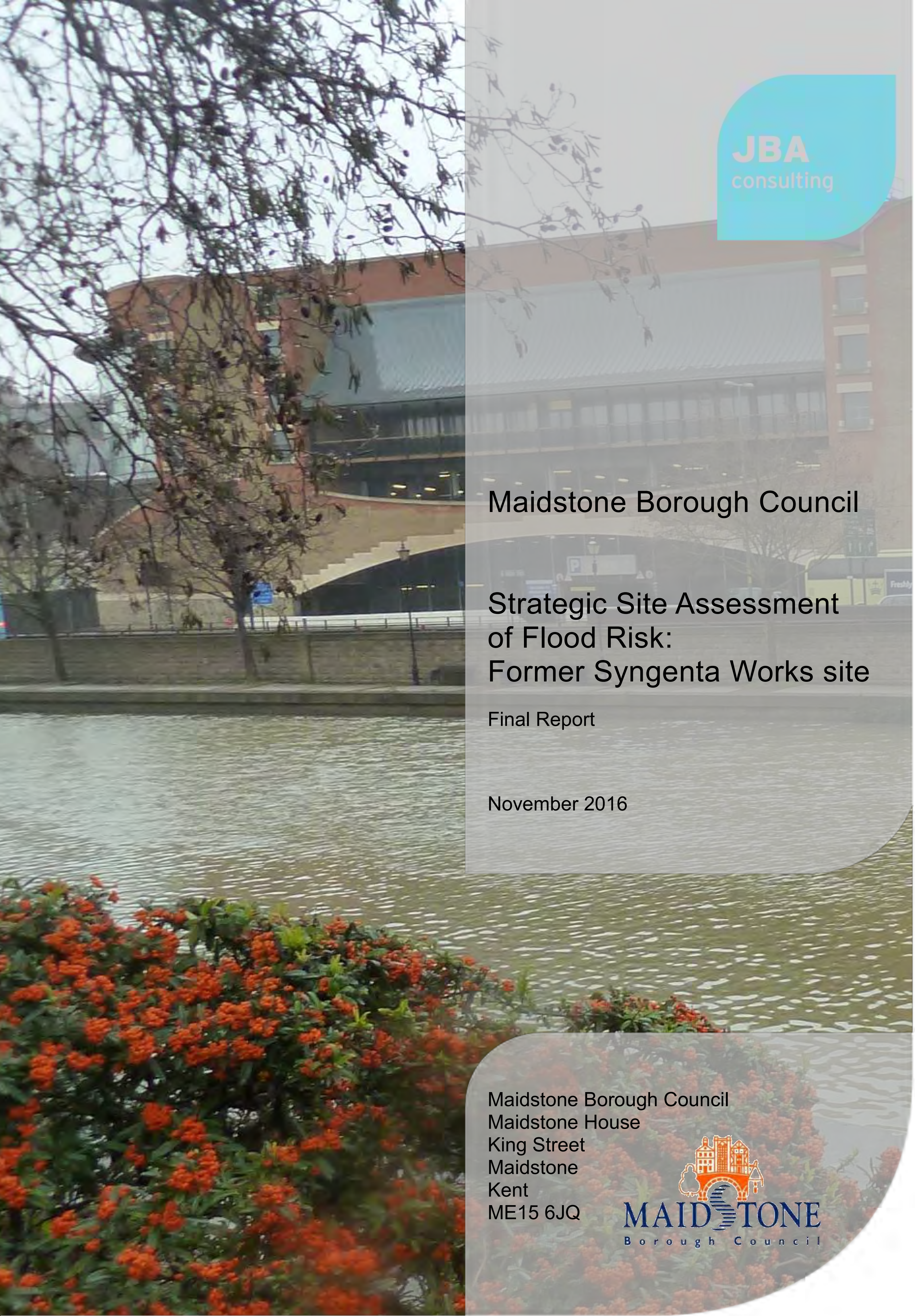

JBA consulting

Maidstone Borough Council

Strategic Site Assessment of Flood Risk: Former Syngenta Works site

Final Report

November 2016

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1 / August 2016	Sections 1-5 only	Cheryl Parks (Maidstone Borough Council)
Draft v2 / October 2016	Full draft report	Cheryl Parks (Maidstone Borough Council)
Draft v3/ October 2016	Updates made following final comments received from the Environment Agency on 19 October 2016	Cheryl Parks and Adam Reynolds (Maidstone Borough Council)
Final v4/ November 2016	Updates made following final comments received from Maidstone Borough Council on 11 November 2016	Cheryl Parks and Adam Reynolds (Maidstone Borough Council)

Contract

This report describes work commissioned by Maidstone Borough Council. The Council's representative for the contract was Cheryl Parks. Georgina Latus and Ben Gibson of JBA Consulting carried out this work.

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Purpose

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Executive Summary

Objectives of the study

JBA Consulting was commissioned to prepare analysis assessing strategic flood risk management approaches at the former Syngenta Works site, Hampstead Lane, Yalding within Maidstone Borough.

The principal objective of the study was to assess whether there are practical potential flood risk management approaches to enable development to be safely implemented at the site. This information will provide Maidstone Borough Council with evidence that allows them to make an informed decision on whether the allocation at the site is appropriate, whether further evidence should be prepared and the likely scope of the measures required.

Assessment approach

The analysis investigated current levels of flood risk at the site, the proposed development type and possible flood risk management options to potentially reduce flood risk. Following initial consideration of a larger number of potential approaches, three strategic flood risk management approaches were considered in greater detail: 1) defences, 2) land raising and 3) channel modification. Each of the three approaches was assessed against five performance measures: a) potential effectiveness of scheme at reducing flood risk, b) comparative cost (including cost of mitigation requirements), c) constraints to implementing the potential flood risk management approach, d) potential requirement for mitigation measures and e) potential to manage residual flood risk after the flood risk management option has been implemented.

Land raising was initially recommended as the strategic flood risk management approach to reduce flood risk at the site and initial assessments prepared to understand the implications.

Maidstone Borough Council subsequently requested that further testing of alternatives was performed using the hydraulic model for the site. This testing assessed the effects of implementing undercroft garaging at ground level, with residential development located on floor levels raised above the peak flood levels. Under this approach it is considered that there would be prohibition by condition of any residential accommodation at ground level.

Using existing flood risk models available for the River Medway made available by the Environment Agency, hydraulic modelling was completed for the site for the pre-development and indicative development scenario and the predicted flood risk compared. This was conducted for the 1% AEP and 1% AEP plus climate change (+35% flows) undefended case events.

The undefended case represents a scenario in which Leigh Flood Storage Area (FSA) is absent from the catchment and flood flows are not attenuated by the storage area. This approach was taken as the initial focus for the study was on strategic flood risk management solutions and therefore the zoning (location of Flood Zones, particularly Flood Zone 3a) of land was of importance.

It is expected that a site-specific development application would consider the actual risk, represented by the defended case scenario (in which Leigh FSA is present). Given the locations of the site within the River Medway catchment, the reduction in flood risk provided by the presence of Leigh FSA is expected to be relatively small. Nonetheless, the flood risk predictions presented in the undefended case are likely to be more conservative (larger) than the defended case event. The outcomes of the development testing (summarised in the report) are expected to be consistent regardless of whether the defended or undefended case are tested.

In addition to testing undercroft garaging, the model representation also considered inclusion of employment land at the west of the site, raised roads within the site (with culverts through these) and a conceptual 'safe' access and egress route north of the site.

Results

The assessment of the indicative development layout gave results that predicted an increase in flood risk to the south, west and east of the site. At the site, increases to peak flood depths of 0.03-0.04m are predicted. Immediately south of the site, flood depths increase by 0.01-0.02m, and in the wider areas flood depths of up to 0.01m are predicted. It is expected that increased flooding results from reduced conveyance through the site, brought about by the presence of the raised roads that are in place to provide safe access. Whilst some culverts were implemented in the road embankments to convey flood water northwards and away from the site, a constriction to flow is still apparent.

The provision of safe access and egress is an important consideration. At the site a conceptual access/egress route was tested, which remains dry for the majority of its length, and where flooding is predicted, has a very low hazard rating. This route is located on third party land and makes use of existing infrastructure, making it particularly important to ensure that the access/egress route schematised is feasible at the planning application stage.

Recommendations

Recommendations based on the results of the analysis prepared largely relate to progressing proposed development forms in greater detail to explore whether there are supplementary measures that could mitigate potential adverse effects.

At the planning application stage, the council should also satisfy themselves that the testing and assessment performed for this study is representative of the future intended development at the site. For instance, if the extent of development changes materially, or the manner in which the development will be implemented is adjusted (e.g. no longer taking forward undercroft garaging), then the suitability of the site for given types of development should be re-assessed.

Specific points to consider relating to future analysis include:

- What shape, size and therefore obstruction, the development will take
- How much floodplain volume is lost due to implementation of aspects of the development (e.g. in the case of undercroft garaging – the columns, pillars and walls which would support the building above) and how this would be compensation on a level for level basis.
- Refining the modelling approach (e.g. model resolution, representation of elements of the scheme) and testing predicted impacts on flood risk for a larger number of events
- How safe access and egress at the site will be achieved and maintained for the lifetime of the development
- How surface water will be managed at the site, particularly given the high levels of fluvial flood risk predicted at the site

Contents

List of Figures

List of Tables

Abbreviations and Glossary of Terms

Term	Definition
AEP	Annual Exceedance Probability
AStGWF	Areas Susceptible to Groundwater Flooding
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRM	Flood Risk Management
Ha	Hectare
JBA	Jeremy Benn Associates Limited
m AOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NPPF	National Planning Policy Framework
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
uFMfSW	Updated Flood Map for Surface Water
WFD	Water Framework Directive

1 Introduction

1.1 Purpose and objectives of analysing strategic flood risk management approaches

This report records the analysis completed in assessing strategic flood risk management approaches at the former Syngenta Works site, Hampstead Lane, Yalding within Maidstone Borough.

The SFRA Addendum document identified flood risk constraints at the site through borough-wide mapping of all sources of flood risk. However, more detailed analysis of flood risk and potential approaches for managing flooding at the site was required. The principal objective of the study was to assess whether there are practical potential flood risk management approaches to enable development to be safely implemented. This information will provide Maidstone Borough Council with evidence that allows them to make an informed decision on whether the current allocation at the site is appropriate, whether further evidence should be prepared and the likely scope of the measures required.

1.2 Site description

The site description is provided in Table 1-1. The site location within Maidstone Borough is shown in Figure 1-1, whilst its setting in a local context is displayed in Figure 1-2.

Table 1-1: Overview information for the site

Site	Area / Parish	Area (ha)	Proposed used	Local Plan allocation reference
Former Syngenta Works, Hampstead Lane, Yalding	Marden and Yalding	13.94	Mixed use	RMX1(4)

1.3 Outputs

This report describes the assessment into current flood risk at the site and the constraints (where present) that this presents to proposed development in the context of National and Local Planning Policy. Existing approaches to managing flood risk within the River Medway catchment are also discussed, and consideration given to how these influence potential flood risk management approaches at the site. The report includes consideration of a preferred ('selected') flood risk management approach based on the outline analysis completed as part of this study. It should be noted that the exercise performed for this study is not a detailed option assessment and that more detailed investigations may identify alternative solutions that are more appropriate. Hydraulic modelling was conducted to support the assessment into the feasibility of the selected approach and the focus has been on the technical performance of the approach assessed.

1.3.1 Structure of the report

The assessment is documented in the following sections:

- Section 1 (this section): Purpose and objectives of the study, overview of the site, outputs from the study and policy considerations for assessment of flood risk at site scale.
- Section 2: Summary of existing flood risk management infrastructure within the borough
- Section 3: Assessment of flood hazards at the site
- Section 4: Assessment of strategic flood risk management approaches at the site
- Section 5: Assessment of the effectiveness of potential flood risk management approaches at the site
- Section 6: Assessment of the selected flood risk management approach at the site
- Section 7: Conclusion and recommendations

Appendix A provides the detailed flood risk summary sheet for the site.

