesses information on fluvial, coastal, surface water, reservoir and groundwater flooding. Flood defence, climate change allowances, guidance for developers and key policies are reviewed. Opportunities for river restoration are highlighted as a benefit to the environment from development. It also specifically identifies risk to potential allocations within the Local Development Plan.

2.2.2. Land at Tudeley (Site ref: 446) is assessed as having few constraints, broad categories have been assigned to each potential plan allocation. These are, 75% to 100% within Flood Zone 1 for fluvial and coastal flood risk and 75% to 100% outside an area at risk of surface water flooding. The site does intersect an area at risk of reservoir flooding and this extent of flooding qualitatively reflects the fluvial flood zones from the river Medway (see Figure 2-1)

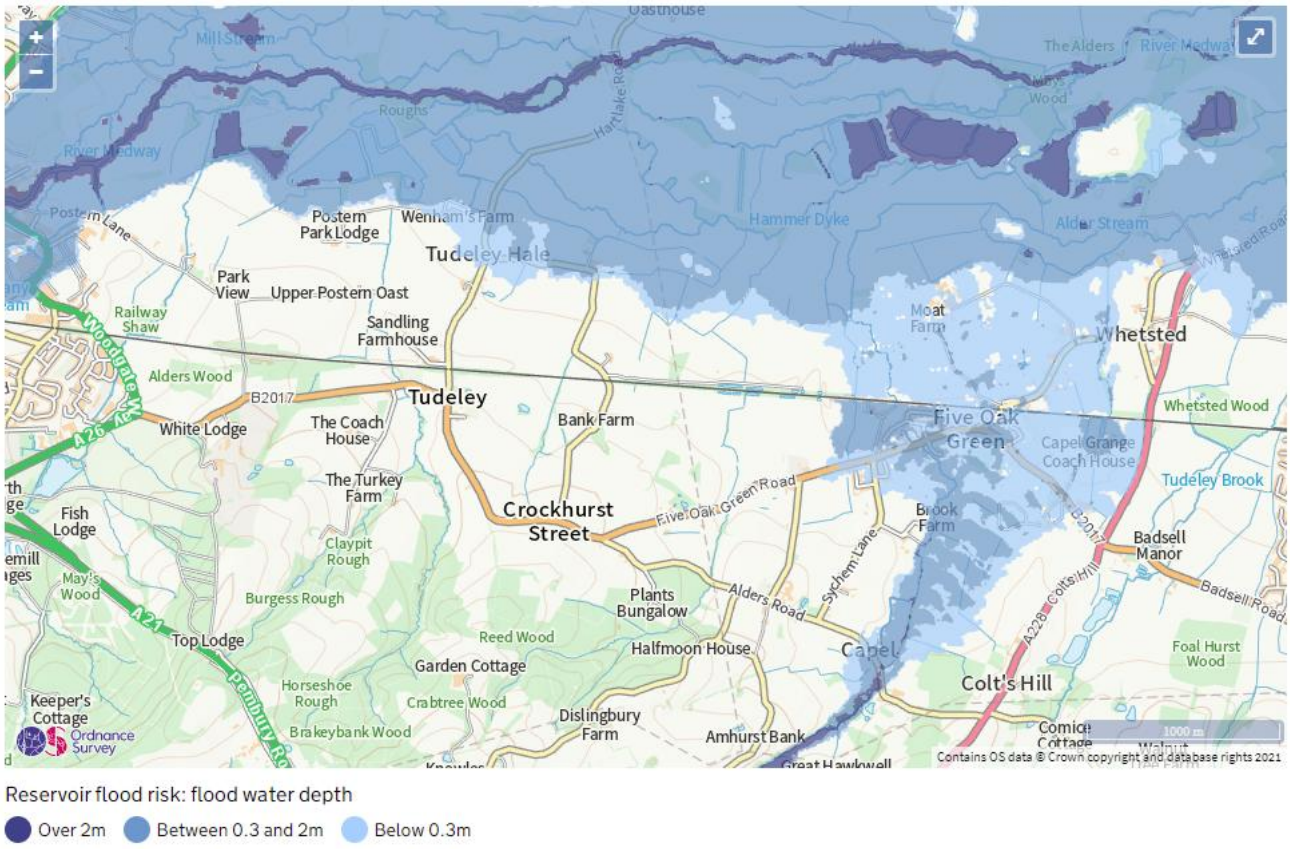

Figure 2-1 – Diagram showing the extent and anticipated depth of flooding from reservoirs (if there was a failure at a reservoir) – Source: The Environment Agency[3].

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

2.2.3. There are many historical incidents of flooding in the Borough that have been listed within the SFRA, mostly associated with the River Medway overtopping its banks. Historical surface water flood events are also highlighted as having affected the Borough, overloading carriageway drains, and causing runoff from agricultural. There is no specific identification of the Tudeley Village allocation as having any significant flood history.

2.2.4. Sustainable Drainage (SuDS) are heavily promoted alongside the multi-functional benefits for flooding, water quality, amenity and biodiversity. Emphasis is given to new developments providing source control and recognising additional requirements may be required in areas where Groundwater Source Protection Zones are located.

2.3 GREEN INFRASTRUCTURE FRAMEWORK FOR PRE-SUBMISSION LOCAL PLAN

2.3.1. The document refers to the multifunctional benefits that green infrastructure (GI) can provide when included within a masterplan. The inclusion of SuDS into blue-green infrastructure and provision of natural flood management are highlighted as a key role and benefits of GI. The policies for strategic sites are designed to 'create high quality environment on garden settlement principals, with GI being the defining characteristics'.

2.4 DEVELOPMENT TOPICS PAPER FRAMEWORK FOR PRE-SUBMISSION LOCAL PLAN

2.4.1. The document is a high-level review of development housing needs, infrastructure delivery and strategies. Section G reviews the likelihood of pursuing new settlements to supply large numbers of new homes. A summary of planning issues not related to the water environment are discussed with regard to meeting National Planning Policy Framework. Further detail is included within the strategic sites topic paper.

2.5 STRATEGIC SITES TOPIC PAPER FRAMEWORK FOR PRE-SUBMISSION LOCAL PLAN

2.5.1. This document contains more detail on the strategic sites to meet the Council's housing needs. Section 5 describes the masterplan at Tudeley, recognising that the whole site is within ownership of one landowner (Hadlow Estates) and is not in an area constrained by flooding. Whilst flood management and SuDS would be fully investigated and mitigated on the site as part of any development in the ordinary way, it also highlights the natural flood management measures being considered by Hadlow Estates in neighbouring catchments. These measures are designed to contribute to the flood management of the wider Medway catchments.

3 FLOOD RISK AND DRAINAGE

3.1 BASELINE CONSTRAINTS AND OPPORTUNITIES

3.1.1. The hydrological setting and local plan policy has been assessed by WSP in two previous high-level documents. These documents are summarised below with the full within copies provided in Appendices A, B and C.

OPPORTUNITIES AND CONSTRAINTS TECHNICAL NOTE (21 OCT 2019)

3.1.2. The northern part of the Tudeley Village site is summarised as being within the fluvial flood plain of the River Medway, and outside of but adjacent to the catchment of the Alder Stream. The main purpose of the study was to establish if the implementation of SuDS and NFM measures would be feasible to free up additional development space.

3.1.3. The report identifies that there are five potential surface water flow routes traversing the site, out of which one is associated with the River Alder (a very small part of the upper catchment) and another one is formed off-site. The rest of the on-site surface water flow paths appear to be locally formed on site and do not reflect surface water runoff from upstream (i.e. south), see Figure 3-1.

3.1.4. Since the report was written, the Tudeley site red line boundary has been made smaller and no longer includes the River Alder catchment. Further work can, however, be undertaken during the planning application process to further investigate the watercourse and surface water flow catchments. This would follow an investigation as to the location of culverts at the railway line and role of any specific drainage along the railway line corridor.

3.1.5. Five catchments were identified in this high-level study, that could be investigated for natural flood management improvements, outside the Tudeley Village red line boundary. There is a significant amount of land outside the red line boundary (See Appendix B) that is available for possible flood mitigation measures as discussed in section 3.1.12 below. These areas could provide possible improvements to the flood management in the wider communities, including Five Oak Green.

3.1.6. The report explains that, based on the estimated residential dwelling density of 25 dwellings per hectare (ha) and the area extent of the site that is not subject to risk of flooding, either from surface of fluvial flows, and free from any other environmental constrains (e.g. Ancient Woodland), there is currently enough space to deliver the estimated 3000 dwellings on site, including 20ha of space that can be reserved for SuDS and other open space. Since the report was written, it has been confirmed that there is expected to be 2800 dwellings on 94.56 ha resulting in a density of 30 dwellings per ha. Open space would equal 50.68ha and combined with other land uses totals 177.15ha site size.

3.1.7. The report mentions the potential opportunity associated with development of Tudeley Village to deliver improvements outside the red line boundary of Tudeley Village but within the ownership of Hadlow Estates. These may include measures such as upstream flood storage or natural flood management solutions, such as leaky dams and re-planted areas, that could potentially reduce peak discharge rates and provide betterment to other communities downstream.

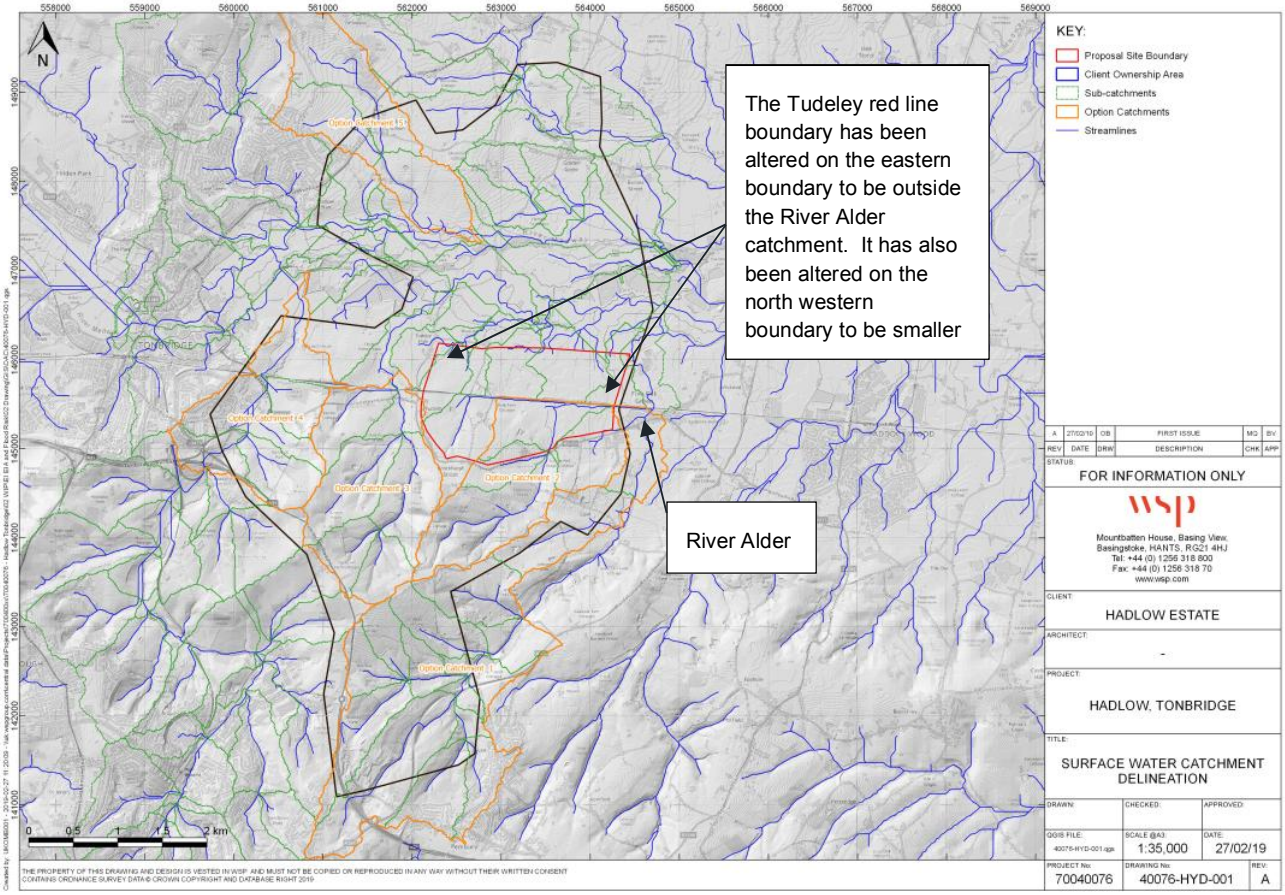

Figure 3-1 – Tudeley site boundary (in red which has since been amended on the eastern and north western boundary), with hydrological catchments shown (orange).

TECHNICAL MEMO – COMMENT ON DRAFT LOCAL PLAN POLICIES (10 OCT 2019)

3.1.8. The memorandum provides a comment on relevant flood risk and drainage policies included in Tunbridge Wells Borough Council's new Draft Local Plan[4] (published 15th August 2019), some of which affect Tudeley Village.

3.1.9. The report summarised that the Policies required:

- the provision of strong, multi-functional green infrastructure to tie the development into the surrounding landscape and integrated with the drainage and flood defence works associated with the delivery of Tudeley Village.
- provision of good quality green and blue infrastructure that promotes biodiversity net gain and enhancement to natural capital whilst simultaneously building resilience against the impacts of climate change.

[4] https://beta.tunbridgewells.gov.uk/__data/assets/pdf_file/0015/300606/Consultation-Draft-Local-Plan.pdf

- appropriate phasing of development, to be linked to the relevant and strategic delivery of infrastructure, including in terms of surface water drainage; in particular the provision of high quality, multiple benefit Sustainable Urban Drainage systems (SuDS).
- provision of net biodiversity gain focused on key, locally important habitats and species.
- Tudeley Village to demonstrate that the development will not exacerbate flooding elsewhere, particularly from the Alder Stream at Five Oak Green, and that as part of the wider delivery of the development, flood storage / attenuation / mitigation is provided as a justification for the release of Green Belt Land.
- regard to be given to the Groundwater Source Protection Zone which falls within the north of the site and the Environment Agency to be consulted as part of any development proposals.

3.1.10. A key recommendation from the technical memorandum, was that certain policies should be redrafted to reflect what is realistically possible through the delivery of Tudeley Village. Paddock Wood is situated in a separate surface water catchment from Tudeley Village and therefore it is not considered that proposals at Tudeley Village will be able to affect flood risk at Paddock Wood. It was recommended that the policies should be re-worded where necessary to reflect that proposals at Tudeley Village only have the potential to effect surface water flood risk '*to particular existing residential areas in Five Oak Green*' and not fluvial flood risk.

3.1.11. It was noted that the provision of NFM measures upstream of Pemble Close [outside the red line boundary of Tudeley Village and a separate watercourse catchment] could potentially provide flood risk protection, enhance biodiversity, reduce nutrient delivery to downstream watercourses, improve water quality and sequester significant amounts of carbon whilst future-proofing the residents of the western part of Five Oak Green.

3.1.12. Following the completion of the technical memorandum to review the draft local plan policies, discussions have taken place to understand further high-level options that could be considered to provide benefits for areas outside the Tudeley Village allocation red line boundary. The availability of a significant area of land in the control of the landowner suggests that the following options could be explored.

- areas of land to be used as upstream flood storage for flood prone catchments e.g. 50% of the Alder Stream Catchment is within the ownership of the landowner.
- land management strategies to incorporate natural flood management techniques such as leaky dams and re-planted areas.
- investigation into land that could allow the retrofit of SuDS e.g. along existing Highway Boundaries or existing built up areas (Capel or the west of Tonbridge).

3.2 KEY CONSULTATION RESPONSES

ENVIRONMENT AGENCY

3.2.1. The EA are a key consultee as part of the site is located within the strategic flood map for planning (Fluvial Flood Zone 2 and 3 of the River Medway). An early engagement meeting was undertaken on 11 March 2020, where the general approach to development was discussed. The key points identified were as follows:

- Leigh Barrier improvement works are progressing, downstream benefits are unknown at this stage but the flood extents of the River Medway are unlikely to change.

- Post development runoff rates would need to be no greater than existing and agreed in consultation with Kent County Council (KCC) in their role of Lead Local Flood Authority (LLFA).
- Efforts should be made to restore straightened watercourse channels. Existing woodland corridors with natural meanders within the site can be used as '*reference reaches*' to base restoration plans on. Enhancement would include widening ponds and shaded areas. Permits may be required to undertake the work.
- Efforts should be made to connect watercourses and other green corridors together.
- De-culverting should be considered.
- New culverts should only be considered to implement crossings.
- Invasive species are recorded on the site and measures should be taken to reduce the risk of spread inside and outside the site boundary.
- Efforts should be made to achieve Environmental Net Gain, enhancing the water environment and connecting features.

3.2.2. It was also noted that Hadlow Estates have been working with South East Rivers Trust to undertake Natural Flood Management measures on areas outside the proposed red line boundary. This is to improve flood risk and biodiversity in the neighbouring catchment of the River Alder.