Figure 1-1: Location of the former Syngenta Works site within Maidstone Borough

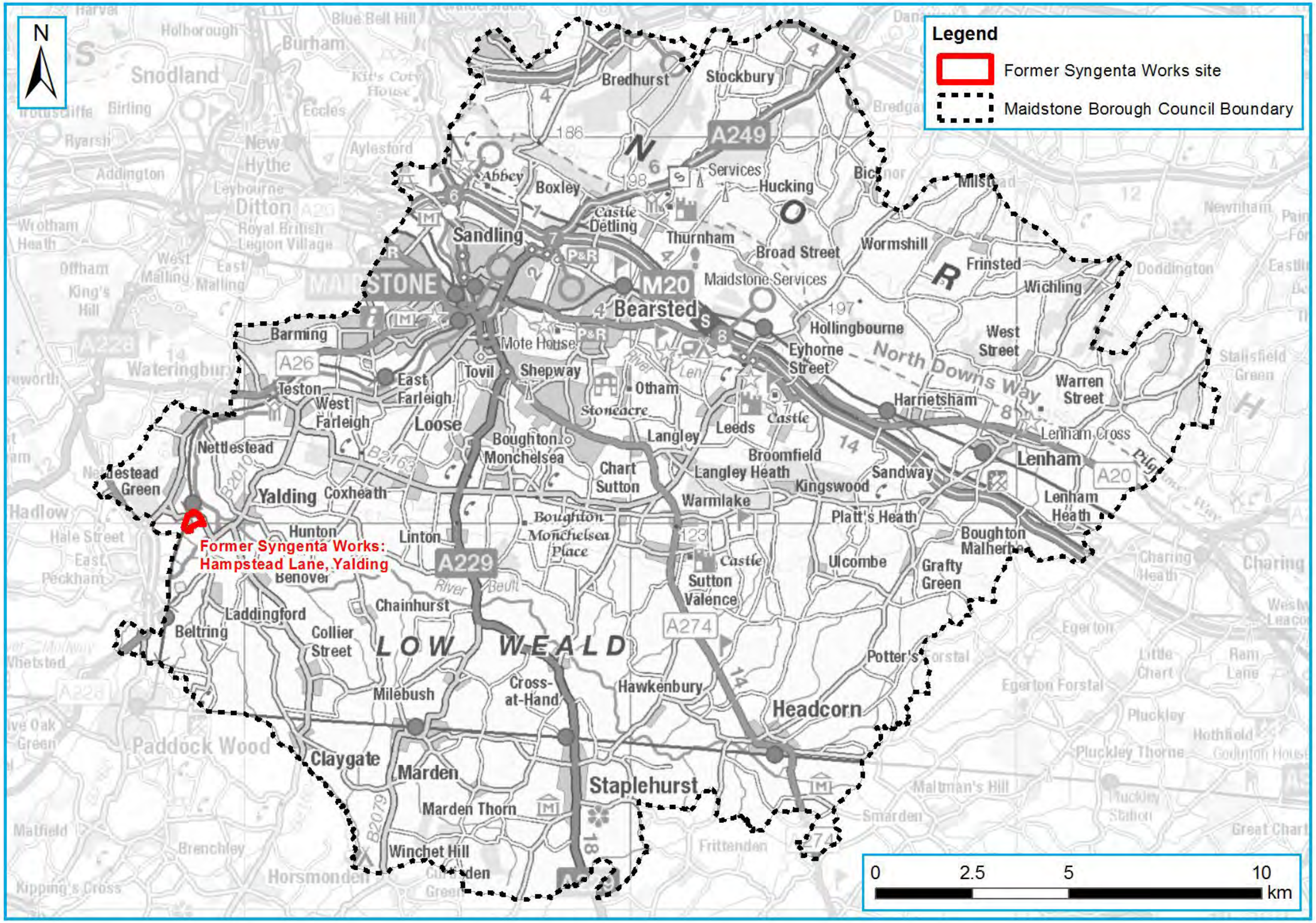

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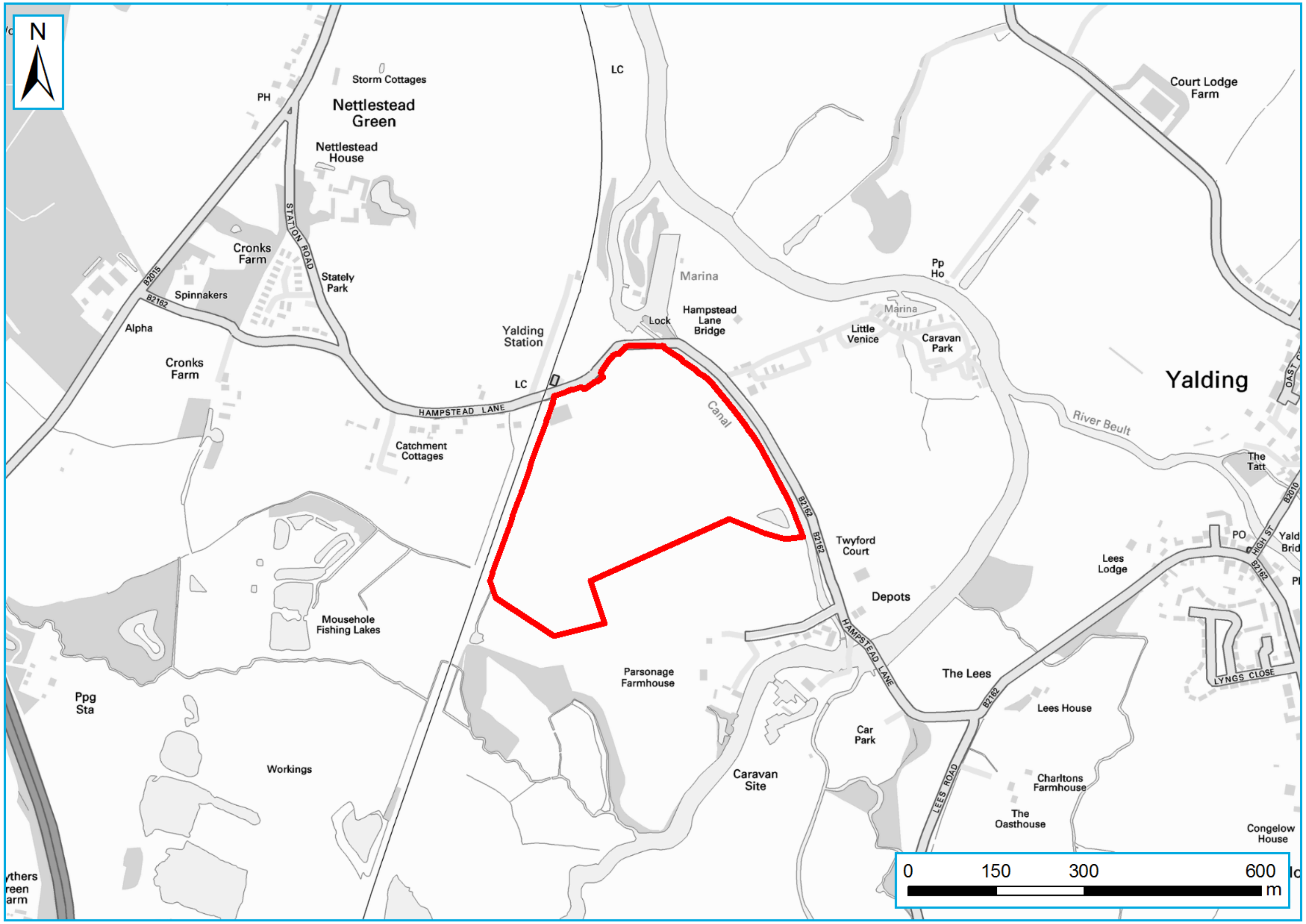
Figure 1-2: Location of the former Syngenta Works site within the local area



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1.4 Policy considerations for assessment of flood risk at a site scale

The assessment of flood risk is primarily based on the following three types of information:

1. Flood zones
2. Actual flood risk
3. Residual risk

1.4.1 Flood Zones

These zones describe the land that would flood if there were no defences present. A concept diagram showing the classification of Flood Zones graphically is included in Figure 1-3. The Government's Planning Practice Guidance identifies the following Flood Zones (see Table 1-2). These apply to both Main River and Ordinary Watercourses.

The preference when allocating land is, whenever possible, to place all new development on land in Zone 1. Since the Flood Zones identify locations that are not reliant on flood defences, placing development on Zone 1 land means there is no future commitment to spending money on flood banks or flood alleviation measures. It also does not commit future generations to costly long term expenditure that would become increasingly unsustainable as the effects of climate change increase.

Figure 1-3: Concept of Flood Zones

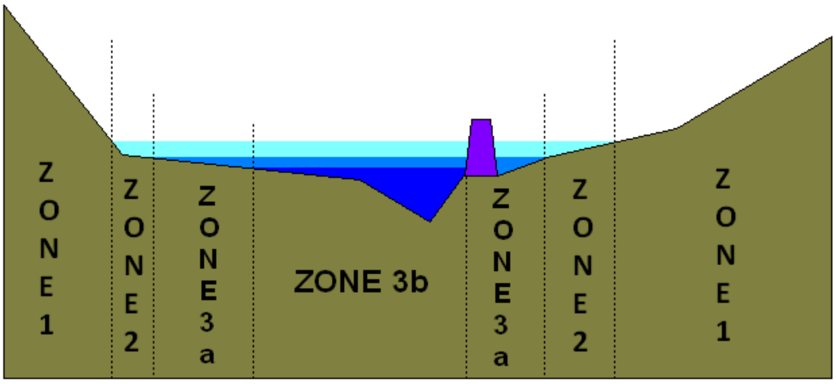


Table 1-2: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
		Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (0.1% – 1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.

Zone	Probability	Description
		Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year Developers and the local authorities should seek to reduce the overall level flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
		Developers and local authorities should seek opportunities to: - reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. - relocate existing development to land in lower risk zones - create space for flooding by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open spaces for flood storage.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere.
		All developments in this zone require an FRA.
		Developers and local authorities should seek opportunities to: - reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. - relocate existing development to land in lower risk zones

1.4.2 Actual Flood Risk

As it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) in any year; and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed.

- The standard of safety must be maintained for the intended lifetime of the development (assumed to be 100 years for residential development). Over time the effects of climate change will erode the present day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

1.4.3 Residual Risk

The residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding (such as flood defences). It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges.
- Or failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.

The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency. In this instance, attention should be paid to the characteristics of flood emergencies and the roles and responsibilities during such events. Additionally, in the cases of breach or overtopping events, consideration should be given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

1.4.4 Context for the strategic site assessment

Table 1-1 indicates that the site is to be considered for mixed use, including both residential and employment development, which are categorised as a More Vulnerable and Less Vulnerable development types, respectively.

When assessing the constraints at the site in terms of fluvial flooding, these vulnerability classifications have been considered with respect to the Flood Zones. The starting point for the evaluation of strategic approaches has been to identify measures that would modify the standard of protection from flooding and potentially the Flood Zone designation that should apply.

1.5 Climate change and flood risk

Flood Risk Assessments are required to demonstrate that future implications of climate change have been considered, and risks managed where possible, for the lifetime of the proposed development. This may include for instance:

- Consideration of the vulnerability of the proposed development types or land use allocations to flooding and directing the more vulnerable away from areas at higher risk due to climate change.
- Use of 'built in' resilience measures. For example, raised floor levels.
- Capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

This latter point acknowledges that there may be instances where some flood risk management measures are not necessary now but may be in the future. This managed adaptive approach' may include, for example setting a development away from a river so it is easier to improve flood defences in the future.

Updated guidance for climate change allowances for flood risk assessment was released by the Environment Agency in February 2016[1] and the latest guidance at the time of planning a development should be considered. The February 2016 guidance provided predictions of anticipated change for:

- peak river flow
- peak rainfall intensity
- sea level rise
- offshore wind speed and extreme wave height

It is necessary to assess how the appropriate commitment to the provision and maintenance of flood risk management measures could be secured at locations where these are required to address climate change effects over the lifetime of proposed new development. This commitment might involve a number of parties and might be needed over a relatively long time period and should normally be evaluated at selected epochs during the lifetime of the development. The commitment to the maintenance and serviceability of existing defences should also be ascertained, together with potential requirements to secure their operation and function under climate change conditions.

1.5.1 Climate change assessment of flood risk at the site

To inform the Strategic Site Assessment hydraulic modelling and mapping of fluvial flood risk from the River Medway expected under climate change was used. The modelling and mapping completed focused on predicting the flood risk at the 2080s epoch (2070-2115) under increased flow rates of +35% and +70%. The fluvial flow allowances represent the High Central and Upper End allowances under the latest guidance.

With respect to the vulnerability classification of development and its intended lifetime, both More Vulnerable and Less Vulnerable development classifications have focused on the Higher Central +35% flows scenario, as it is understood that the Upper End +70% estimate would primarily be used to assess the appropriateness of Essential Infrastructure. It should be noted that the commercial development may typically have an expected lifetime closer to the 2050s epoch (2040-2069) which has an increased flow of +25% associated with the Higher Central estimate. However, in the absence of this information from the current flood risk modelling, the +35% case information has been used. Given the flood risk predicted at the former Syngenta Works site in current Flood Zone 3a, it is not expected that the use of +35% will alter the outcomes of the assessment.

[1] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

2 Summary of existing flood risk management infrastructure

2.1 Overview of Flood Risk Management Infrastructure

The River Medway catchment has a history of human intervention to manage river water both during times of high and low flows. The following sections describe the principal flood risk management interventions and discusses at a high level their current, and potential future, influence within the catchment, and at the development site.

2.1.1 Leigh Flood Storage Area

Leigh Flood Storage Area (FSA) is an online storage reservoir located on the River Medway 2-3km upstream of Tonbridge and was constructed in 1982. The FSA is kept empty under normal flow conditions, but during times of raised flows this asset attenuates floods from the Upper Medway catchment (River Medway and River Eden) and aims to reduce the flow passing downstream through Tonbridge and beyond. The FSA consists of an impounding embankment with an outflow through three radial gates. It is operated to limit forward flows but has a maximum impounding level of 28.05 metres Above Ordnance Datum Newlyn (m AOD). If that level is likely to be exceeded, then alternative operation of the FSA is considered by the Environment Agency.

Assigning a single standard of protection for the FSA is not possible as the inflows to the FSA, volume of water stored and reduced outflows possible, leading to reductions in flooding varies on an event by event basis. The FSA has been regulated under the Reservoirs Act 1975 (now under the Flood and Water Management Act 2010) and has a condition grade of 1 (Very Good).

2.1.2 East Peckham Flood Storage Area

East Peckham FSA is an online storage reservoir located on Coult Stream (a tributary of the River Medway) approximately 600m upstream of East Peckham and was constructed in 2006. The flood storage area, located on farmland which is normally empty of flood water, reduces flows passing downstream by the presence of a Hydro-Brake device which limits the maximum flow output to approximately 0.6m^3/s (excluding potential overtopping flows). The FSA can hold up to 90,000m^3 of floodwater behind the dam[2]. Prior to the construction of the East Peckham FSA, a 100-year rainfall event could have resulted in a flow output of up to 4m^3/s[3].

The standard of protection provided by the FSA will be variable based on the duration and volume of a given flood event even if the peak flows remain the same (e.g. FSA will be more likely to become full if flood volumes are larger). On this basis, a single standard of protection cannot be assigned. The FSA has been regulated under the Reservoirs Act 1975 (now under the Flood and Water Management Act 2010) and has a condition grade of 1 (Very Good).

Given the small size of Coult Stream in the context of flood flows experienced in the River Medway, and the distance of the FSA away from the development site, it is not considered that this FSA is particularly influential to managing flood risk at the site.

2.1.3 Operable structures (radial gates, sluices and locks)

Numerous operable structures are present along the River Medway upstream of, adjacent to, and downstream of the development site. Typically, lock gates are located adjacent to radial gates structures and often vertical sluice structures. They manage water levels under normal conditions, but are operated during flood events to help manage and maintain the passage of flood flows downstream. During flood events the lock gates are closed, whilst radial gates open to raise the gate out of the water and permit passage of flow downstream.

Whilst it is expected these structures may influence the overall timing of water level change throughout the catchment, the impacts on peak water levels and extents for large flood events are expected to be small because for the majority of events widespread floodplain inundation is expected, at which time the influence of in-channel structures reduces.

[2] Kent County Council Flood Risk to Communities – Tonbridge and Malling (2016)
[3] Kent County Council Flood Risk to Communities – Tonbridge and Malling (2016)

2.1.4 Defences

Within the River Medway catchment, raised flood defences are present alongside sections of channel or set back from the channel to protect certain areas from river flooding. No defences are present adjacent to the former Syngenta Works site. However, their presence in the catchment evidences the benefit that these can have at reducing flood risk to discrete locations, even in areas that experience very large flow rates and volumes of flows.

The defences in closest proximity to the development site are located in Tonbridge and downstream of Maidstone. In Tonbridge, raised walls are present along large parts of the River Medway channel notably adjacent to Avebury Avenue, Buleys Weir to Wharf Road and Tonbridge Town Walls and Town Lock defences between Wharf Road and Town Lock. These defences provide flood risk protection from fluvial flooding. Raised flood defences are also present downstream of Maidstone beyond Allington Lock, where these defences primarily protect from the predominant flood risk of tidal ingress along the River Medway.

2.2 Flood risk management infrastructure being considered in the catchment

2.2.1 Leigh Flood Storage Area capacity enhancements

The Kent County Council Flood Risk to Communities – Tonbridge and Malling (March 2016) report[4] has stated that prior to the floods that occurred over the winter of 2013/2014, work is planned to be carried out on the Leigh FSA by the Environment Agency to extend the life to 2035. Since the winter 2013/2014 event a partnership has formed between the Environment Agency, Kent County Council and Tonbridge & Malling Borough Council to bring forward plans to increase the capacity of the Leigh FSA. It is anticipated that preliminary works are to commence in 2018, with the aim to complete the main construction by 2022. The planned works will be a direct benefit to Tonbridge and Hildenborough, and should also reduce the risk of flooding in East Peckham. Reductions in peak flows beyond East Peckham are also expected, but the magnitude of changes in flood risk brought about by the FSA reduces with distance, particularly after flows from significant other tributaries of River Beult and River Teise enter the River Medway. For the site, some reduction in flows (and therefore water levels) during a given flood event would be expected, but this is likely to be relatively small and unlikely to be of sufficient significance as to whether the site should be developed or not.

2.2.2 Flood Storage Areas on the River Beult and River Teise

Strategic flood storage schemes on the River Beult and River Teise catchments have been investigated by the Environment Agency as a means to reducing flooding to communities downstream. However, it is understood that these schemes were not progressed due to technical elements of the schemes not providing the required levels of benefit. Given the large flow rates, volumes of flood water and length of flood events, the reduction in flood risk resulting from implementation of these schemes (e.g. reductions in levels/extents and magnitude of events for which they provide benefit to communities) would be relatively limited. This ultimately means the schemes are not only not viable from a cost-benefit perspective, but would not provide any meaningful reduction in flood risk to communities. They are therefore not viable for technical reasons and would not be progressed.

2.3 Existing work on strategic flood risk management approaches at the site

It is understood that consultants have conducted analysis into flood risk and potential flood risk management options at the site. This study has not been made available for use in this assessment, and it is understood that this was based on historic flood risk modelling information, which has since been superseded by the data used to inform this assessment. Whilst it is understood that the information presented here will inform the site owners about flood risk and potential mitigation measures at the site, information from the other study has not informed this work.

[4] Kent County Council Flood Risk to Communities – Tonbridge and Malling (2016). Available: http://consultations.kent.gov.uk/gf2.ti/-/682530/19783461.1/PDF/-/FRTC_Tonbridge_and_Malling_2016.pdf

3 Assessment of flood hazards

3.1 Overview of approach

The SFRA forms an integral part of Maidstone Borough Council's evidence base, in terms of identifying locations for development and preparation of flood risk policies in the emerging Local Plan, with one of the objectives of an SFRA being to help inform site allocations so they are in accordance with the NPPF.

This assessment of the site considers flood risk across the site, identifying the scope of site-specific Flood Risk Assessments and informing local policies to provide sustainable developments that potentially reduce flood risk to existing communities.

To help inform the understanding of flood risk from all sources at the site, a detailed site summary table has been prepared and this is provided within Appendix A. The information contained within these tables provides information on flood risk constraints at the site which may affect development, and determine the scope of flood risk management measures that may be needed to reduce flood risk.

Information presented within the document includes:

- Site area
- Proportion of the site in each Flood Zone
- NPPF and Exception Test guidance
- Mapping including Flood Zone extents, climate change extents, surface water extents, fluvial flood depths, velocities and hazard mapping
- A broad-scale assessment of suitable SuDS techniques and considerations
- The presence of any flood defences
- Whether the site is covered by a flood warning service
- Whether there are any access and egress issues for the site
- The potential impacts of climate change in the future
- Advice on the preparation of site-specific FRAs and considerations for developers.

3.1.1 Information used to inform the detailed site summary sheets

Sources of data used to inform the understanding of fluvial, surface water and groundwater flood risk at the site is recorded in Table 3-1.

Table 3-1: Source of data used to inform the assessment of flood risk at the site

Site name	Fluvial	Surface water	Groundwater
Former Syngenta Works	Medway Scenario Mapping and Modelling study (2015) and climate change modelling (2016)	Updated Flood Map for Surface Water (uFMfSW)	Areas Susceptible to Groundwater Flooding (AStGWF)

3.2 Note on SuDS Suitability

The hydraulic and geological characteristics of the site were assessed to determine the constraining factors for surface water management. This assessment is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

The assessment is based on catchment characteristics and additional datasets, such as the AStGWF map and Soil maps of England and Wales which allow for a basic assessment of the soil characteristics. LIDAR data was used as a basis for determining the topography and average slope across the site. Other datasets were used to determine other influencing factors on potential SuDS.

These datasets include the following:

- Historic landfill sites
- Source Protection Zones
- Groundwater Vulnerability Zones
- Detailed River Network
- Environment Agency Flood Zones
- OS Open Data on Sites of Special Scientific Interest (SSSI)

This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable. SuDS techniques were categorised into five main groups, as shown in Table 3-2, and are included in the site summary table. This assessment should not be used as a definitive guide as to which SuDS would be suitable but used as an indicative guide of general suitability. The site is predicted to be intersected by Flood Zones 3b and 3a, indicating relatively frequent predictions of fluvial inundation. No account of flooding at the site and how surface water drainage would take place when part or all of the site is flooded has been considered. Further site-specific investigation should be conducted to determine what SuDS techniques could be utilised on a development.

Table 3-2: Summary of SuDS Categories

SuDS Type	Technique
Source Controls	Green Roof, Rainwater Harvesting, Pervious Pavements, Rain Gardens
Infiltration	Infiltration Trench, Infiltration Basin, Soakaway
Detention	Pond, Wetland, Subsurface Storage, Shallow Wetland, Extended Detention Wetland, Pocket Wetland, Submerged Gravel Wetland, Wetland Channel, Detention Basin
Filtration	Surface Sand filter, Sub-Surface Sand Filter, Perimeter Sand Filter, Bioretention, Filter Strip, Filter Trench
Conveyance	Dry Swale, Underdrained Swale, Wet Swale

The suitability of each SuDS type for the site allocation has been displayed using a traffic light colour system in the summary table (Table 3-3). The assessment of suitability is broadscale and indicative only; more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. The LLFA should be consulted at an early stage to ensure that SuDS are implemented and designed in response to site characteristics and policy factors.

Table 3-3: Traffic light system of SuDS suitability used for site summary tables

Suitability	Description
(Red)	The SuDS Group and its associated techniques may be unsuitable
(Amber)	The SuDS Group and its associated techniques may be suitable at the development but is likely to require additional considerations or engineering works
(Green)	The SuDS Group and its associated techniques are likely to be suitable

3.3 Outcomes of the assessment

Based on the information presented within the site summary table (Appendix A), Table 3-4 provides a summary of the main flood risk constraints at the site and provides an indication of the reduction in flood risk which would be required to permit development.

Table 3-5 presents a summary of fluvial flood risk information for the site which gives more detail on the nature of the flood risk constraints. The maximum and mean flood depth, velocity and hazard rating values are provided for Flood Zones 3b, 3a and 2.

Where there is requirement for the Exception Test to be passed, this involves consideration of the two parts of the Test:

1) Whether the development will provide wider sustainability benefits to the community that outweigh flood risk
2) Whether the development will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

The focus of discussion presented within Table 3-4 is based on the second of these aspects, specifically relating to flood risk.

Table 3-4: Overview flood risk drivers and constraints for development at the site

Main flood risk constraints	Implications for proposed development
Fluvial flood risk Fluvial flood risk (River Medway) is the main constraint at the site, with 25% of the site in Flood Zone 3b, and the remainder of the site within Flood Zone 3a. Risk of Flooding from Reservoirs (a residual risk) is also apparent. Flood risk from surface water and groundwater flooding is relatively low.	Residential development would not normally be permitted on 25% of the site located within Flood Zone 3b. For the remaining 75% of the site located in Flood Zone 3a, the Exception Test would need to be passed. Less vulnerable development (e.g. commercial development) would not be permitted on 25% of the site located within Flood Zone 3b, but would be appropriate in the remaining 75% of the site. Safe access and egress in times of flood would need to be achieved: the site is surrounded by flood water and the Hazard rating (risk to life) is high (Danger for Most) in current Flood Zone 3a (Hazard rating would increase under predicted climate change). Given the large area of the site, deep and extensive flood water, the potential for adverse impacts elsewhere e.g. through displacement or deflection of water, is considered high. Development would need to consider how the residual risk of reservoir failure would be managed. Although surface water flood risk is relatively low, consideration would need to be given to how surface water runoff would be stored during times of flood, as given the onsite flooding predicted, surface systems of storage are unlikely to be effective.

Table 3-5: Summary of fluvial flood risk information at the site for Flood Zone events

Flood Zone 3b (max) [mean]	Flood Zone 3a (max) [mean]	Flood Zone 2 (max) [mean]
Proportion of site: 25.1%	Proportion of site: 73.7%	Proportion of site: 1.2%
Depth (m): (1.46) [0.22]	Depth (m): (3.06) [1.02]	Depth (m): (4.58) [2.57]
Velocity (m/s): (0.98) [0.06]	Velocity (m/s): (2.13) [0.13]	Velocity (m/s): (1.99) [0.19]
Hazard: (3.1) [1.0]	Hazard: (3.7) [1.6]	Hazard: (4.8) [2.6]

Table 3-6 presents the volume of fluvial flood water predicted to be on the site at the time of maximum flood depths associated with Flood Zones 3b, 3a and 2. This information provides context to the volume of water which may be displaced if land were raised or protected to remove the site area from flooding.

Table 3-6: Peak volume of flood water on the site in each Flood Zone

Flood Zone 3b	Flood Zone 3a	Flood Zone 2
7,460 m^3	135,600 m^3	356,600 m^3

4 Assessment of strategic flood risk management approaches

4.1 List of flood risk management approaches

A range of flood risk management approaches which could reduce flood risk at the development site are described in the following section. Given that fluvial flood risk has been determined to be the major constraint on development, the approaches considered have focused on 'river' flooding.

Since the scope of the project is to focus on flood risk management opportunities for the site, catchment-wide measures to managing flood risk which might typically be considered for a catchment-wide assessment of flood risk reduction were not included.

Approaches to managing flood risk at the site are separated into five themes: 1) Wall or embankment defences, 2) Land raising, 3) Storage of flood water, 4) Structural modification and 5) Operations. These five themes were taken forward as the basis for preliminary assessment of the approaches. Table 4-1 lists these flood risk management approaches and provides details on the assumptions made on their respective characteristics. Within the followings sections the applicability of each of these approaches is considered in the context of selected factors.

Table 4-1: Flood Risk Management approaches considered

FRM approach	Sub-category	Description
Wall or embankment defences	Localised	Defences confined to a relatively small area (e.g. risk areas), implemented to prevent specific areas of land from flooding
	Strategic	Defences covering a large geographic area intended to: Change the manner in which the flood wave propagates e.g. to improve conveyance for an entire reach by constraining the entire flood flow in-bank, or to reduce floodplain inundation at lower magnitude events, resulting in greater storage for larger magnitude events *OR* Facilitate the movement of flood water onto specified areas of land within a catchment, usually to facilitate storage upstream of a risk area
Land raising	-	Increasing the elevation of land at a development site to reduce its flood risk.
Storage of floodwater	Localised	Smaller scale storage areas sited close to risk areas resulting in localised reductions in water level during flood events
	Strategic	Larger scale storage areas, usually sited distant from risk areas resulting in large scale reductions in water levels during flood events
Structural modification	-	Amendments to the geometry of structures, such as bridges and culverts, in order to either increase or reduce conveyance as a means to reducing flood risk upstream or downstream, respectively
Operations	Structures	Changes to the operation of structures in order to alter the conveyance through these structures during a flood event
	Channel modification	Amending the geometry or location of existing channels, or the construction of new channels to alter how flood water is conveyed through the system

4.2 Wall or embankment defences

4.2.1 Strategic

Due to the expansive nature of the floodplain and River Medway system, the implementation of strategic defences throughout the study area would need to be widespread if acting as a means of preserving floodplain storage for greater magnitude events. This approach is unlikely to be favourable, particularly in light of the risk predicted for relatively frequent magnitude flood events. Equally, disconnecting the river channel from the floodplain is unlikely to be favourable with regards to hydromorphic and ecological aspects and achieving wider Water Framework Directive (WFD) objectives. Consequently, localised defences are a more favourable approach to flood risk management, and were the basis for considering defences for the remainder of the assessment.

4.2.2 Localised

The merits of localised defence lines at the site was assessed in terms of identified flow routes into and from the site. Where it was apparent that a site was inundated by a key flow route or point where banks levels were exceeded, defence lines were considered for testing at this location. This assessment was informed by:

- review of existing hydraulic model outputs; and
- review of bank levels in light of peak water levels (channel exceedance)

In general terms, it was considered that localised defences would be particularly relevant given the distinct risk areas and their close proximity to the watercourse.

Defences included in assessment

Consideration of where defences would need to be implemented focused on the change in flood extents between Flood Zones. The defence line(s) schematised focused on implementing defences to higher ground than the Flood Zone 3a extent (including the +35% increase in flows for climate change required by the guidance). Removing the land from Flood Zone 3a would reduce the flood risk at the site. However, it should be noted that the Exception Test would still need to be completed to demonstrate that:

- the site itself will be safe from flooding, including means of safe access under flood conditions (as part of this consideration should give to whether the site may become isolated during flood conditions, making safe access and egress more difficult to achieve);
- the developed site will not increase flood risk elsewhere e.g. through displacement of flood flow routes or loss of floodplain storage.

The focus on the +35% flows scenario for Flood Zone 3a was completed as this is expected to help evidence that the defence would not be exceeded by the Flood Zone 3a flood for the lifetime of development. In the latter situation, the site may still be expected to be intersected by Flood Zone 2, as the defences would be bypassed. In this case, it is expected the safety of the development would be considered as management of the residual risk of flooding.

The locations that defences were considered further within the assessment are noted in Table 4-2 and their locations illustrated in Figure 4-1.

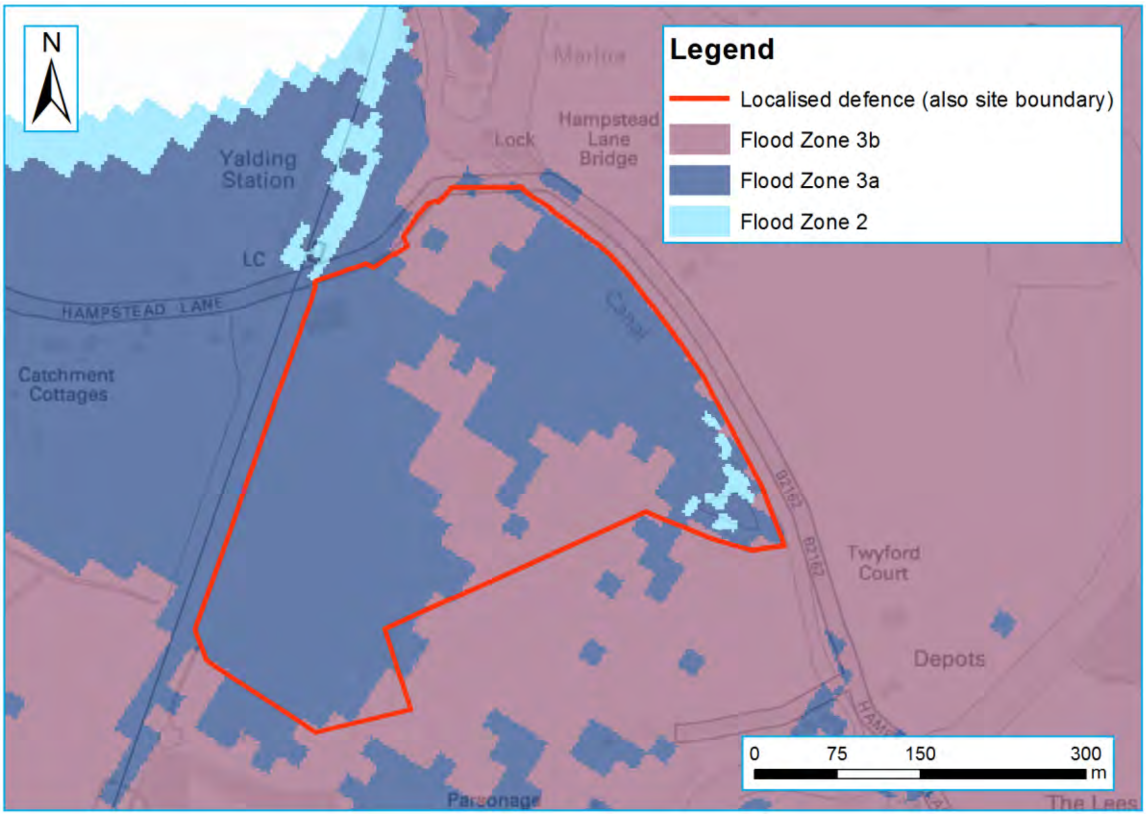
Table 4-2: Localised defences considered further for strategic approaches assessment

Defence description	Justification for selection
Surrounding the site to prevent ingress of flood water from Flood Zone 3a. Elevation would be water level associated with Flood Zone 3a when flows are increased by 35%, plus an allowance of 0.3m additional elevation. Length = 1,700m Maximum defence height* = 3.3m Average defence height^ = 2.4m	This defence would be required to prevent ingress of water into the site in Flood Zone 3a. The site is surrounded by Flood Water in Flood Zone 3a, so implementing defences for only part of the site is not considered viable as these would be bypassed. The +35% flow climate change allowance for Flood Zone 3a is used as this allows for consideration of safety of the development over its lifetime. The +0.3m allowance is included as an additional allowance for estimated freeboard.