KENT COUNTY COUNCIL (LEAD LOCAL FLOOD AUTHORITY)

3.2.3. The LLFA is a key consultee on local flood risk (surface water, groundwater and rainwater induced sewer flooding) as well as sustainable drainage (SuDS). An early engagement meeting was undertaken on 10 March 2020 where the general development principals were discussed. The key points identified were as follows:

- Infiltration drainage may not be suitable on the site due to the geology / hydrogeology but confirmation by detailed site investigations in respect of future planning applications would occur.
- Source control SuDS interlinked with other storage areas would be preferred over solely using large site-based storage at downstream locations. Runoff rates and volumes for upstream storage areas may be relaxed if the final surface water discharge rates and volumes for that specific drainage network comply with the SuDS Standards.
- Rate of surface water discharge may need to be less than existing greenfield runoff rates to provide betterment downstream.
- Efforts should be made to restore watercourses where possible and increase conveyance and ecology
- Avoid culverting of water features and provide a 600mm minimum culvert for e.g. road crossings.
- Engagement may be needed with Southern Water regarding adoption of SuDS.
- Phasing of the development would consider how the drainage strategy will be developed as the site is built out.
- A Flood Investigation report is available for recent flooding events in the area (discussed below in section 3.3).

3.3 ADDITIONAL AVAILABLE INFORMATION

3.3.1. Flooding occurred on 9 February 2020 at Five Oak Green and KCC LLFA have provided a Section 19 Report[5] that summaries the incident and potential sources of flooding. The flood was associated with Storm Ciara, which caused heavy rain and strong winds across the UK. Heavy rain fell in a short period of time, consequently river levels rose quickly in the Alder Stream and overtopped the riverbanks. Highway drainage, local drainage ditches and the sewer network were unable to cope with the volume of water.

3.3.2. Approximately 40 properties were reportedly flooded by a combination of overland low, sewage and surface water. Many of the properties experienced internal flooding. The flood event has been assessed by the LLFA as having 3.3% probability of occurring in any single year.

3.3.3. This flood event occurred in a different fluvial catchment to that of Tudeley Village development site; the proposed development of Tudeley Village itself is not considered to affect flood risk in Five Oak Green. As noted at 3.1.12, however, offsite works within land owned by the Hadlow Estate if the Tudeley Village proposal proceeds could be undertaken to provide possible improvements to the flood management in the wider communities, including Five Oak Green.

3.3.4. Local residents have raised several concerns with the strategic development proposals. A local group, “Save Capel”, produced “TWBC Draft Local Plan Representation under Regulation 18 Objection to policies STR/PW1 & AL/PW1 Capel East STR/CA1 & AL/CA1 Tudeley”, dated 15 November 2019. The main issues raised in this report related to;

- Appropriate climate change impacts being considered throughout the development
- Local flood history and concerns about increasing the local flood risk
- Providing adequate SuDS to prevent additional surface runoff from the development making flood risk in the area worse
- Prevent pollution to groundwater and groundwater abstraction Source Protection Zones.

3.3.5. The Save Capel report refers to a local flood history on Sherenden Road near Lilley Farm which is within the Tudeley Village site boundary. This appears to be at a location where an ordinary watercourse is culverted under an existing road adjacent a dwelling. Outside the Tudeley Village site boundary a flood history is noted at Hartlake Road within the River Medway flood plain to the north of the site, on Crockhurst Street (possibly associated with highway runoff to the south of the site) and low ground adjacent to a watercourse in the vicinity of the existing solar farm to the east of the site.

3.3.6. The issues raised in the report are not considered to affect the principle of development at Tudeley Village, but rather relate to matters of detail in respect of the implementation of development at that location which would be the subject of more detailed design work and appropriate solutions in line with policy and best practice as part of any required technical studies (e.g. flood risk assessment, drainage strategy or ground investigations) that would support the planning application.

[5] https://www.kent.gov.uk/__data/assets/pdf_file/0010/118594/section-19-flood-investigation-five-oak-green.pdf

3.4 FLOOD RISK AND DRAINAGE FURTHER OPPORTUNITIES

3.4.1. An initial masterplan has been developed by Brooks Murray Architects to assist with the visualisation of development at Tudeley Village strategic site.

3.4.2. We identify below below further opportunities in relation to the detailed design of proposals for Tudeley Village in respect of flood risk and drainage for the proposals in line with policy and best practice and taking into account the feedback received by the various stakeholders.

Flood Risk

3.4.3. Hydraulic modelling of the River Medway (Main river) and local, ordinary watercourses crossing the site would be expected in the detailed design work in the ordinary way such that:

- Any localised detailed existing baseline flood risk associated with those watercourses can inform the more detailed development of a masterplan which avoids any onsite at risk areas,
- It would support and inform any proposed river restoration design (see below).

3.4.4. Future modelling would also include an assessment of surface water overland flow pathways (which may form part of the ordinary watercourse upper catchments) helping in informing the surface water drainage strategy of the site.

3.4.5. There is significant opportunity to restore existing watercourses to a more natural state than the current use within agricultural land. A more detailed investigation at the masterplanning or planning application stage in respect of the current watercourse locations and drainage connections could identify areas that could benefit from integrated water management and provide additional ecological benefits.

3.4.6. Increasing the watercourse corridor width would allow meanders, pools and shaded areas which can have multifunctional benefits including, appropriate inclusion of climate resilience (both in flood and drought conditions) and building connections of blue and green corridors (or infrastructure).

3.4.7. There is also an opportunity to provide environmental net gain through this restoration process.

3.4.8. Part of that watercourse investigation at the more detailed stage would assess all the existing culverts or other structures to evaluate their condition at that point and design standard with relation to water levels and flows as detailed changes to structures have the potential to affect low flow conditions.

3.4.9. There would be opportunities to alleviate any pre-existing flooding problems associated with such structures and provide any required mitigation, such as those which may already exist at the existing railway line or road crossing near Lilley Farm. This detailed design work may also highlight areas where culverts could be removed or 'daylighted' in line with current best practice within CIRIA Culvert, Screen and Outfall Manual (C786F), 2019[6].

[6] https://www.ciria.org/ItemDetail?iProductCode=C786F&Category=FREEPUBS

3.4.10. Any new culverts in any detailed design would need to demonstrate that they are required e.g. for road access. A new culvert would be expected to be a minimum of 600mm in diameter to meet with the CIRIA Culvert Manual best practice guidance and Kent County Council Land Drainage Policy[7].

3.4.11. The existing overland flow routes would be maintained or incorporated into proposed green or blue corridors south to north across the development. This will be part of the design for exceedance requirements which would ensure that the masterplan can cope with extreme rainfall events exceeding the proposed design standard, allowing for climate change uncertainties.

3.4.12. The Alder Stream is a watercourse that flows through the settlement of Five Oak Green. It is a complex and sensitive watercourse which is not considered to be affected by the proposals for Tudeley Village itself, but there is an opportunity for works to be delivered on land outside the red line boundary of Tudeley Village site that would provide betterment to that area. Additional assessment could be undertaken to evaluate the potential benefits that might be achieved through intervention in the Alder Stream catchment.

Drainage and SuDS

3.4.13. It is best practice to allow enough space at an early stage in the planning process of developments so not to limit the implementation of an integrated and comprehensive SuDS strategy as part of the masterplan, which reflect policy, best practice and the comments of relevant stakeholders during the consultation process. A common rule of thumb is to allow 10 - 15% of developable area for SuDS to facilitate the implementation and maintenance strips required including along watercourses.

3.4.14. A high-level drainage strategy of the Tudeley Village masterplan has already been developed by Brooks Murray Architects on behalf of the applicant (see Figure 3-2). This drainage concept plan includes the provision of green spaces that overlap with potential SuDS areas; swales adjacent to roads and SuDS attenuation basins or ponds. Source control SuDS are indicated to be incorporated within the landscaping areas, such as rain gardens.