* Maximum defence height estimated by determining the maximum difference between peak water level at the site in the Flood Zone 3a (+35% flows) event against the ground levels recorded in 1m filtered LIDAR data.

^ Average defence height estimated by determining the average difference between peak water level at the site in the Flood Zone 3a (+35% flows) event against the ground levels recorded in 1m filtered LIDAR data.

Figure 4-1: Location of defence considered at the former Syngenta Works site



4.3 Land raising

Increasing the elevation of land for whole or parts of the site could be implemented to prevent flood flows affecting the land. The elevation selected could be determined to coincide with the designation of the site (or part of the site) from one Flood Zone to another (e.g. from Flood Zone 3b to Flood Zone 3a). Raising of land which floods would reduce the volume of storage on the floodplain in a flood event. Such ground level adjustments would therefore require level for level floodplain volume compensation (so no loss of floodplain storage occurs) and also analysis to evidence that the increase in ground levels does not result in adverse changes in flood risk elsewhere, e.g. through deflection of flood water. Assessment of loss in floodplain storage if land were to be raised to remove the land from a given Flood Zone is presented in Table 3-6.

The land raising included in this assessment assumed increasing ground above the Flood Zone 3a flood level, reducing the flood risk at the site. Removing the land from Flood Zone 3a would reduce the flood risk at the site. However, it should be noted that the Exception Test would still need to be satisfied to demonstrate that:

- the site itself will be safe from flooding, including means of safe access under flood conditions (as part of this consideration should give to whether the site may become isolated during flood conditions, making safe access and egress more difficult to achieve);
- the developed site will not increase flood risk elsewhere e.g. through displacement of flood flow routes or loss of floodplain storage.

The nature of land raising considered further within the assessment is noted in Table 4-3. The focus has considered that land on the site within Flood Zones 3b or 3a would be raised above the level of Flood Zone 3a. In practice, there are numerous options that could be considered for land raising (e.g. areas of the site, elevations selected), which would likely be defined if land raising is taken forward. Consideration would need to be given to addressing climate change and ensuring the development is safe for its lifetime. This could include raising the site to a higher elevation to reduce the residual risk from higher flood events.

Table 4-3: Land raising at the site considered further for strategic approaches assessment

Site	Description
Former Syngenta Works	Raising of the full site area to the level of flood water in Flood Zone 3a. The full site is selected as the whole area is Flood Zone 3b or 3a

4.4 Storage of flood water

4.4.1 Localised

The volumes of flow, and peak flow rates, associated with flooding on the River Medway is considerable. Therefore, it is expected that capacity for attenuation of flood water on part of the site is minimal. Additionally, due to the River Medway already being well connected to the floodplain during flood events, the potential for localised storage within the site is considered limited, due to difficulties in storing water on the floodplain at greater levels than currently predicted, within relatively small geographic areas.

On the basis on the constraints identified above, localised storage on the site has not been considered further.

4.4.2 Strategic

The catchment has a history of strategic flood storage at Leigh Flood Storage Area (FSA), which stores the peak flows of flood events to reduce flooding downstream (refer to section 2.1.1). The Environment Agency are investigating means of increasing the capacity of the FSA to store increased volumes of water during floods to further reduce outflows passing downstream (refer to section 2.2.1). Additional storage of flood water at the Leigh FSA, potentially reducing peak flows, would likely provide some degree of benefit to the site. However, given the distance of the site from the FSA, they are unlikely to see notable reductions in flood risk and may not be of significance as to whether a site should/could be allocated or not. Additionally, strategic storage options have been considered on the River Beult and River Teise (refer to section 2.2.2), but it is understood that the benefit to flood risk (e.g. reductions in levels/extents and magnitude of events for which they provide benefit) would be relatively limited.

Based on the information obtained, further strategic flood storage sites have not been considered in the context of benefitting the site. However, it is recommended that future enhancements at Leigh FSA are considered further if development at the site is progressed, as reductions in flood risk brought about by the increased capacity of this flood risk management infrastructure could reduce the requirement for flood risk management schemes at the site.

4.5 Structures

Consideration was given to the hydraulic influence of bridges and culverts within close proximity to the site using peak water levels for the existing hydraulic model of the River Medway (Model 3). The difference in water levels across the structures in the Flood Zone 3b, 3a and 2 events were reviewed to understand whether these structures were acting as a constriction to flow, elevating water levels at the site.

The presumption with this approach is that elevated water levels upstream of a structure are contributing to flood risk and that increasing conveyance through a structure would reduce flood risk by lowering these water levels. It is plausible that the reverse may be true in that a structure may be reducing flood risk by retaining water upstream of a risk area, meaning reduced levels are apparent downstream. Nonetheless, this assessment focused on the former.

The details of the assessment are recorded in Table 4-4, where Hampstead Lane Road Bridge, the main road crossing over the River Medway near the site, was not shown to have a notable influence on flood levels at the site. Considering the information presented, adjustments to structures as a means to reducing flood risk to facilitate development at site was not considered further.

Table 4-4: Structure assessed whether constricting flows and elevating levels

Structure name and distance from site	Difference in water levels between upstream and downstream sides of structure
Name: Hampstead Lane Road Bridge Distance: circa 200m south of the site	Flood Zone 3b event: +0.06m Flood Zone 3a event: +0.02m Flood Zone 2 event: +0.00m

4.6 Operations

4.6.1 Structures

Vertical sluice and radial gate structures

The hydraulic significance of vertical sluice and radial gate structures within the River Medway catchment is evident. However, whilst lock gates are closed during flood events for safety reasons, radial gate and vertical sluice gates are opened to permit free passage of water and reduce the likelihood of increased flood risk brought about by blockages. Hampstead Lock, Anchor Sluices and Radial Gate are adjacent to the former Syngenta Works site. Given the widespread inundation of the floodplain predicted during times of flood, it is expected that these structures would have limited influence on flood risk at the development site.

Accordingly, adjustments to the operation of vertical sluice and radial gate structures has not been considered further. It is plausible that closing gates upstream of the site during a flood event would encourage greater floodplain inundation, perhaps reducing risk downstream, but this would likely be minor during large flood events, and would require significant interventions to mitigate changes in flood risk to third parties.

4.6.2 Channel modification

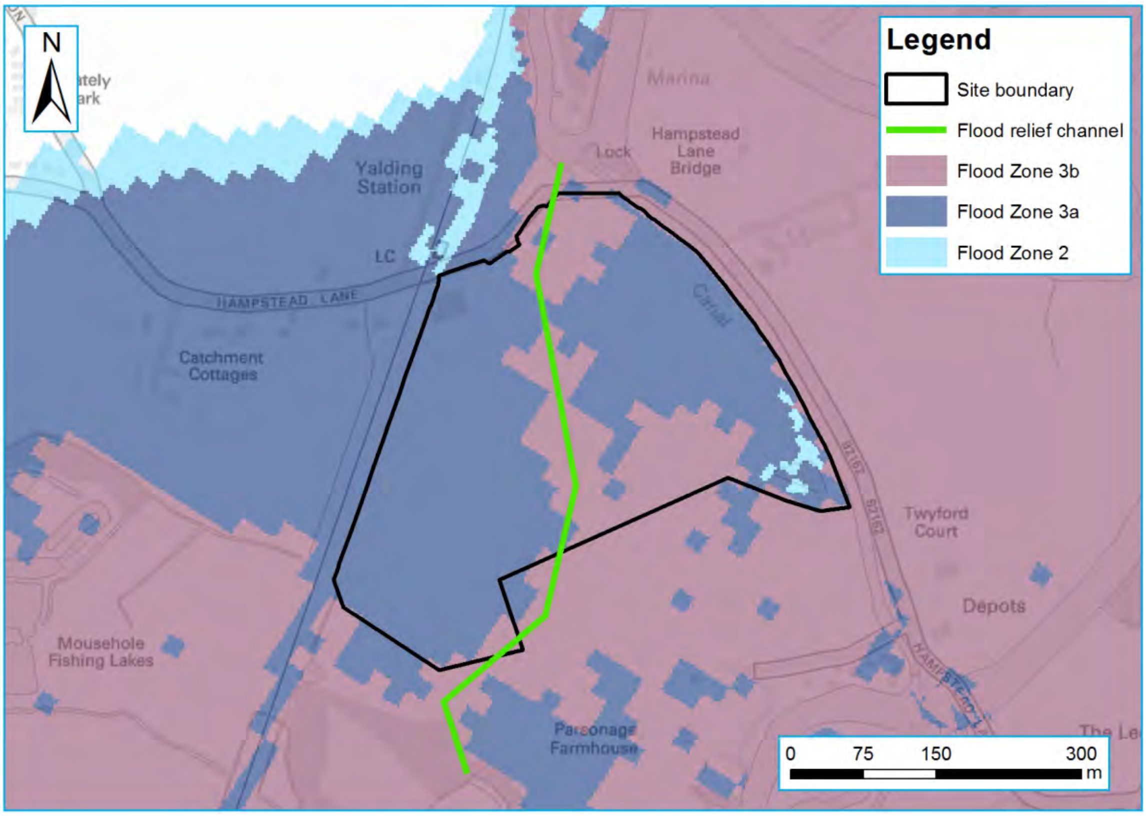
Modification of the River Medway channel could influence its capacity to convey flood water past and beyond the site. Channel modification could take the form of increasing its width or depth, grading the channel to increase its gradient or produce a more consistent slope, or implementing additional channels (e.g. a bypass or flood relief channel) to convey water away from the site. With any adjustment of channels, it would be important to consider how significant the adjustment would influence flood risk. Generally, given the size of the channels and extent of floodplain inundation predicted under large events, it considered changes to flood risk would be small. Additionally, potential future adjustment (and return back to pre-modification conditions) would need to be considered.

The opportunity for channel modification adjustments has been considered for the development site within Table 4-5. Given existing structures are located in close proximity to the development site downstream (at Anchor Sluice / Hampstead Lane area) it is not considered that modification to the main channel upstream of these would provide appreciable benefits given these structures are likely to remain the main influence on conveyance (their capacity is assumed not to increase).

Table 4-5: Channel modification considerations at the site

Channel modification	Justification for selection
Flood alleviation/bypass channel through the site directing flood water from the floodplain to the south of the site to the channel north of the lock gates at Hampstead Lane	It is not considered that local adjustments to the River Medway channel would make appreciable differences to flood risk given the well-connected channel and floodplain and the presence of structures at Anchor Sluice (Hampstead Lane). Channel diversion through the site may provide opportunity to increase flows downstream and less water levels at the site. A very significant flood channel might have some benefit, but this is unlikely to be affordable or practical.

Figure 4-2: Location of the potential channel modification considered at the site



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Note: route of flood relief channel at the former Syngenta Works site is indicative, and has been drawn to connect an existing channel south west of the site to the channel downstream of Hampstead Lock, following lower elevation ground on the site.

5 Effectiveness of flood risk management approaches and potential impact at the allocation site

5.1 Overview

The former Syngenta Works site has constraints to development in terms of flood risk across the full site area, with fluvial flood risk being identified as the main contributor to risk. Refer to Appendix A for more details.

For this assessment it is assumed that there is a requirement to locate the intended development across the whole site and therefore flood risk management approaches considered have reflected this. In practice, smaller areas of the land may be intended for development, in which case the need for site-wide strategic measures may not be apparent and the approaches considered here could be scaled back.

5.2 Assessment approach

Consideration is given to each of the list of strategic options which could reduce flood risk at the site. A matrix of each potential flood risk management approach is prepared comparing the aspects of managing flood risk listed below.

- Potential effectiveness of scheme at reducing flood risk
- Comparative cost (including cost of mitigation requirements)
- Constraints to implementing the potential flood risk management approach
- Potential requirement for mitigation measures
- Potential to manage residual flood risk after the flood risk management option has been implemented

It should be noted that no substantive consideration of environmental impacts has been made as part of the assessment beyond assessment of flood risk.

The study involves outline evaluation of approaches to develop an understanding of their respective capacity to reduce flood risk at the site. The intention is to gain an appreciation of the scale of measures required so the principle of development can be supported. The level of detail applied to the evaluation is commensurate with the outline nature of the study and therefore the following allowances should be made:

- No detailed structural analysis has been undertaken;
- No geotechnical analysis has been undertaken;
- No material analysis has been undertaken;
- No services searches have been undertaken;
- No contaminated land searches/assessments have been undertaken;
- No engineering drawings of the short-listed options have been produced;
- Simplifying assumptions have been used, and stated, as appropriate;
- Typical sections and alignments are indicative (and have been determined as such for modelling purposes); and
- If progressed in the future, designs may differ, based on variables that are outside the scope of this work.

Whilst various elements have not been considered as part of the current level of assessment, if the approaches are to be developed further these will need to be considered and progressed.

To provide a level of quantification to the decision-making process, allowing for a more objective short-listing process, each approach was judged according to whether it is expected to provide positive benefit or detriment to each criteria. Scoring was applied to each criteria, following which an overall score for each flood risk management approach was derived. The scores applied for each criteria were relative across all types of flood risk management approaches being considered, so the perceived benefits from the respective approaches were directly comparable. Whilst numbers are assigned on a very high to very low rating, it is acknowledged that the values assigned may be open to interpretation and involve an element of judgement. It is intended that these could and would be refined if flood risk management measures are taken further. It is possible that the metrics used in the ranking scheme could be adjusted to reflect the relative importance of the various aspects, but no such allowances have been made in this study.

It should be noted that at this stage, the assessment is of a high-level nature and the scoring has reflected this. There are numerous factors which could influence the score assigned to a given flood risk management approach, which would be refined as a scheme progresses. For instance, consideration of the constraints to implementing the potential flood risk management approach may be dependent upon many things including the material on the site, and being used for the scheme, raising questions such as:

- Where will material be sourced from?
- How will material required be delivered to, or disposed of from, the site (form of transport, number of movements required)
- What is the cost of the material?
- Is the material to be used (or already on site) contaminated?
- Does the proposed material (or existing conditions at the site) have the required geotechnical properties?

5.3 Scoring system

The scoring system adopted is reported within the five tables below. The tables consider the effectiveness of the approach at flood management (Table 5-1), cost (Table 5-2), constraints to implementation (Table 5-3), potential requirement for mitigation (Table 5-4) and potential to manage residual risk at the site after implementing the flood risk management approach (Table 5-5).

Table 5-1: Scoring criteria for assessing the effectiveness of the flood management approach

Score	Effectiveness of flood management
-2	Very low potential for reduction in flood risk
-1	Low potential reduction in flood risk
0	Medium potential reduction in flood risk
1	High potential reduction in flood risk
2	Very high potential reduction in flood risk

Table 5-2: Scoring criteria for assessing the cost of potential flood risk management approach

Score	Cost
-2	Very high cost
-1	High cost
0	Medium cost
1	Low cost
2	Very low cost

Table 5-3: Scoring criteria for assessing the constraints to implementing the potential flood risk management approach

Score	Constraints to implementation
-2	Significant constraints involving third party flood risk or wider effects
-1	Constraints involving third party flood risk and wider effects
0	Some constraints involving third party flood risk and wider effects
1	Low level of constraints involving third party flood risk or wider effects
2	No constraints involving third party flood risk or wider effects

Table 5-4: Scoring criteria for assessing the potential requirement for mitigation measures

Score	Potential requirement for mitigation
-2	Very high potential impact to land near the site
-1	High potential impact to land near the site
0	Medium potential impact to land near the site
1	Low potential impact to land near the site
2	Very low potential impact to land near the site

Table 5-5: Scoring criteria for assessing the potential to manage residual risk at the site after implementation of the FRM approach

Score	Potential to manage residual risk at the site
-2	Very low potential to manage residual risk at the site
-1	Low potential to manage residual risk at the site
0	Medium potential to manage residual risk at the site
1	High potential to manage residual risk at the site
2	Very high potential to manage residual risk at the site

5.4 Comparative assessment of strategic FRM approaches

The scoring of potential FRM approaches at the former Syngenta Works site are recorded in Table 5-6. Comments are provided where applicable.

Table 5-6: Scoring of potential FRM approaches at the former Syngenta Works site

Potential FRM approach	Aspect						Additional comments
	Effectiveness of the scheme	Cost	Constraints to implementation	Potential requirement for mitigation	Potential to manage residual risk	Total score	
Defence	2	-1	-1	-1	-1	-2	Expected to fully defend the site to the desired level. Cost expected to be lower than land raising due to lower volumes of material required. Constraints to implementation high due to very long length of defence. Residual risk remains high as ground within the defended area would still be as per the original floodplain.
Land raising	2	-2	-2	-1	1	-2	Expected to fully defend the site to the desired level. Cost expected to be higher than defences due to larger volumes of material required. This could reduce if free issue material was available. Constraints to implementation very high due to notable land raising (large material requirements) over a very large area. Residual risk lower than defences as ground is raised above the design flood level, reducing risk in larger events.
Channel modification	-1	-2	-1	1	0	-3	Given scale of flooding on site and the expansive and well connected floodplain, a diversion channel is expected to provide minor impact on reducing flood risk.

5.5 Preferred potential flood risk management approach at the site

The site is dominated by fluvial flood risk, with Flood Zone 3b affecting 25% of the site and Flood Zone 3a affecting the majority of the remaining site area. The site is also surrounded by Flood Zone 3a. At the maximum extent of Flood Zone 3a, average flood depths of 1.02m and maximum flood depths of 3.06m are predicted, indicating considerable depths and volumes of water.

A diversion channel was considered to have limited effectiveness at reducing flood risk given the flow rates passing across the well-connected and widely inundated River Medway floodplain. Considering this and the high cost of implementing the approach, a score of -3 was recorded and the approach was not taken forward as a preferred (selected) approach.

Localised defences surrounding the site and land raising of the site boundary, both of which are constructed to above the flood level predicted in Flood Zone 3a, received the same score of -2. Both approaches were considered to have the same effectiveness at reducing flood risk, as they would both be expected to remove the site from flooding in the Flood Zone 3a event. Additionally, both are considered to require the same requirement for mitigation in terms of increasing flood risk elsewhere, as they would provide the same obstruction to flow and loss of floodplain volume at the design level.

Whilst both land raising and defence approaches received the same overall score, the land raising approach is considered to result in notably lower residual risk compared with the defence approach. Lower residual risk is expected for land raising given the site elevation would be raised, reducing flood depths in events larger than the design standard. However, the defence approach would retain the same ground levels, so in cases where the defence level was exceeded (events larger than that associated with Flood Zone 3a) the existing flood depths would be expected to occur. Additionally, the presence of the defences surrounding the site may impede drainage of flood water, but also increase risk through potential of breach failure resulting in rapid inundation, both of which may increase the residual risk. It should be noted that no consideration of flood risk outside of the site boundary has been made at this stage. Flood risk is high outside of the site, which is likely to be of significance for evidencing safe access and egress in times of flood. Given these constraints careful consideration of emergency planning would be required, potentially requiring the need for management arrangements (including formal emergency plans) to ensure residents safely vacate in times of flood to safe refuge, and also take measures to increase the safety of the site in times of flood e.g. maintaining the effectiveness of on-site flood management measures e.g. voids under buildings and removing obstructions (e.g. cars) from flood pathways.

Localised defences score more highly for cost and constraints to implementation, given that amongst other things lower volumes of material would be required for the defence approach (land raising volume of circa 160,000m^3 based on analysis of flood volumes), geotechnical considerations generally only apply to where the defence is being implemented and overall implementation of the approach is considered more straight-forward.

In considering the selection of one strategic approach, testing its effectiveness to the design standard (removing the site from Flood Zone 3a) and understanding the impacts on flood risk to areas away from the site, both land raising and defences are expected to result in the same outcome given the same obstruction to floodplain flow and loss of floodplain volume would be associated with each. This means that selection of a preferred approach then needs to consider the other factors discussed e.g. residual risk vs. cost and constraints to development. This is a matter which would likely be better progressed at more detailed stage when available funds for the development and future management plans would be understood.

Given a key focus for the assessment is managing flood risk at the site to facilitate development, it is considered that land-raising would be a preferable strategic approach due to residual risk being lower, which would increase the chance of evidencing development would be safe for its lifetime. <u>Therefore, the land raising approach was recommended for testing within the hydraulic model.</u>

6 Analysis of selected flood risk management approach

6.1 Consideration of site based development flood risk management measures rather than strategic approaches to managing flood risk

The recommended strategic approach for reducing flood risk at the site was reported to Maidstone Borough Council, along with the Environment Agency who provided responses to the recommendations made. Initial feedback received on the strategic approaches presented in section 5.5 identified that there was general agreement to the land raising approach at the site on the basis that the residual risk would be lower compared with a defence-based option.

At the site, Maidstone Borough Council requested that testing of alternatives was performed using the hydraulic model. This testing would assess the effects of implementing undercroft garaging at ground level, with a view that residential development would be implemented at higher levels (e.g. above the 100-year (1% AEP) plus climate change allowance flood levels). Under this approach it is considered that there would be prohibition by condition of any residential accommodation at ground level.

The undercroft parking/garaging approach for residential dwellings would result in existing ground levels at the site being retained, which it is considered may lessen the predicted impacts on flood risk to third party land. Section 6.2 reports on the site layout/scheme tested at the site, along with the modelling approach adopted. Section 6.3 discusses the change in flood risk due to the proposed development, and how this influences the potential for taking the site forward for development. It should be noted that the modelling and analyses prepared are simplistic in their form compared with the level of detail that would be expected for a detailed submission. The testing completed has only been prepared to understand whether the principle of the proposed development form can be achieved and not specific site schemes or layouts. It is also noted that the measure tested is not strategic, but involves site specific responses to address flood risk issues.

Although consideration of a site within a Level 2 SFRA context is typically to focus on the actual risk at a site (e.g. the defended case event), the modelling prepared has remained focused on the undefended case event as the original intention of the study was to consider strategic flood risk management measures and how these would affect the extent of flood zones. As the approach adopted in the modelling assessment of the site adopts the undefended case this probably provides results that describe slightly higher levels of flood hazard than might be actually experienced (in a defended case situation). However, it is not considered that the reduction in hazard for the actual risk would affect the conclusions that can be drawn from the assessment with respect to decision making on the principal of allocating land for development and the approach does include some consideration of the residual risk (without presence of flood risk management measures). Clearly if more detailed proposals are prepared at the site then the actual risk should be considered, although the residual risk will still be a material consideration so the conditions without the presence of flood mitigation measures would also need to be evaluated. The actual risk describes the conditions where the flows and levels at the site benefit from the performance of the Leigh FSA, which acts to lessen flows passing downstream in a defended case.

It should be noted that the flood risk information for the site indicates that flooding predicted in the Flood Zone 3a event (including allowance for climate change) makes providing safe access and egress during times of flood difficult. A conceptual access and egress route tested within the hydraulic model suggested that this may be possible, but it would be necessary to secure third party consent and agreement to construct new features associated with this route (e.g. footbridge over the railway line suitable for all site occupants, and route from the west of the railway line to ground to the Station Road area). It would be necessary to evidence safe access and egress over the lifetime of development for the development to be considered safe (one of the key elements of the Exception Test). Whilst a conceptual measure to achieve safe access and egress was implemented within the site testing, this would likely necessitate material offsite works which the assessment has not considered whether are feasible, e.g. due to land ownership or interactions with current infrastructure.

6.2 Site/development flood risk management approach tested and modelling approach

6.2.1 Site layout/scheme tested

The scheme tested is based upon a site layout provided by Maidstone Borough Council which formed part of potential development information submitted by St Modwen Properties Plc (file name supplied: *ED2-17 Marden and Yalding - Former Syngenta Works, Hampstead Lane, Yalding.pdf*). The document presented site layout information in the form of a plan view drawing prepared by Barton Willmore in 2009 (Figure 6-1).

The site layout comprises employment land at the south west of the site area, residential development to the east with roads connecting these two areas of the site and connecting to Hampstead Lane to the north. The existing building at the north west of the site remains unchanged. The employment land has five buildings separated by hardstanding used for car parking. The residential development has various roads between properties. No information on the type of buildings or drainage arrangements at the site are presented known.

The scheme modelled sought to represent the employment land at the south west of the site, which is located at ground level (i.e. not raised above ground level to have undercroft parking/garaging below the building). The residential dwellings were schematised to raise habitable floor levels above the ground level, with undercroft parking/garaging at ground level below this. Roads indicated on the site plan were raised above the 1 in 100-year (1% AEP) plus 35% flows peak water level so that these access/egress routes remain dry in the event, and culverts were implemented under the raised roads to facilitate the flow of water northwards, thereby reducing obstruction to natural flow paths.

Flood depths and velocities in the Flood Zone 3a (plus 35% flows) event result in hazard rating which is likely to preclude safe access and egress (refer to Appendix A). Therefore, an indicative approach for creating a safe access and egress route was schematised – whereby from the north of the site (roads on the site are expected to remain dry) the level of Hampstead Lane is raised to Yalding Railway station, from which it is possible that the footbridge could provide an egress route to the western side of the railway. Beyond this further land raising is schematised westwards towards the intersection of Hampstead Land and Station Road. It should be noted that this is a conceptual scheme and not based on actual details. The feasibility of this conceptual access and egress route would need to be investigated further. Whilst roads are raised above the 1 in 100-year (1% AEP) plus 35% flows flood level, it would also be necessary for a development to indicate how the dwelling itself connects with the road network to maintain a continuous safe access and egress route (e.g. through raised walkways from the entrance of properties to the road). Additionally, consideration should be given to safe means of access and egress for occupants with reduced mobility, as well as whether safe vehicular access would be possible.

6.2.2 Modelling approach

The modelling approach adopted to represent the conceptual site layout is documented in Table 6-1 and key elements of the scheme are displayed in Figure 6-2. The hydraulic model made use of the River Medway hydraulic model for the area (referred to as 'Model 3') which was made available to use by the Environment Agency and was developed as part of the Medway Catchment Mapping and Modelling study (2015). The model extends from downstream of Tonbridge, to East Farleigh on the River Medway and also includes the River Beult from Smarden and River Teise from Goudhurst Road, near Horsmonden, to their confluence with the River Medway. The spatial resolution of model grid cells within the area of the model in which the site resides is 20m. The scheme layout was simulated for the undefended case 1 in 100-year event (1% AEP event), with and without increases to flows by 35% to account for the effect of climate change (two scenarios were tested). To understand the influence of the scenario being tested at the site, model predictions were compared with those in which the scenario was not implemented.

Figure 6-1: Potential site layout at the former Syngenta Works site (including surrounding area), prepared by Barton Willmore