[7] https://www.kent.gov.uk/__data/assets/pdf_file/0007/104929/Land-drainage-policy.pdf

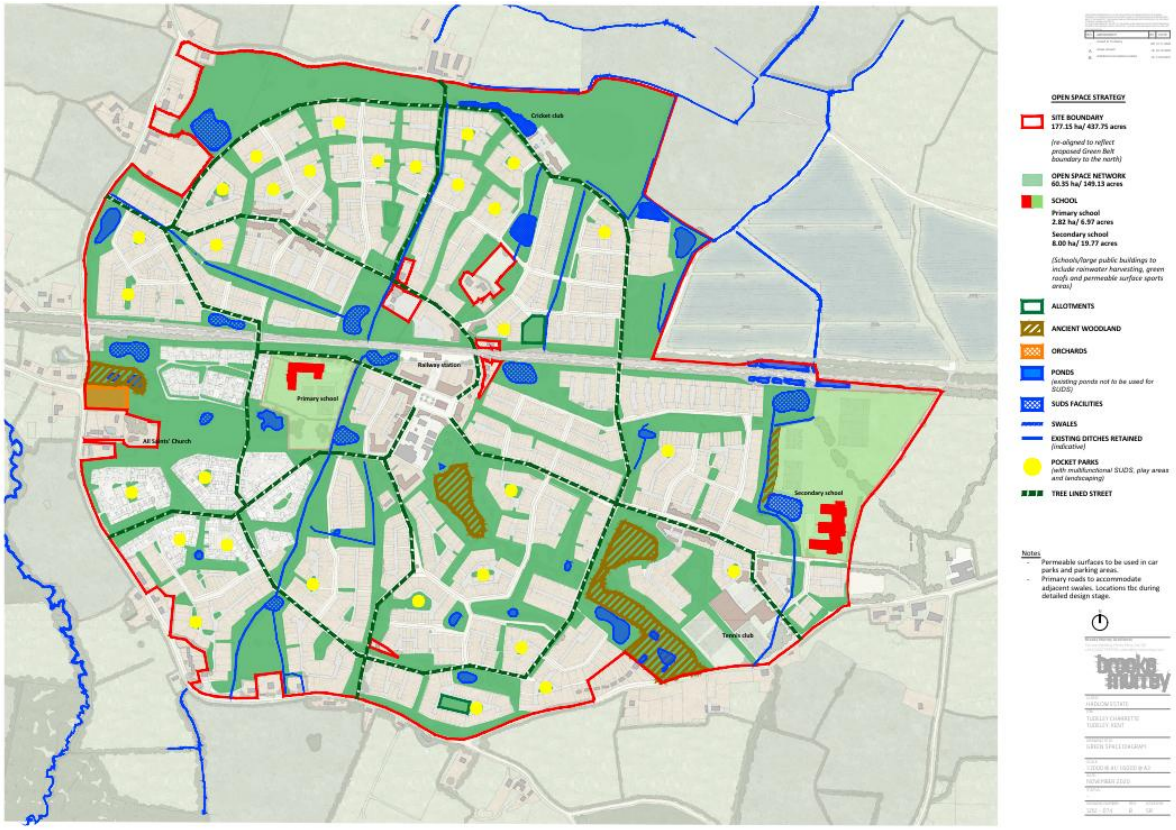

Figure 3-2 - Indicative masterplan with high level concept SuDS shown.

3.4.15. CIRIA SuDS Manual (2015) and policies identify that where infiltration is not feasible due to poor infiltration rates or high groundwater levels, discharge should be directed to a watercourse at pre-development greenfield runoff rates and volumes, or at rates agreed with the EA and / or LLFA.

3.4.16. In the more detailed design process, further intrusive investigations would take place to identify the most appropriate drainage solutions, and this would consider infiltration testing, watercourse walkover surveys in relation to connection to the wider network and further investigation of groundwater levels.

3.4.17. The detailed drainage proposals will be able to consider SuDS elements such as

- Water reuse including rainwater harvesting where practical. There are school, large commercial and allotment uses being proposed at Tudeley Village which may be able to deliverrainwater harvesting.
- Source control SuDS including green roofs on commercial areas, bioretention areas e.g. raingardens or tree pits as part of the landscaping on large avenues and public realm spaces identified in Figure 3-2 with the potential for permeable surfaces in sports areas and public realm spaces.
- Surface water conveyance networks that enhance biodiversity such as planted swales or planted filter trenches, along the road network. These can link and integrate into existing blue (watercourse) and green (woodland) corridors.
- Attenuation systems such permanently wet ponds or wetlands and dry basins.

- Identification of multifunctional areas such as small pocket parks combining SuDS (water quantity and quality management), biodiversity (planted areas) and amenity areas (seating or small informal play spaces). See Figure 3-2.

Phasing of the development can ensure that the drainage strategy can be implemented appropriately.

4 SUMMARY

4.1.1. WSP was commissioned to review readily available existing and additional new information related to flood risk and drainage for the Tudeley Village masterplan. The site is near Tudeley, Tunbridge Wells, Kent and has been put forward for inclusion within the Tunbridge Wells Borough Council Local Plan (ref: CA1). It is 177.15 ha in size and comprises of a proposed mixed-use development of residential, commercial, primary and secondary school, allotment and open space uses.

4.1.2. Flood risk is a key consideration in developing a suitable masterplan for the site but it is considered that the site can be developed as a safe and sustainable development as the majority of land contained within it is not at risk of fluvial and surface water flooding. The limited area of floodplain associated with the River Medway is capable of being avoided other than for green open spaces and water compatible uses.

4.1.3. A comprehensive surface water drainage strategy optimising the use of SuDS can be delivered which will ensure that the development would not cause any increase in the rate of runoff offsite downstream. In fact, opportunities exist to improve and protect the existing green and blue infrastructure as part of the SuDS design.

4.1.4. The Green Space Plan (Appendix D), provided by Brooks Murray Architects, illustrates where flood management is currently envisaged within the overarching strategic masterplan. It identifies green corridors alongside existing watercourse and locations for SuDS.

4.1.5. Hadlow Estates is a longstanding local landowner and controls a significant amount of land outside the Tudeley Village development boundary. The Estate is keenly aware of existing flooding issues within neighbouring communities. Development at Tudeley Village will not affect those communities, but there is a potential opportunity to provide betterment to those communities by strategic interventions which can be put in place within the upstream catchment of the Alder Stream to help reduce flood risk to downstream.

Appendix A

WSP - WSP OPPORTUNITIES AND CONSTRAINTS TECHNICAL NOTE (21 OCT 2019)

Hadlow Estates

OPPORTUNITIES AND CONSTRAINTS

Technical Note

40076-OAC-001
MARCH 2019

CONFIDENTIAL

Hadlow Estates

OPPORTUNITIES AND CONSTRAINTS

Technical Note

REPORT: CONFIDENTIAL

PROJECT NO. 70040076

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CONTENTS

1 INTRODUCTION 1

2 POLICY AND GUIDANCE 3

2.1 NATIONAL PLANNING POLICY / GUIDANCE 3
2.2 REGIONAL GUIDANCE 4
2.3 LOCAL POLICY 5
2.4 LOCAL GUIDANCE 5

3 CURRENT HYDROLOGICAL REGIME 7

3.1 RIVER MEDWAY, ALDER AND SURFACE WATER FLOW ROUTES 7
3.2 SITE GREENFIELD RUNOFF RATES 7

4 SITE GEOLOGY 9

5 NATURAL FLOOD MANAGEMENT STATUS QUO 10

5.1 IMPACTS OF AFFORESTATION ON SURFACE WATER RUNOFF 10

6 SUB-CATCHMENT CHARACTERISTICS, OPTIONS AND ASSESSMENT 11

6.1 GREENFIELD RUNOFF RATES FOR OPTION CATCHMENTS 11
6.2 OPTION CATCHMENT 1 11
6.1 OPTION CATCHMENT 2 11
6.2 OPTION CATCHMENT 3 12
6.3 OPTION CATCHMENT 4 12
6.4 OPTION CATCHMENT 5 13

7 CONCLUSION 14

APPENDICES

APPENDIX A

SITE LOCATION PLAN

APPENDIX B

CATCHMENT MAPPING

APPENDIX C

HYDROLOGICAL ESTIMATES

APPENDIX D

GEOLOGY

1 INTRODUCTION

APPOINTMENT AND BRIEF

1.1.1. WSP was commissioned to provide a technical note on flood risk and surface water drainage matters, with a focus on considering flood reduction and attenuation using Sustainable Urban Drainage Systems (SuDS) and Natural Flood Management (NFM) solutions. The main purpose of the study is to establish where the implementation of SuDS and NFM measures might be warranted to free up additional development space.

SITE LOCATION

1.1.2. The site is located on the Hadlow Estate near Tudeley, Tunbridge Wells, Kent (OS Grid Reference TQ 62654 45631). The nearest postcode is TN11 0PQ (refer to Site Location Plan in Appendix A).

SITE SETTING

1.1.3. The site area is approximately 244ha and the current land use is predominantly agricultural, with a railway embankment (South Eastern Main Line) traversing the site. The site is part of the Hadlow Estate, which covers a much more extensive area (refer to Site Location Plan in Appendix A).

1.1.4. The site is bordered by agricultural fields and small residential developments on all sides (Tudeley, Tudeley Hale, Five Oak Green and Crockhurst Street).