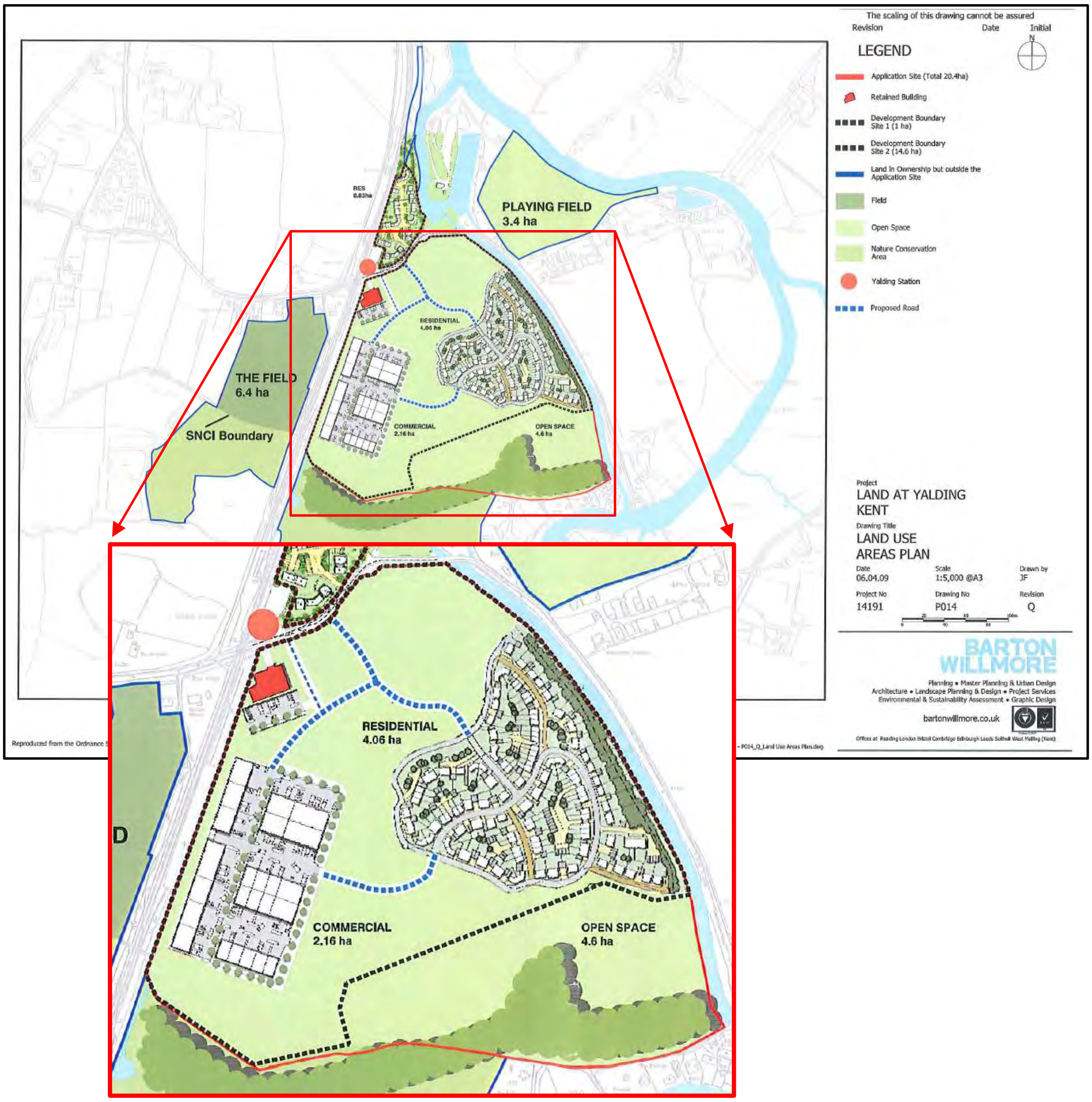
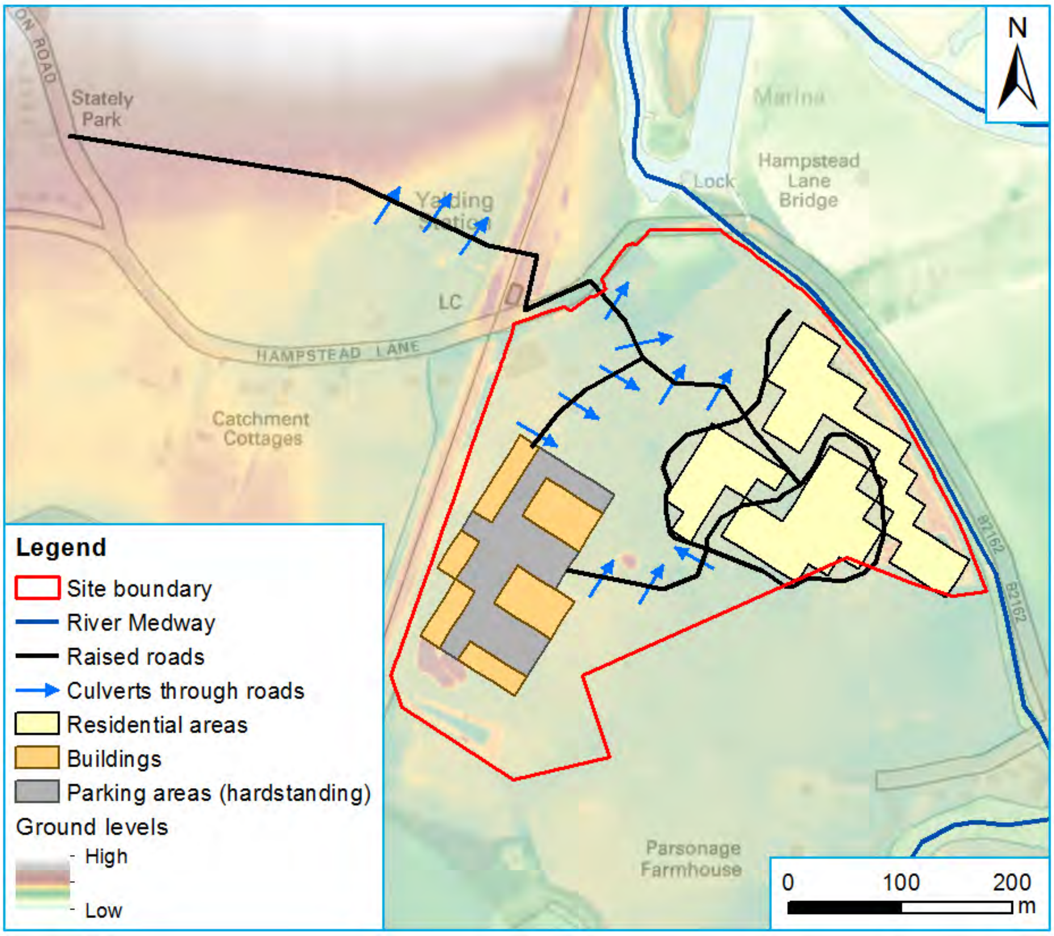


Table 6-1: Modelling approach for elements of the former Syngenta Works site testing

Element	Modelling approach
Base ground levels (prior to adjustment for the scheme)	These remain as per the existing modelling, which is informed from filtered LIDAR data, available at 1m resolution.
Employment land (hardstanding)	The model grid cells associated with the areas of hard standing were set to have a hydraulic roughness of n=0.08, used within the model to represent road surfaces.
Employment land (buildings)	The model grid cells associated with the areas of hard standing were set to have a hydraulic roughness of n=0.30, used within the model to represent buildings.
Residential land (undercroft parking/garaging beneath buildings)	Model cells which intersect the areas of residential land were adjusted in two ways to represent the presence of buildings: 1) Model cell sides were reduced in width by 10% to account for the influence of columns piers and walls at the perimeter of buildings. A form loss coefficient of 2 was also applied to make an account of losses that would be expected as water flows through the undercroft parking/garaging area 2) The volume of model cells was reduced by 10% to make an account of potential loss of floodplain volume due to columns, pillars, walls, stairwells etc. No representation of the first floor level and above was made as it is considered that this would be located above the design events considered. No change in hydraulic roughness at the residential land was implemented.
Roads	The model grid cells which are intersected by the roads were raised to a fixed elevation of 13.4m AOD. This elevation is slightly above the predicted 1 in 100-year (1% AEP event) plus 35% flows undefended case peak flood water level (Flood Zone 3 +35% flows).
Culverts under/through roads	At every other grid cell intersected by the raise roads (circa 40m spacing) outside of the residential area, two culverts were schematised through the road. These were 1m high and 2m wide rectangular culverts. Invert levels of the culverts were based on existing ground levels within the model grid.
Access/egress route	The model grid cells which are intersected by the indicative access route were raised to a fixed elevation of 13.4m AOD. This elevation is slightly above the predicted 1 in 100-year (1% AEP event) plus 35% flows undefended case peak flood water level (Flood Zone 3 +35% flows).

Figure 6-2: Schematic of modelled elements of the former Syngenta Works site testing



6.3 Influence of proposed development site scheme on flood risk

6.3.1 Change in predicted flood risk

Changes in predicted flood risk brought about by the schematisation of the site configuration reported in 6.2.1 are displayed in Figure 6-3 and Figure 6-4 for the 1% AEP and 1% AEP (plus 35% flows) undefended case events, respectively. In each figure, the change in flood depths after implementing the site configuration are reported, along with whether the scenario resulted in areas of increased or decreased flooding. A tolerance of 1mm is applied to the depth mapping, with any change in flood depths of less than 1mm not being reported as either and increase or decrease. It should be noted that in practice, the confidence that can be placed in the predictions of flood level difference in the model would warrant a larger band being used (e.g. due to the simplifications made in the modelling and scheme testing approach), but this has been selected as the overall change in levels in small, so provides a sensible banding.

In both events tested, flood depths are predicted to increase upstream (south, west and east) of the site. Peak flood depths are predicted to increase by 0.03-0.04m at the site itself, south of where the roads are implemented. South of the site boundary, increased flood depths of up to 0.02m are predicted (also west of the railway line in the 1% AEP + 35% flows event), extending southwards adjacent to the railway line to the north of Stoneham Lock. Beyond this area, predicted increases in flood depths are up to 0.01m, with the increased flooding predicted to extend west towards Hale Street, East Peckham, south beyond Laddingford and east towards Hunton. Reductions in flood depths of up to 0.01m are predicted downstream (north) of the site boundary. Across the area, changes in flood extents are small in both events, with only minor changes in the area predicted as flooded (typically single model cells). This is expected given the changes in water levels are small, and the floodplain is so widely inundated.

Within the 1% AEP event, the roads remain dry, with flooding removed from these routes. However, in the 1% AEP +35% flow event, the access/egress route schematised west of the railway experiences very shallow flooding, indicating the level needed to be raised slightly higher. Flood Hazard rating in the 1% AEP +35% flow event (Figure 6-5) indicates that where flooding of the access and egress route is predicted at this location, the hazard rating is very low. The reduction in flooding at the site is also evident.

Increased flooding predicted south of the site (as well as decreased flooding predicted north of the site) following the implementation of the site configuration suggests that the site is reducing conveyance of the floodplain. Elements of the floodplain reduced the northerly flow of flood water resulting in deflection of water and 'backing up' behind the site layout. Each element of the scheme (e.g. roads, employment land, residential land) has not been tested in isolation. However, it is expected that the presence of the roads across the floodplain may be a major contributing factor. Whilst culverts were implemented under the roads (2 no. 1m x 2m culverts every 40m), these are still likely to provide a constriction compared with the natural floodplain. It is considered that other elements of the scheme, such as the presence of the buildings at the employment land loss of floodplain volume (associated with the roads also), may be less influential, given the floodplain is expansive, widely inundated and the flood volumes are so large. Of note is that within the modelling the residential properties between the roads remain flood free due to presence of the raised roads. In practice, culverts may be implemented under the roads, connecting the residential areas and providing some additional conveyance through the floodplain. This would be beneficial for drainage of the residential areas but also lessen the volume of floodplain 'lost' due to the residential areas currently remaining dry. Future more detailed assessment may seek to take this approach forward in more detail.

Sensitivity testing was performed to understand whether increasing the number of culverts under the roads (as a means to increasing conveyance through the site) would lessen the predicted increase in flood risk. This involved additional modelling for both the 1% AEP and 1% AEP +35% flows events where the number of culverts modelled through the road was doubled. These outputs are presented in Figure 6-6 and Figure 6-7, respectively. In each case the same trend in flooding is predicted, but the depth changes predicted are slightly smaller. This evidences that further refinement of the scheme design could further mitigate the increased flooding. However, this would likely necessitate more detailed understanding of the proposed form of development, and feasibility of implementing culverts through the road. There may also be opportunity to explore other measures to improve conveyance through the site (e.g. implementing preferential drainage routes or landscaping to facilitate floodplain flow from south to north).

Figure 6-3: Change in flood depths and extents after implementing the indicative development form at the former Syngenta Works site (1% AEP undefended case event)

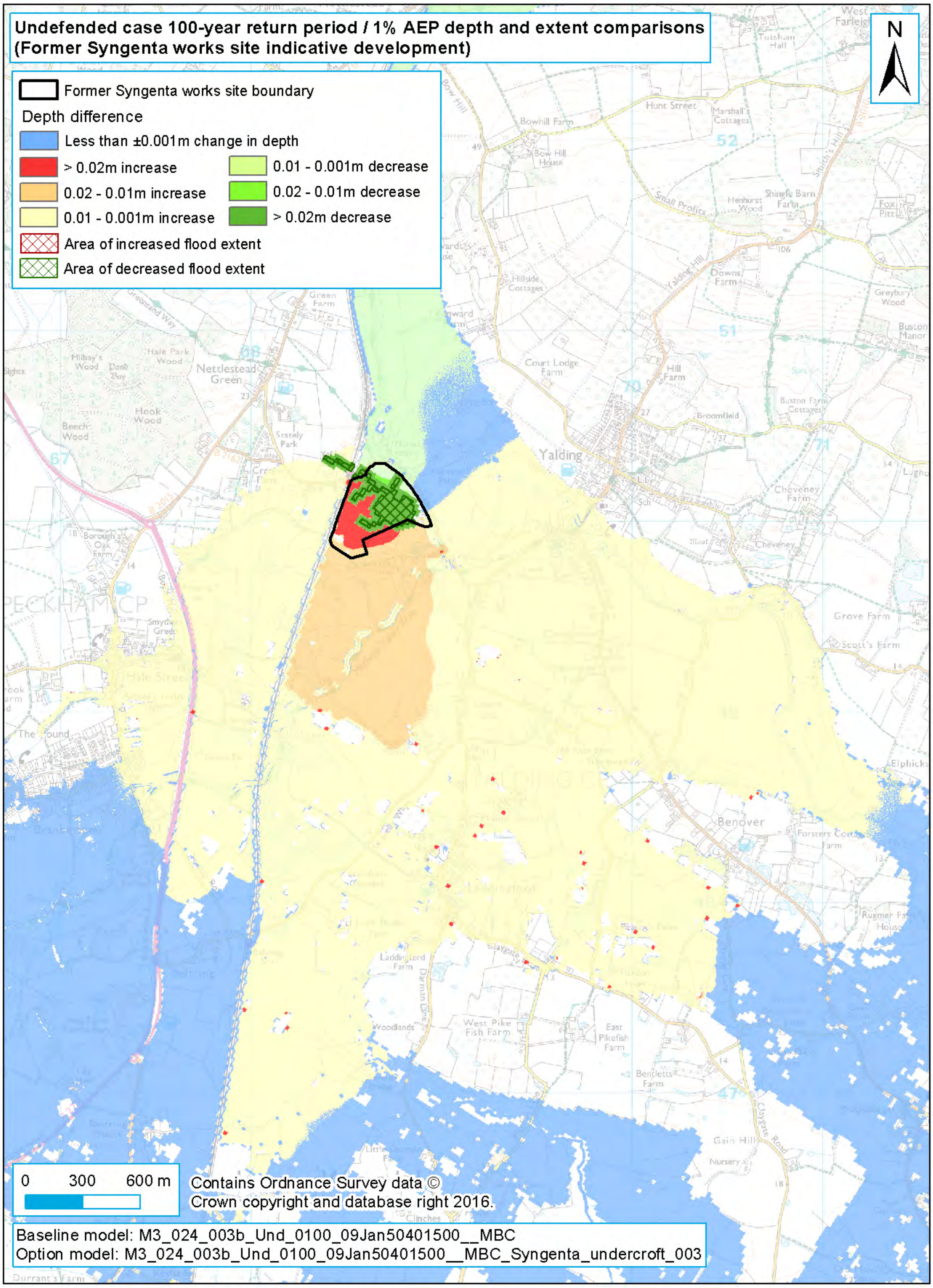


Figure 6-4: Change in flood depths and extents after implementing the indicative development form at the former Syngenta Works site (1% AEP + 35% flows undefended case event)

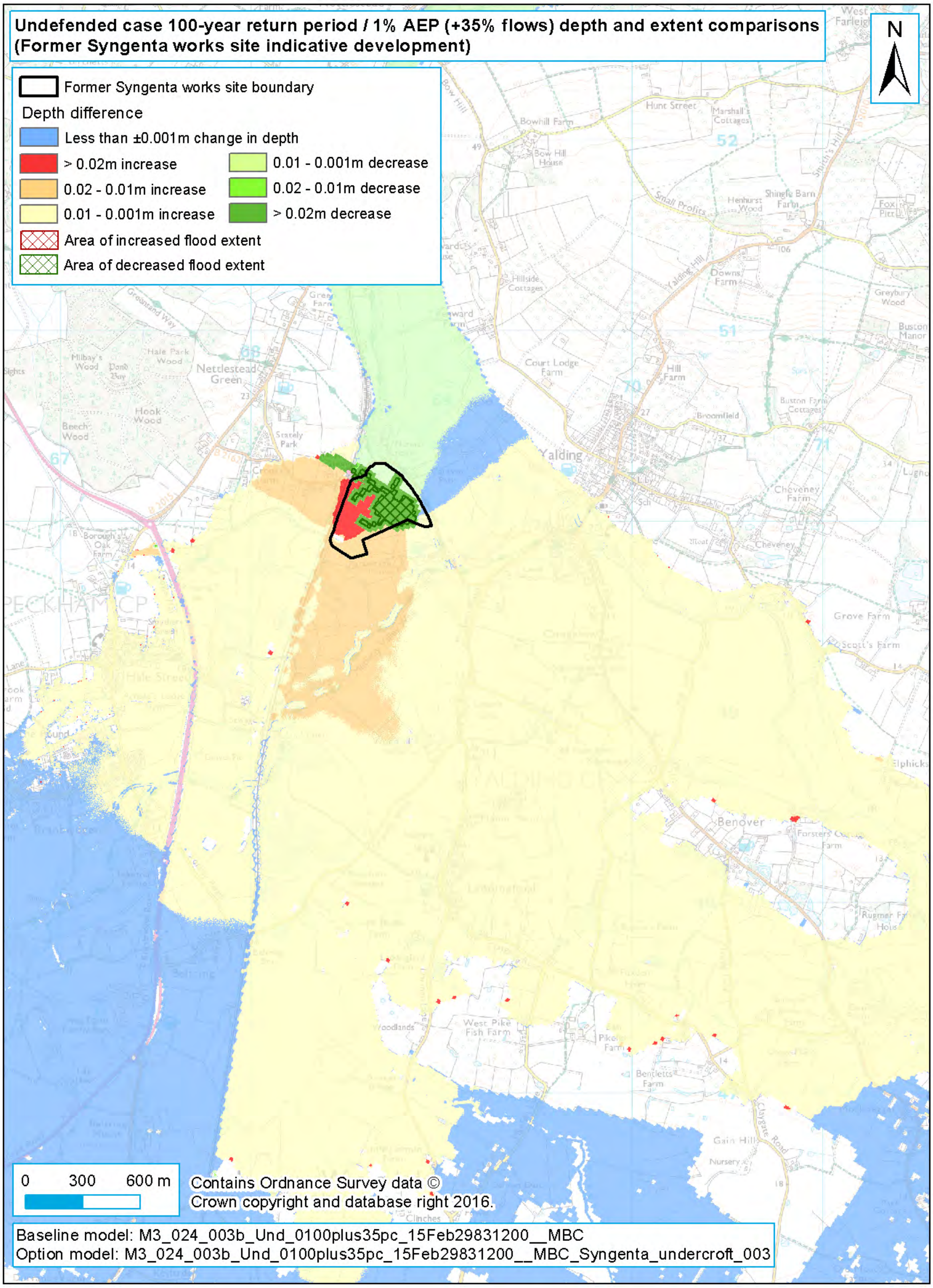


Figure 6-5: Hazard rating at the former Syngenta Works site, after implementing the indicative development form (1% AEP + 35% flows undefended case event)

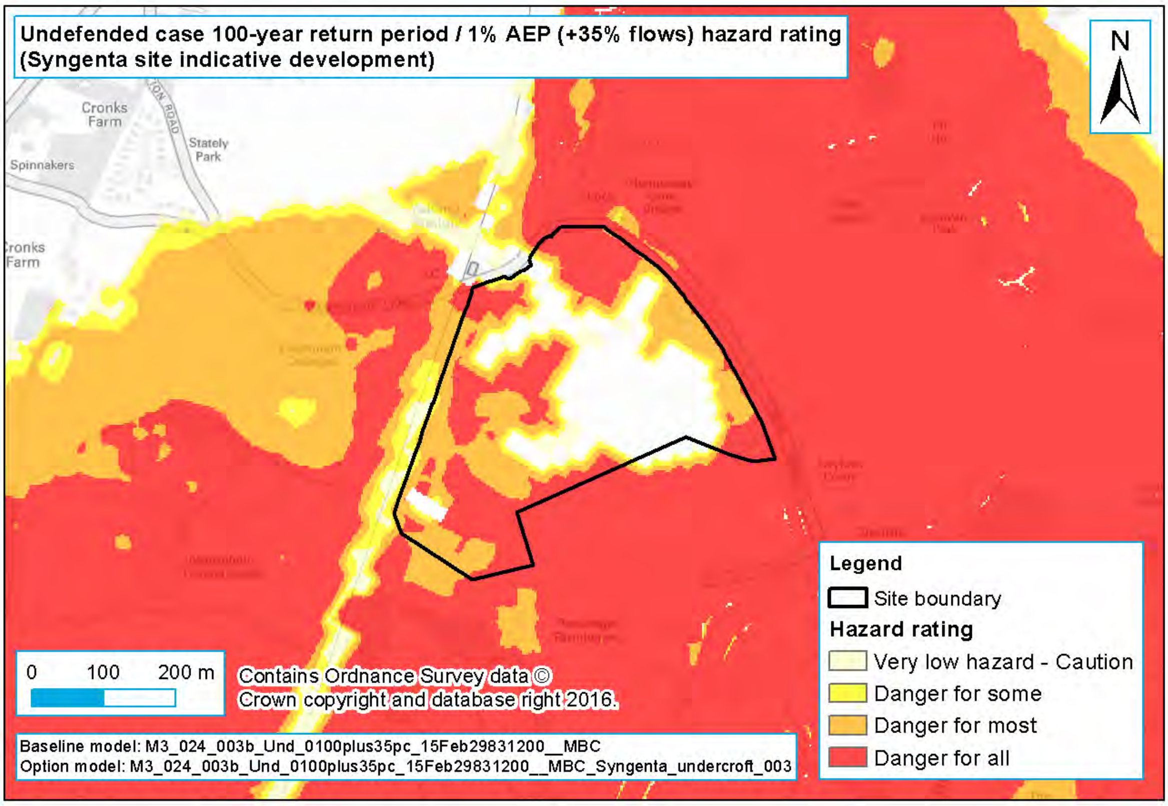


Figure 6-6: Change in flood depths and extents after implementing the indicative development form at the former Syngenta Works site, with double the number of culverts under roads (1% AEP flows undefended case event)

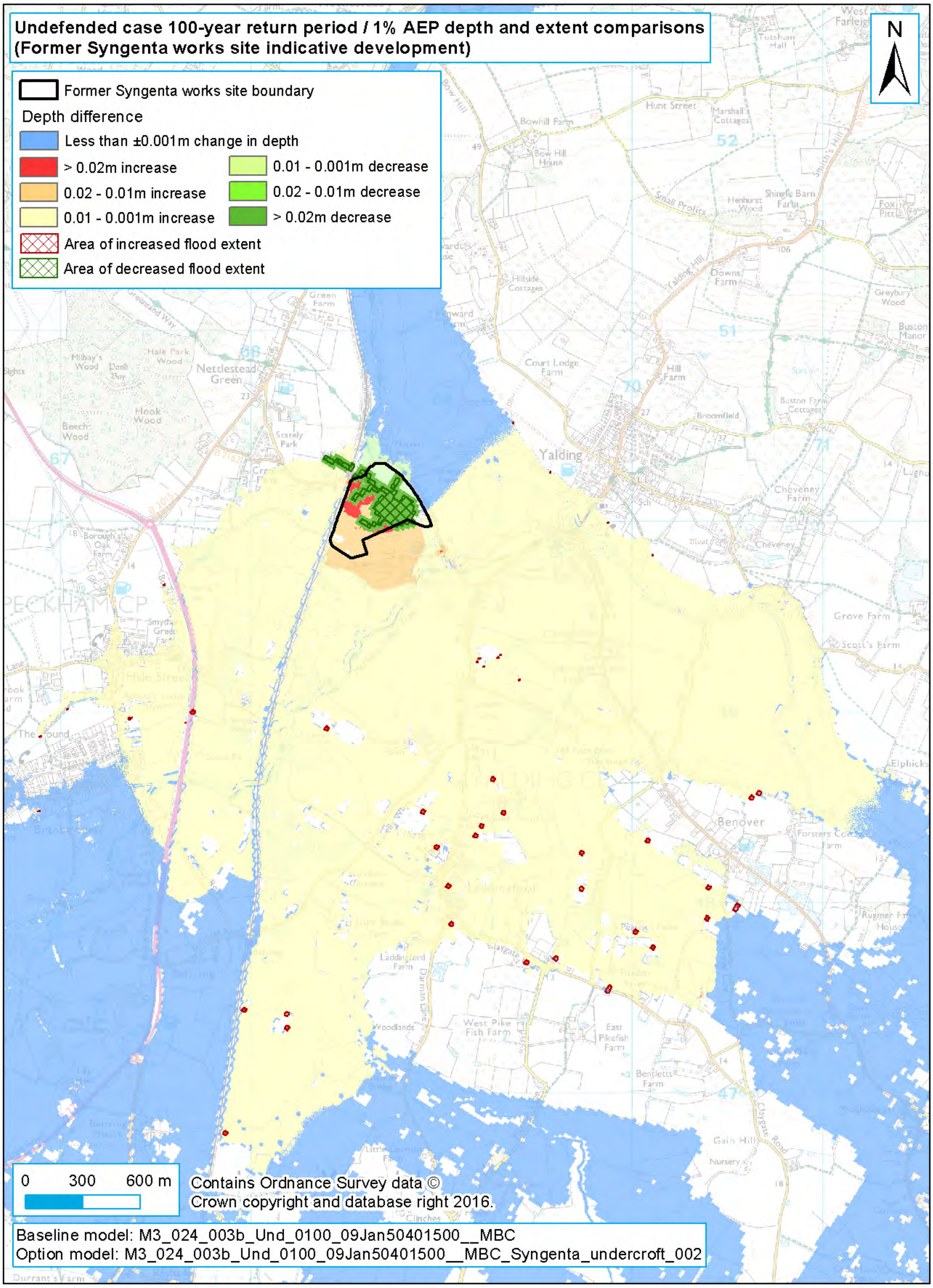
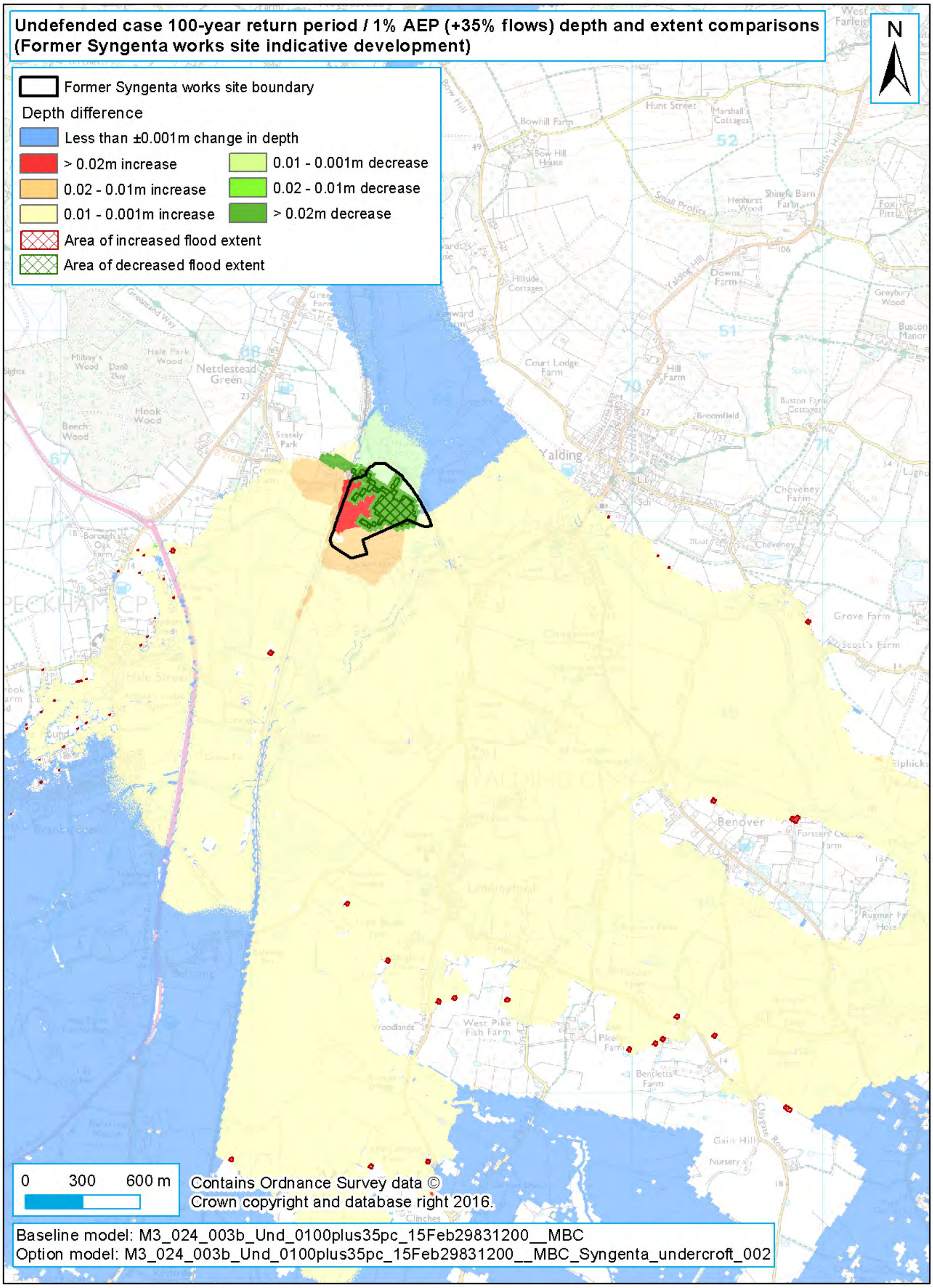


Figure 6-7: Change in flood depths and extents after implementing the indicative development form at the former Syngenta Works site, with double the number of culverts under roads (1% AEP + 35% flows undefended case event)



6.3.2 Potential for development following implementation

The modelling prepared, and presented above, investigating changes in flood risk resulting from the implementation of an indicative development at the former Syngenta Works site, shows a worsening of flood risk due to the presence of the development. Changes in flood extents are negligible, but flood depths are predicted to rise by up to 0.02m immediately south of the site boundary, and by 0.01m for a much larger geographical extent. Without further consideration of measures to mitigate these effects, such detriment in flood risk is unlikely to be acceptable.

Testing completed to date suggests that it may be possible to lessen the increase in flood risk by adjusting the development form and introducing further measures to mitigate the effects of the obstruction to flow presented by the proposed development. Progression of further testing is likely to be needed before the site can be progressed for development. In addition to the requirement to manage conveyance through the site so that no increase in flood risk is predicted, another element of this will be to evidence that there is no loss in floodplain volume on a level for level basis. Raising of land at the site (as has been tested with the roads), but also the presence of columns/pillars/walls associated with the undercroft parking/garaging will result in a loss of floodplain volume for which must compensation should be provided on land close to, the site. Based on ground levels at the site, it does not appear that onsite mitigation will be possible, so third party land is likely to be required to achieve this. Within the hydraulic model, full 20m wide grid cells are adjusted to represent the road on site. In practice, the roads are likely to be narrower than this, lessening the loss in floodplain volume. However, the obstruction to flow these present will remain given they intersect the floodplain.

A conceptual access and egress route to/from the site has been tested within the hydraulic model. Whilst this appears effective, evidenced by either no flooding, or in the case of the north western part of the access route, very shallow flooding, the feasibility of this access/egress route has not been investigated. For instance, the route involves third party land, modifications to the highway (Hampstead Lane) and assumes that the footbridge across the railway line is suitable for access and egress, or a further bridge in a similar location is constructed. Safe access and egress is likely to be a key element to the progression of any residential scheme at the site, and therefore careful consideration of how this would be achieved will be required.