1.1.5. The Alder Stream, an Environment Agency Main River crosses the site to the east. An ordinary watercourse (a tributary of the Hammer Dyke) runs along the northern border of the site and joins the River Medway approximately 2km to the northeast. To the west, another ordinary watercourse flows parallel to the site, approximately 200m away from the site boundary.

1.1.6. There are five surface water flow routes traversing the site, out of which one is associated with the River Alder and another one is formed off-site. The rest of the on-site surface water flow paths appear to be locally formed on site.

AIM AND OBJECTIVES

1.1.7. This high-level study aims to investigate the current hydrological regime of the site and determine where strategic SuDS / NFM measures could be located in such a way that they would have an impact on surface water flow paths crossing the site and downstream areas, and help reduce the amount of storage that needs to be provided on site.

1.1.8. A qualitative assessment for several options will be made based on existing local policy aspirations, current scientific knowledge and existing regional hydro-morphology to develop solutions that complement the regional character of the area and are bespoke to each individual sub-catchment.

1.1.9. To achieve this aim, the following objectives have been completed:

- A desk study and data research including review of:
  - The National Planning Policy Framework (NPPF), 2018;
  - The NPPF Flood Risk and Coastal Change Planning Practice Guidance (PPG);
  - Non-statutory technical standards for sustainable drainage systems, DEFRA 2015;
  - The SuDS Manual (CIRIA C753), CIRIA 2015;
  - Building Regulations Approved Document H, 2015;

- River Medway Catchment Flood Management Plan, 2009;
- Tonbridge And Malling Borough Council: Core Strategy (2007)
- Tonbridge and Malling Borough Council: Strategic Flood Risk Assessment (SFRA); 2016
- Kent County Council: Preliminary Flood Risk Assessment (PFRA), 2011;
- Kent County Council: Kent's Local Flood Risk Management Strategy (LFRMS), 2017 - 2023;
- Kent County Council: Drainage and Planning Policy Statement, 2017;
- Kent County Council: The Kent Design Guide. Making it Happen – Sustainability (Drainage Systems);
- Water. People. Places, A guide for master planning sustainable drainage into developments, 2013; and

- A desk review of scientific reports on and current understanding on NFM measures and their impact on catchment hydraulic processes.

1.1.10. The following technical studies have been undertaken to support the evidence base for this assessment:

- An assessment of the opportunities and constraints presented by the water environment to development.
- An estimate of surface water flows based on the current conditions at the site and known existing drainage systems.
- Estimation of post-development surface flows based on the development proposals and attenuation requirements.

2 POLICY AND GUIDANCE

2.1 NATIONAL PLANNING POLICY / GUIDANCE

NATIONAL PLANNING POLICY FRAMEWORK (2018)

2.1.1. The National Planning Policy Framework (NPPF) requires a Flood Risk Assessment (FRA) should be undertaken:

- For all developments greater than 1 Hectare (ha) in size in Flood Zone 1;
- All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has a critical drainage problem; and,
- Where proposed development or a change of use (e.g. from commercial to residential) to a more vulnerable class may be subject to other sources of flooding (e.g. surface water drains, reservoirs).

2.1.2. The NPPF also requires development to be allocated towards areas at lowest risk of flooding (The Sequential Test), and if necessary the development proposals would be subject to satisfying the requirements of the Exception Test.

FLOOD RISK AND COASTAL CHANGE PLANNING GUIDANCE

2.1.3. The NPPF is supported by the National Planning Practice Guidance (PPG). The Flood Risk and Coastal Change PPG states that an FRA must outline the following:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere; and
- whether the measures proposed to deal with these effects and risks are appropriate.

2.1.4. Within Table 2 (Flood Risk Vulnerability Classification) of the NPPF and the Flood Risk and Coastal Change Planning Practice Guidance (PPG), the Proposed Development would be likely be classified as ‘More Vulnerable’ (i.e. Residential).

2.1.5. Table 3 (Flood Risk Vulnerability and Flood Zone Compatibility) of the PPG, states that More Vulnerable development is appropriate in Flood Zones 1 and 2. The Proposed Development would be required satisfy the requirements of the Exception Test in order for More Vulnerable development to be located within Flood Zone 3.

NON-STATUTORY SUSTAINABLE DRAINAGE TECHNICAL STANDARDS (MARCH 2015)

2.1.6. The non-statutory sustainable drainage technical standards document sets out the technical standards for sustainable drainage systems (SuDS).

2.1.7. The standards state that for greenfield developments the peak runoff rate from the development to any highway drain, sewer or surface water body should never exceed the peak greenfield runoff rate for the same event.

2.1.8. For greenfield developments, where reasonably practicable, the runoff volume from the development to any highway drain, sewer or surface water body should not exceed the greenfield runoff volume for the event that has a 1% chance of occurring in any given year. If this is not practical, the runoff volume must be discharged at a rate that does not increase flood risk.

2.1.9. The drainage system must be designed so that unless an area is designated to hold and/or convey water as part of the design:

- flooding does not occur on any part of the site for events up to and including rainfall events with a 3.3% chance of occurring in any given year and
- flooding does not occur during rainfall events with a 1% chance of occurring in any given year, in any part of a building or utility plant susceptible to water.

2.1.10. The design of the site must ensure that where reasonably practicable flows resulting from a rainfall in excess of a 1% annual probability rainfall event are managed in exceedance routes that minimise risks to people and property.

2.1.11. Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

2.1.12. The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the system. Any drainage which does occur must be minimised and restricted before the drainage system is classified as complete.

BUILDING REGULATIONS APPROVED DOCUMENT H (UPDATED 2015)

2.1.13. Part H of the Buildings Regulations: Drainage and Waste Disposal, establishes a hierarchy for surface water disposal, which encourages a SuDS approach. The hierarchy stipulates that surface runoff not collected for reuse must be discharged to one or more of the following in order of priority:

- Discharge into the ground (infiltration); or, where not reasonably practicable,
- Discharge to a surface water body; or, where not reasonably practicable,
- Discharge to a surface water sewer, highway drain, or another drainage system; or, where not reasonably practicable,
- Discharge to a combined sewer.

2.2 REGIONAL GUIDANCE

RIVER MEDWAY CATCHMENT FLOOD MANAGEMENT PLAN, 2009;

2.2.1. The River Medway Catchment Flood Management Plan (CFMP) was published in December 2009 by the Environment Agency and sets out the flood risks, the sources of these risks and any associated concerns or issues in the River Medway catchment from rivers, groundwater and surface water. The CFMP establishes a number of flood risk management policies which will deliver sustainable flood risk management for the long term.

2.2.2. The site falls into sub-area 1 of the CFMP ‘Upper Catchment’ where the most significant flood risk in this unit is from the river. Currently, 157 properties are at risk from the 1 in 100 year flood event.

2.2.3. In sub-area 1 the preferred policy option is Policy 3, “areas of low to moderate flood risk where we are generally managing existing flood risk effectively”. This policy will tend to be applied where the risks are currently appropriately managed and where the risk of flooding is not expected to increase significantly in the future. However, we keep our approach under review, looking for improvements and responding to new challenges or information as they emerge. We may review our approach to managing flood defences and other flood risk management actions, to ensure that we are managing efficiently and taking the best approach to managing flood risk in the longer term.

2.2.4. Actions specific to the area in which the Site is located are:

- Undertake System Action Management Plans (SAMPs) to review maintenance regimes and to maintain current level of investment.
- Work towards improving the flood warning service, Floodline Warnings Direct. Improve the accuracy of real-time flood warnings by assisting the development of our National Flood Forecasting System.
- Investigate opportunities to work with landowners to create wetland habitat (link to Regional Habitat Creation Programme).
- Implement the outcomes of the Middle Medway strategy, such as investigating schemes for Forest Row, Five Oak Green and Little Mill.
- Influence the development of emergency response plans.

2.3 LOCAL POLICY

TONBRIDGE AND MALLING BOROUGH COUNCIL: CORE STRATEGY (2007)

2.3.1. Tonbridge and Malling Borough Council adopted their Core Strategy in September 2007, which identifies that a significant area of the Borough lies in the River Medway floodplain. The Core Strategy recognises the importance of flood protection and defences in mitigating this risk for existing and future development sites.

2.3.2. Policy CP10 1 states:

- Within the floodplain, development should first seek to make use of areas at no or low risk of flooding before areas at higher risk, where this is possible and compatible with other policies aimed at achieving a sustainable pattern of development.
- Development which is acceptable or otherwise exceptionally justified within areas at risk of flooding must:
  - Be subject to a flood risk assessment;
  - Include an appropriately safe means of escape above flood levels anticipated during the lifetime of the development; and
  - Be designed and controlled to mitigate the effects of flooding on the site and the potential impact of the development on flooding elsewhere in the floodplain.

2.4 LOCAL GUIDANCE

KENT COUNTY COUNCIL: TONBRIDGE AND MALLING BOROUGH COUNCIL: STRATEGIC FLOOD RISK ASSESSMENT (SFRA) (2016)

2.4.1. The 2016 Tonbridge and Malling Borough Strategic Flood Risk Assessment (SFRA) replaces the Level 1 SFRA published in 2006 and updated in February 2011. It provides supporting evidence for the emerging local plan.

KENT COUNTY COUNCIL: PRELIMINARY FLOOD RISK ASSESSMENT (PFRA) (2011)

2.4.2. The Kent County Council Preliminary Flood Risk Assessment (PFRA) was published by the Council in September 2011 to provide a high-level overview of the flood risk within the County and to identify areas of significant flood risk that needed to be investigated further.

KENT COUNTY COUNCIL: KENT LOCAL FLOOD RISK MANAGEMENT STRATEGY (LFRMS) (2017-2023)

2.4.3. The strategy sets out the roles and responsibilities of flood risk management partners within the County, highlighting the position of the County Council as the Lead Local Flood Authority under the Flood and Water Management Act 2010.

2.4.4. Groundwater presents a significant source of flooding in parts of Kent as there are large areas of permeable aquifers, particularly the chalk aquifers of the North Downs. Groundwater flooding occurs in a number of areas across the North Downs, most notably along the Nailbourne Valley.

KENT COUNTY COUNCIL: DRAINAGE AND PLANNING POLICY STATEMENT (2017)

2.4.5. This policy statement sets out how Kent County Council, as Lead Local Flood Authority and statutory consultee, will review drainage strategies and surface water management provisions associated with applications for major development.

2.4.6. The LLFA's Drainage and Planning Policy Statement outlines KCC's requirements for the development of drainage strategies prepared in support of development proposals.

2.4.7. The guidance reiterates the importance of pre-application consultation with the LLFA to ensure that any issues are addressed at an early stage. If the submitted application does not comply with the non-statutory technical standards and/or NPPF, Kent County Council may object the application.

2.4.8. Drainage schemes should be designed to match greenfield discharge rates, volumes and follow natural drainage routes. They should match infiltration rates and discharges as far as possible for all events up to and including the climate change 1 in 100 (1% AEP) design event.

2.4.9. Infiltration rates should be maximised in a drainage scheme wherever possible. The opportunities of infiltration should be utilised even if the underlying soils are relatively impermeable.

KENT COUNTY COUNCIL: THE KENT DESIGN GUIDE. MAKING IT HAPPEN – SUSTAINABILITY (DRAINAGE SYSTEMS)

2.4.10. This document sets out the processes which need to be considered when preparing a drainage design for a development and the specific requirements for drainage of adoptable residential and industrial/commercial roads.

WATER.PEOPLE. PLACES, A GUIDE FOR MASTER PLANNING SUSTAINABLE DRAINAGE INTO DEVELOPMENTS (2013)

2.4.11. This guidance is listed within the *Drainage and Planning Policy Statement* as an essential document to reference. This guidance outlines the processes for integrating sustainable drainage systems (SuDS) into the master planning of large and small developments.

3 CURRENT HYDROLOGICAL REGIME

3.1 RIVER MEDWAY, ALDER AND SURFACE WATER FLOW ROUTES

3.1.1. The site is located south of the River Medway, bordering on the fringe of Flood Zones 2 and 3. Flood Zones 2 & 3 cover approximately 30ha (Flood Zone 3) and 48ha (Flood Zone 2) respectively.

3.1.2. Topographically, the site falls from south to north towards the River Medway. A surface water catchment mapping exercise covering Hadlow Estate reveals there are multiple surface water catchments on the estate, some of which may suitable for NFM measures to reduce discharge during pluvial events to the Medway River, and hence improving the regional catchment's water retention properties. The surface water catchment where options were considered are numbered Watershed 1 to 5 (refer to figure 40076-HYD-001 in Appendix B).

3.1.3. The surface water catchments fall naturally from the topographically high areas of the south towards the River Medway, some being interrupted by a railway line embankment.

3.1.4. Before exiting the land ownership area, the River Medway drains a catchment area of approximately 700 km^2 out of its total catchment area of 2,400 km^2.

3.1.5. The combined area of all the surface area catchments is approximately 17km^2, representing roughly 2.4% of the River Medway catchment drained to site.

3.1.6. The Environment Agency's (EA) Risk of Flooding from Surface Water (RoFfSW) dataset indicates that there are a number of surface water flow routes crossing the area (see page 5 of WSP Flood Risk Pack in Appendix B). The suitability of the EA's RoFfSW dataset over the ownership area varies between 'Town to Street' and 'County to Town' level in terms of suitability.

3.1.7. 'Town to Street' suitability means that the dataset is suitable for identifying flood extents and approximate depths that are reliable for a local area of land but not for individual properties. 'County to Town' suitability indicates that the dataset is suitable for identifying which parts of towns are at risk and approximate extents, shallower and deeper areas but the dataset is unlikely to be reliable for a local area (refer to figure 40076-SWF-001 in Appendix A).

3.2 SITE GREENFIELD RUNOFF RATES

3.2.1. The site area covers approximately 244ha and is predominantly greenfield, with minor developments interspersing agricultural fields.

3.2.2. Kent County Council (KCC) will generally require the use of the more detailed and up-to date FEH dataset within detailed drainage design submissions. Where FSR data is used to determine the extreme rainfall intensity values for a site, KCC expects FSR/FEH ratios depicted in Appendix 1 of the 'Rainfall runoff management for developments report[1] to be used to adjust the calculated attenuation

[1] (https://www.gov.uk/government/publications/rainfall-runoff-management-for-developments Environment Agency, 2013)

requirements. For a typical present day 6 hour, 100 year rainfall event, the FSR values are around 80-90% of the FEH value. If FEH is unavailable (and unless otherwise calculated), KCC will accept a rainfall depth M5-60 of 26.25 mm to be utilised in appropriate modelling software to account for this variation.

3.2.3. For the purpose of determining the attenuation needed for a proposed development of, say, 3,000 dwellings during an 1% Annual Exceedance Probability (AEP) event, an infiltration rate of 5 x 10^{-3}m/day was assumed (approximately 0.2mm/hr). This corresponds to the upper limit of clay infiltration rates.

3.2.4. Impermeable areas were estimated by assuming a density of 25 dwellings per hectare, and an approximate 65% hardstanding area across the development. Assuming a development size of 3000 dwellings, the total impermeable area is estimated as 78ha.

3.2.5. Table 3-1 below lists the greenfield runoff rates (refer to UK SuDS report in Appendix C) and estimated storage volume required (refer to Micro Drainage Quick Storage Estimates in Appendix C) to attenuate development flows, based on the assumption that overland flows originating from outside the development do not have to be attenuated and can be managed through other methods, such as NFM measures in their respective catchments.

3.2.6. The parameters used in the estimation of unattenuated post development rates are available in Appendix C. The brownfield rates indicate that discharge from the site post development would be roughly 10 times higher than existing greenfield rates.

3.2.7. Without infiltration and assuming 0.5m average depth, the total space needing to be reserved for SuDS is approximately 10-15ha but this will vary depending on the position, size and number of SuDS features, although the option of underground storage in oversized pipes coupled with surface SuDS might present an alternative option.

Table 3-1 – Site Runoff Rates

Event	Greenfield Runoff Rates (GRR) (m^3)	Unattenuated Brownfield rates (m^3) for 15min summer storm (Cv = 0.85)	Average intensity for 15min summer storm (mm/hr)	Storage needed 1% AEP + 40% with infiltration ($5x10^{-3}$) and discharge at GRR (m^3)	Storage needed 1% AEP + 40% without infiltration but with discharge at GRR (m^3)
Qbar	1.0	-	-	-	-
1 in 1 year	0.8	9.81	41.0	13400	13300
1 in 30 year	2.2	24.0	100.3	25500	25500
1 in 100 year	3.1	31.4	131.3	32200	32300
1 in 100 year +20%	3.1	37.7	157.6	41000	41000
1 in 100 year +40%	3.1	44.0	183.9	49900	49900

4 SITE GEOLOGY

4.1.1. The site bedrock geology consists of the Tunbridge Wells sandstone and Wadhurst Clay formations, with some superficial deposits consisting of clay and silt present in north of the railway embankment (refer to figures 40076-BGS-001 and 002 in Appendix D).

4.1.2. Infiltration rates[2] for sandstone bedrock range between $5x10^{-5}$ and $2x10^{1}$ m/day, whereas for clay and silt infiltration rates lie in the region of $5x10^{-7}$ to $5x10^{-3}$ for clay and respectively 10^{-3} to 10^{-1} for silt.

4.1.3. Infiltration rates are likely to vary considerably across the site and the rates presented above are indicative only. Infiltration rates should be verified by a BRE365 compliant intrusive ground investigation for the purpose of designing a drainage strategy.

[2] http://nora.nerc.ac.uk/id/eprint/7457/1/CR06160N.pdf

5 NATURAL FLOOD MANAGEMENT STATUS QUO

5.1 IMPACTS OF AFFORESTATION ON SURFACE WATER RUNOFF

5.1.1. A systematic review of the evidence available is not currently available, hence there is no "off the shelf" approach to upland catchment management and any solution needs to be tailored to the particular environment of the catchment. It is unlikely that any one method will work to the same extent everywhere. The main reason for the absence of the aforementioned systematic review of evidence is that there is very little published scientific evidence that changes in the way uplands are managed will reduce the flood impact during extreme events but the evidence that does exist is positive.

5.1.2. Based on the few studies that are available, the challenge of using NFM is one of scale and magnitude. Land use management is shown to have an impact on flood peak and attenuation capacity of a basin and should work for lower return period (RP) events in small catchments, however it is important to understand that a regional level generalization cannot be made from the studies available. Based on the studies done so far, the conclusion is that NFM has an impact on lower return period events but not on the more extreme events although it will impact on the catchment antecedent conditions.

5.1.3. The Centre for Ecology and Hydrology (CEH) carried out experiments to determine the impact of afforestation on infiltration rates in Pontbren, Wales. The results indicate that infiltration in forested areas is around 60 times more than in grassland; however, the results should be interpreted with care.

5.1.4. Forest planting is useful as it mitigates diffuse pollution and enhances the hydraulic properties of soil, lowering runoff compared to soils of other vegetation types. Ignoring the difference between runoff generation on fields with sycamore or pine. Surface runoff is extremely rare in forested areas, whereas on a grazing field, an event comparable to the 1 in 2 year storm will produce surface runoff[3]. NFM solutions should be quantified not just on flood risk benefit, but also on ecological enhancement, habitat creation and pollution mitigation factors.

5.1.5. Planting trees can reduce flood risk in some cases[4], but a high intensity forest land use, such as grazing, could counteract any positive effect of trees. When rainfall exceeds the rate at which water can enter the soil it flows rapidly over the land's surface into streams and rivers. Trees can help to reduce the risk of surface runoff by increasing the number of large pores in the soil through which water can drain more easily. Land use, such as grazing, also affects the soil's structure and its ability to absorb water but less is known about the effect of this land use in forests compared to grasslands where it has been well studied.

[3] http://nora.nerc.ac.uk/id/eprint/517993/
[4] https://www.ceh.ac.uk/news-and-media/news/forest-grazing-counteracts-effectiveness-trees-reduce-flood-risk

6 SUB-CATCHMENT CHARACTERISTICS, OPTIONS AND ASSESSMENT

6.1 GREENFIELD RUNOFF RATES FOR OPTION CATCHMENTS

6.1.1. Table 6-1 below gives an estimate of the Greenfield Runoff Rate (GRR) for the surrounding catchments. The proposed solutions have been qualitatively rated against these values.

Table 6-1 - Greenfield Runoff Estimates for Option Catchments

Catchment	1	2	3	4	5
Area (ha)	666	284	228	247	234
GRR (m^3)	8.46	3.61	2.90	3.14	2.97

6.2 OPTION CATCHMENT 1

6.2.1. Catchment 1 (refer to figure 40076-HYD-101 in Appendix B) has an area of 6.7km^2. The catchment includes the Alder Stream which appears to be controlled at Old Church Road by an artificial lake. Alder Stream flows through Five Oak Green, under the railway embankment and through the Proposed Development site near Moat Farm.

6.2.2. On site, the Alder Stream's flood zones 2 and 3 extents coincide, however from available datasets, it is not possible to establish where the River Medway floodplain ends and the Alder Stream floodplain begins.

6.2.3. Although the area is outside the boundary of the client controlled land, a series of improvements along this riverine corridor and could provide a benefit to the residents of Five Oak Green whilst freeing up additional development space on site by reducing both the extent of on-site floodplain and reducing the amount of floodplain compensation required.

6.2.4. Possible improvements along this riverine corridor might consist of debris dams and impoundments which would force flooding to occur on agricultural land and upland woodlands, thereby alleviating risk to the residents of Five Oak Green. The main mechanism of flooding in Five Oak Green appears to be the Alder Stream overtopping its bank and water ponding against the railway embankment. It is concluded that NFM measures in this catchment may provide a benefit to people and property in Five Oak Green.

6.2.5. The suitability of the RoFfSW dataset for most of this catchment is 'Town to Street' suitability means that the dataset is suitable for identifying flood extents and approximate depths that are reliable for a local area of land.

6.2.6. Any assessment of floodplain reduction for this catchment should consider hydraulic modelling of the Alder Stream and its floodplain.

6.1 OPTION CATCHMENT 2

6.1.1. Catchment 2 (refer to figure 40076-HYD-102 in Appendix B) has an area of 2.5km^2. The RoFfSW dataset indicates that a surface water flow route forms in this catchment and makes its way to Hammer

Dyke across the site. The drainage path length for the surface water flow route is approximately 3.7km from the upmost point of the catchment to where it discharges into Hammer Dyke.

6.1.2. The catchment uplands starting at Alders Road boasts extensive woodland, covering the first 1.8km of the surface water flow route drainage path length.

6.1.3. The introduction of NFM features such as leaky dams and debris dams here would force water to disperse onto the forest floor and infiltrate rather than coalesce into a stream, thereby increasing the retention time of the catchment.

6.1.4. Additionally, creating an online storage area upstream of the Five Oak Green Road (B2017, near the George and Dragon Cottage) with a controlled outflow could eliminate the surface water flow route from the site, reducing the amount of storage required on site and freeing up additional development space.

6.1.5. Additional features within this catchment such as NFM or SuDS for interception, conveyance and attenuation could be deployed to alleviate flooding problems for Five Oak Green Road (B2017) and adjacent properties.

6.1.6. The catchment area upstream of the site is approximately 1.8km^2 a corresponding GRR rate of 2.28m^3/s for the 1%AEP event. Reducing this to 0.28m^3/s would allow the development to increase discharge rates from 3.1m^3/s (refer to Table 3-1) to 5.1m^3/s effectively reducing the required storage from 49,900m^3 to 42,700m^3 for a 1% AEP +40% climate change event.

6.2 OPTION CATCHMENT 3

6.2.1. Catchment 3 (refer to figure 40076-HYD-103 in Appendix B) has an area of 2.8km^2. The catchment includes an ordinary watercourse which flows west of Tudeley and discharges to the River Medway upstream of Porter's Lock. The watercourse is unnamed and is possibly a simple ditch draining the adjacent agricultural land. Increasing the retention time of water in this catchment via the introduction of NFM measures should have beneficial impacts on the River Medway by reducing nutrient rich runoff entering the stream.

6.2.2. The upstream part of the catchment is forested and the discharge rate is controlled by the watercourse crossing underneath the railway embankment. The estimated GRR for this catchment is approximately 2.9m^3/s.

6.2.3. The option here would be to develop a flood storage area upstream of the railway embankment which could reduce overall surface water runoff to the River Medway by approximately 2.5m^3/s. This would allow an increase in flow from the proposed development from 3.1m^3/s (refer to Table 3-1) to 5.6m^3/s, providing a reduction in the attenuation volume required (e.g. from 49,900m^3 to 41,300m^3 for a 1% AEP +40% climate change event). The flood storage area could also be used as a water harvesting system for the area.

6.3 OPTION CATCHMENT 4

6.3.1. Catchment 4 (refer to figure 40076-HYD-104 in Appendix B) has an area of 2.3km^2. The catchment sits on the downstream end of a watercourse draining 13.5km^2 of both urban and agricultural land upstream of the A21.

6.3.2. It is unlikely that any NFM measures would be successful in reducing peak flood flows for this catchment and the option most likely to successfully reduce flood risk to south east Tonbridge and

River Medway would be the upgrade of the unnamed pond in Somerville Park to a full flood storage reservoir.

6.4 OPTION CATCHMENT 5

6.4.1. Catchment 5 (refer to figure 40076-HYD-105 in Appendix B) has an area of 2.3km^2 and drains agricultural land to the River Medway. The catchment has a significant surface water flow route which contributes directly to the River Medway flood risk status as well as diffuse agricultural pollution.

6.4.2. It may be possible to implement NFM measures in the form of afforestation and retention ponds to reduce the GRR from approximately 3m^3/s to approximately 0.5m^3/s. This would significantly increase the water retention capacity of the catchment and reduce diffuse agricultural pollution input into the River Medway from this catchment. The runoff reduction would also make a contribution towards flood risk reduction along the River Medway corridor, albeit a modest one.

6.4.3. This would allow an increase in flow from the proposed development from 3.1m^3/s (refer to Table 3-1) to 5.6m^3/s, providing a reduction in the attenuation volume required (e.g. from 49,900m^3 to 41,300m^3 for a 1% AEP +40% climate change event).

7 CONCLUSION

7.1.1. WSP was commissioned to provide a technical note on flood risk and surface water drainage matters, with a focus on considering flood reduction and attenuation using Sustainable Urban Drainage Systems (SuDS) and Natural Flood Management (NFM) solutions. The main purpose of the study is to establish where the implementation of SuDS and NFM measures might be warranted to free up additional development space.

7.1.2. The site is located on Hadlow Estate near Tudeley, Tunbridge Wells, Kent (OS Grid Reference TQ 62654 45631). The nearest postcode is TN11 0PQ (refer to Site Location Plan in Appendix A).

7.1.3. The site area is approximately 244ha and the current land use is predominantly agricultural, with a railway embankment (South Eastern Main Line) traversing the site roughly through the middle. The site is part of Hadlow Estate, covering a much more extensive area (refer to Site Location Plan in Appendix A).

7.1.4. The Alder Stream, an EA Main River crosses the site to the east. An ordinary watercourse (a tributary of the Hammer Dyke) runs along the northern border of the site and joins the River Medway approximately 2km to the northeast. To the west, an ordinary watercourse flows parallel to the site, approximately 200m away from the site boundary.

7.1.5. The site is located south of the River Medway, bordering areas of Flood Zones 2 and 3. Flood zones encroach the site by 30ha (Flood zone 3) and 48ha (Flood zone 2) respectively.

7.1.6. There are five surface water flow routes traversing the site, out of which one is associated with the River Alder and another one is formed off-site. The rest of the on-site surface water flow paths appear to be locally formed on site. The datasets are considered reliable for the purpose of this study.

7.1.7. The combined area of all the surface area catchments is approximately 17km^2, representing roughly 2.4% of the River Medway catchment drained to site.

7.1.8. The site area covers approximately 244ha and is predominantly greenfield, with minor developments interspersing agricultural fields.

7.1.9. Impermeable areas were calculated by assuming a density of 25 dwellings per hectare, including associated infrastructure of which only 65% is assumed to be hardstanding areas. Assuming a number of 3000 dwellings, the total impermeable area is calculated as 78ha. Based on Micro Drainage quick storage estimates, the total volume of water required to be stored for a 1%AEP +40% climate change event is 49,900m^3 which can be reduced to 41,300 m^3 – 42,700m^3 by providing attenuation outside the boundary of the Proposed Development Site.

7.1.10. Apart from providing attenuation outside the development area, other options consist of providing floodplain compensation in other parts of the ownership boundary or moving the proposed development to areas that are not within a flood zone encroachment zone.

7.1.11. Based on the estimated residential dwelling density of 25 dwellings per hectare and the area extent of the site that is not subject to risk of flooding either from surface of fluvial flows and free from any other environmental constrains (e.g. Ancient woodland) there is currently enough space to deliver the estimated 3000 dwellings on site, including 20ha of space that can be reserved for SuDS and other open space.

Appendix A

SITE LOCATION PLAN

KEY:

- Proposal Site Boundary
- Client Ownership Area
- Location Point

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	26/02/19	OB	FIRST ISSUE	MQ	BV

STATUS:

FOR INFORMATION ONLY

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CLIENT:

HADLOW ESTATE

ARCHITECT:

-

PROJECT:

HADLOW, TONBRIDGE

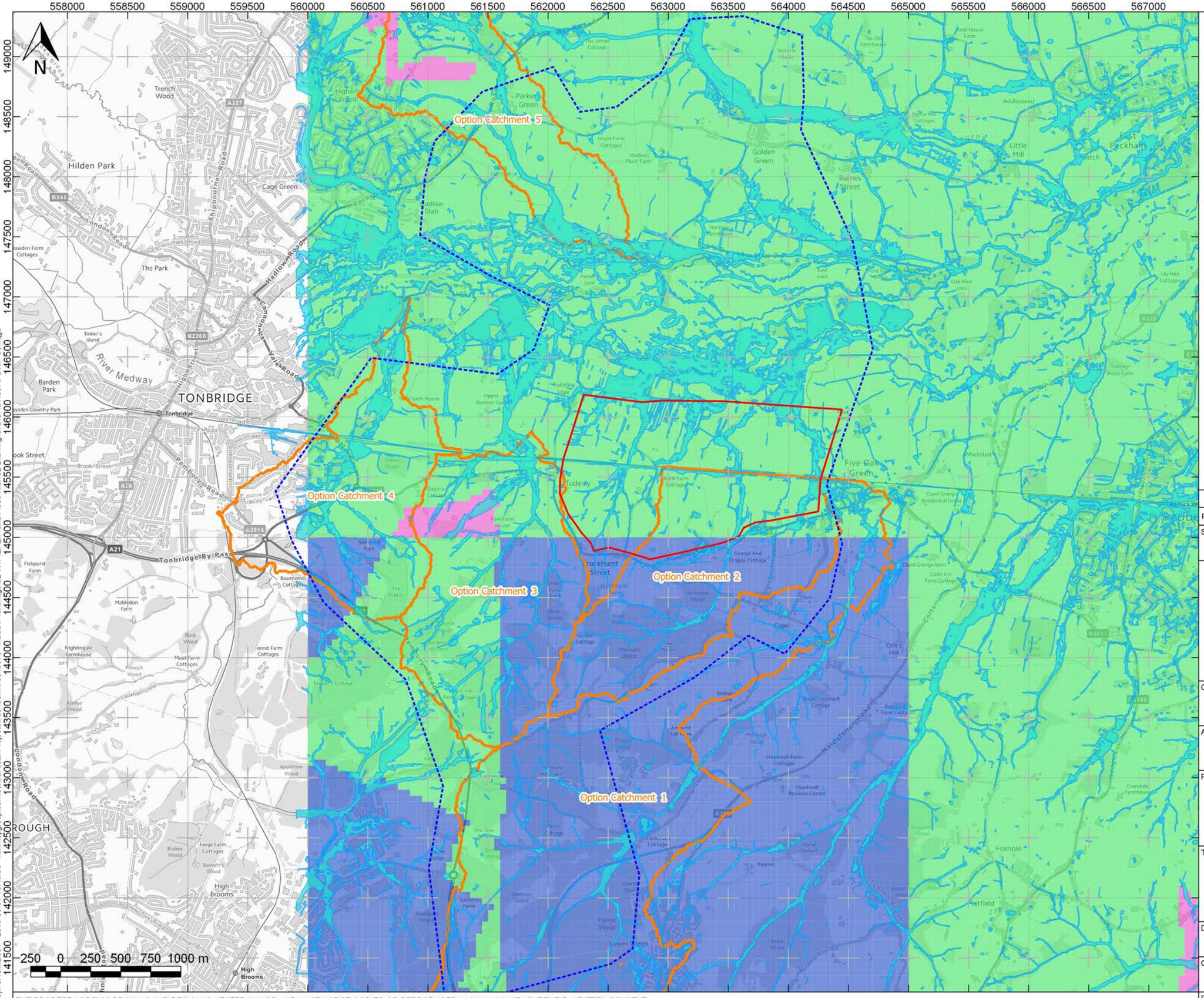
TITLE:

SITE LOCATION PLAN

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
40076-LOC-002.qgs	1:35,000	26/02/19

PROJECT No:	DRAWING No:	REV:
70040076	40076-LOC-002	A



KEY:

- Ownership Boundary
- Site Boundary
- Catchment Management Options

RoFSW Suitability

- National to County
- County to Town
- Town to Street

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	01/03/19	OB	FIRST ISSUE	MQ	MQ

STATUS: FOR INFORMATION ONLY

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CLIENT: HADLOW ESTATES

ARCHITECT: -

PROJECT: HADLOW, TONBRIDGE

TITLE: RISK OF FLOODING FROM SURFACE WATER DATASET SUITABILITY

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
40076-SWF-001.qgs	1:30,000	01/03/19

PROJECT No:	DRAWING No:	REV:
70040076	40076-SWF-001	A

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