At this point it is important to note that only one possible site layout/configuration has been tested as a means to providing indicative information on changes in flood risk. Therefore, are numerous factors which could influence how flood water interacts with the site, and how flooding is predicted to change post-development. If development at the site is progressed, it will be necessary to prepare more detailed flood risk modelling to support the actual scheme being proposed.

7 Conclusions and recommendations

7.1 Conclusions

Analysis has been performed on strategic flood risk management approaches at the former Syngenta Works site within Maidstone Borough. The analysis investigated current levels of flood risk at the site (presented in Appendix A), the proposed development type and possible flood risk management options to potentially reduce flood risk at the site.

Following initial consideration of strategic flood risk management approaches, three were considered in greater detail: 1) defences, 2) land raising and 3) channel modification. Each option was assessed against five performance measures: a) potential effectiveness of scheme at reducing flood risk, b) comparative cost (including cost of mitigation requirements), c) constraints to implementing the potential flood risk management approach, d) potential requirement for mitigation measures and e) potential to manage residual flood risk after the flood risk management option has been implemented. At the site, land raising was recommended as the strategic flood risk management approach to consider further as a means to reducing flood risk, and initial assessments were prepared to understand the implications.

Feedback on the initial assessments received from Maidstone Borough Council and the Environment Agency was that both parties were in agreement that land raising was the preferred choice of strategic flood risk management approach at the site. However, Maidstone Borough Council requested that further testing of alternatives was performed using the hydraulic model which covers the area of the former Syngenta Works. The strategic approach of raising land across all or parts of the site was therefore not progressed further. The revised testing assessed the effects of implementing undercroft garaging at ground level, with residential development located on floor levels raised above the peak flood levels. Under this approach it is considered that there would be prohibition by condition of any residential accommodation at ground level.

Hydraulic modelling was completed for the pre-development and indicative development scenarios at the site. This was conducted for the 1% AEP and 1% AEP plus climate change (+35% flows) undefended case events. Under the indicative development scenarios implementation of undercroft garaging was tested, but the model representation also considered employment land at the west of the site, raised roads within the site (with culverts through these) and an indicative 'safe' access and egress route north of the site. Refer to section 6.2 for further information.

At the site, the assessment of the indicative development layout gave results that predicted an increase in flood risk to the south, west and east of the site. At the site itself increases to peak flood depths of 0.03-0.04m are predicted. Immediately south of the site, flood depths increase by 0.01-0.02m, and in the wider areas flood depths of up to 0.01m are predicted. It is expected that increased flooding results from reduced conveyance through the site, brought about by the presence of the raised roads that are in place to provide safe access. Whilst some culverts were implemented in the road embankments to convey flood water northwards and away from the site, a constriction to flow is still apparent. Increasing the number of culverts and also including these through the roads at the residential area itself may reduce the predicted increases to flood depths.

At the site the provision of safe access and egress requires a satisfactory solution. A conceptual access/egress route was tested, which remains dry for the majority of its length, and where flooding is predicted, has a very low hazard rating. However, it should be noted that the route is located on third party land, makes use of existing infrastructure, and the feasibility of the access/egress route schematised has not been determined.

7.2 Recommendations

Recommendations following the analysis prepared largely relate to progressing proposed development form in greater detail to explore whether there are supplementary measures that could mitigate potential adverse effects.

If it is proposed to further progress development schemes, it may be advisable to refine the modelling approach (e.g. model resolution, representation of elements of the scheme) and test predicted impacts on flood risk for a larger number of events, such as events smaller than the 1% AEP event. At the planning application stage, the council should satisfy themselves that the testing and assessment performed for this study is representative of the future intended development at the site. For instance, if the areal extent of development changes materially, or the manner in which the development will be implemented (e.g. no longer taking forward undercroft garaging) is adjusted, the suitability of the site for given types of development should be re-assessed.

Specific points to consider relating to future analysis include:

- What shape, size and therefore obstruction, the development will take. This also includes the positioning of the employment and residential land and orientation of the roads.
- How much floodplain volume is lost due to implementation of aspects of the development (e.g. the raised roads, and in the case of undercroft garaging – the columns, pillars and walls which would support the building above) and how this would be compensation on a level for level basis.
- How safe access and egress at the site will be achieved and maintained for the lifetime of the development
- How surface water will be managed at the site, particularly given the high levels of fluvial flood risk predicted at the site

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Appendices

A Site flood risk summary sheet

Former Syngenta Works, Hampstead Lane, Yalding

OSNGR: 568667, 150059	**Net developable area:** 13.94ha		Brownfield	
Flood Zone Coverage:	**FZ3b** 25.1%	**FZ3a** 73.7%	**FZ2** 1.2%	**FZ1** 0.0%

Proposed development details:

It is proposed that the site is developed for mixed land uses (Less Vulnerable and More Vulnerable development types).

Sources of flood risk:

The main source of risk to the site is from fluvial flooding from the River Medway. The mapping suggests that that the majority of the site is located within FZ3a. However, the central section of the site is located within FZ3b where water has to flow or be stored in times of flood.

When considering Flood Zone 3a with a 35% increase in peak flows (to account for climate change), the hazard rating for the majority of the site is classified as 'Danger for All'. The western area and eastern boundary of the site, however, have a hazard rating for 'Danger for Most' and 'Danger for Some'.

A few small areas of the site are at risk from surface water flooding; most of which are located within the area of FZ3b.

Exception Test Required?

Yes – A More Vulnerable development type is proposed as located within FZ3a.

More Vulnerable and Less Vulnerable developments should not be permitted in FZ3b.

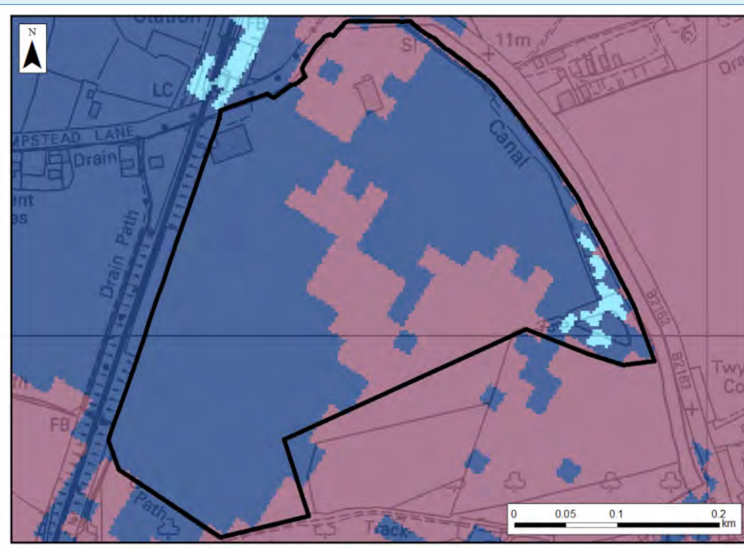
NPPF Guidance:

To pass Part 'b' of the Exception Test, a FRA should demonstrate that the development will be safe, avoid increasing flood risk elsewhere, and reduce the flood risk overall.

- The majority of the strategic site is located in FZ3a and FZ3b, meaning Highly Vulnerable development is not appropriate at this site.
- Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development. The sequential approach should be applied to development layout, locating the most vulnerable land uses in areas at lowest risk. High risk areas should be used for open spaces where possible.
- Modelling of future scenarios of climate change indicates that there is likely to be an increase in flood depths in FZ3a at the site. Flood extents change little as the site is already widely inundated. The future extents should be considered when applying the sequential approach to the layout.
- The exact ground and groundwater conditions at the site are unknown and should be investigated further as part of the design of the drainage system and any other flood risk mitigation measures.
- To avoid increasing flood risk elsewhere, the effect of any modifications to the site topography on flood risk should be considered, and appropriate surface water management techniques should be adopted.

Flood Zone Map:

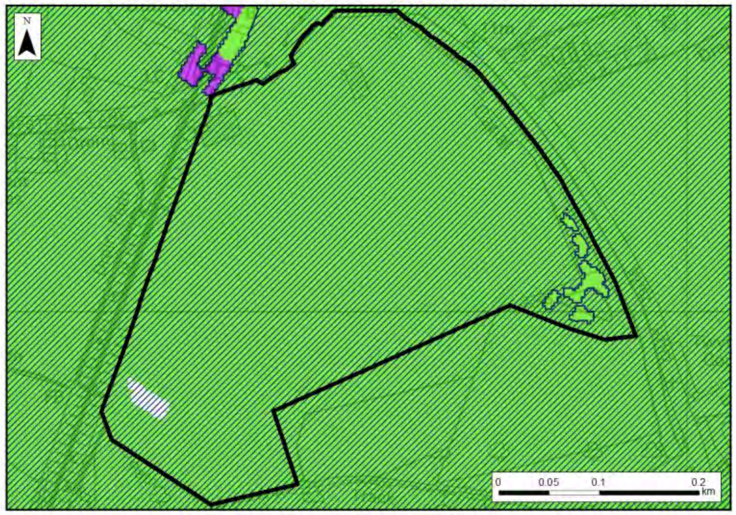
- Maidstone Borough Council boundary
- Strategic site boundary
- Flood defences
- Areas benefitting from defences
- Flood Zone 3b
- Flood Zone 3a
- Flood Zone 2



No flood defences are located in close proximity to the site.

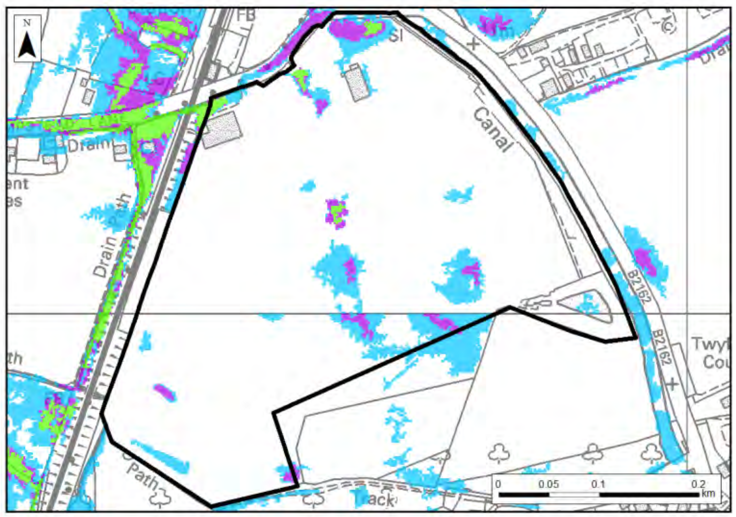
Climate Change Map (fluvial flood risk – Flood Zone 3a):

- Maidstone Borough Council boundary
- Strategic site boundary
- Flood Zone 3a
- Flood Zone 3a with climate change (+35%)
- Flood Zone 3a with climate change (+70%)



Surface Water Map:

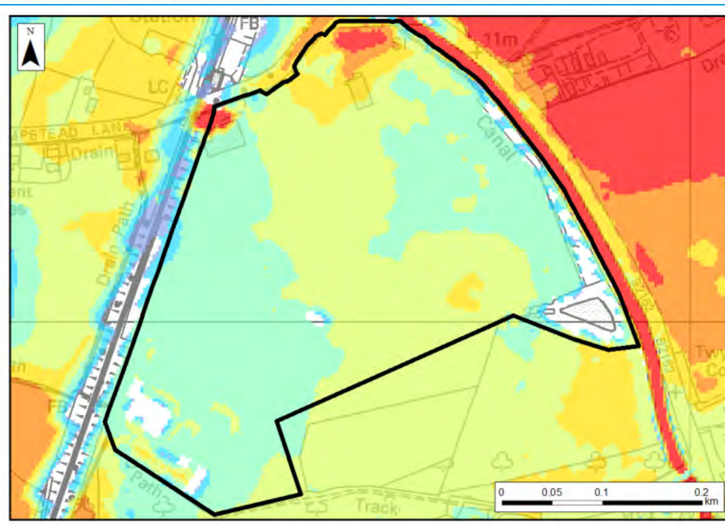
- Maidstone Borough Council boundary
- Strategic site boundary
- uFMfSW 30-year extent
- uFMfSW 100-year extent
- uFMfSW 1000-year extent



Depth Map – Undefended case 1 in 100-year (1% AEP) flood event:

- Maidstone Borough Council boundary
- Strategic site boundary

Depth (m)	
0.00 - 0.10	1.00 - 1.50
0.10 - 0.50	1.50 - 2.00
0.50 - 1.00	2.00 - 2.50
	2.50 - 5.00



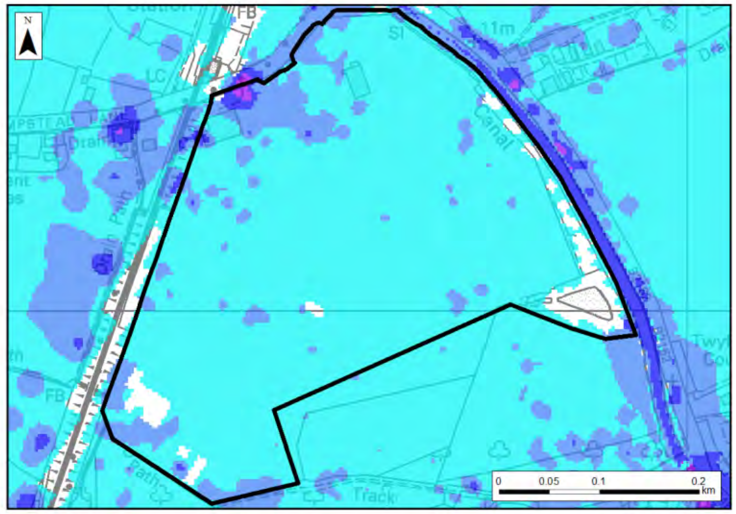
Velocity Map - Undefended case 1 in 100-year (1% AEP) flood event:

Maidstone Borough Council boundary

Strategic site boundary

Velocity (m/s)

- 0.0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0



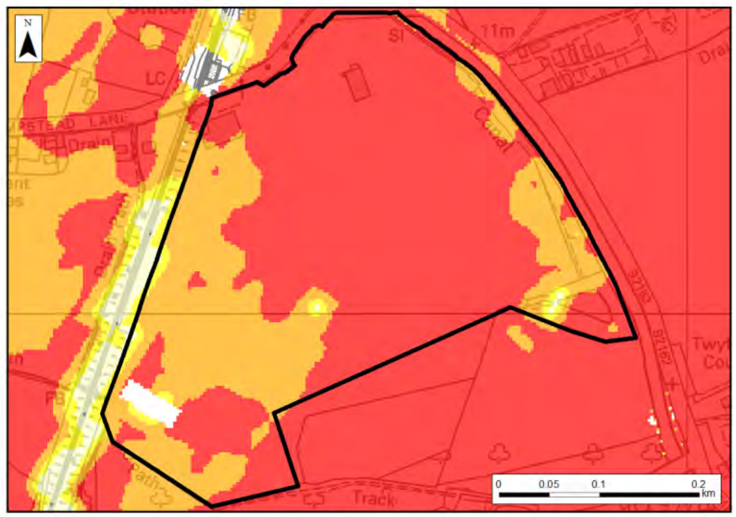
Hazard Map - Undefended case 1 in 100-year plus 35% flows (1% AEP + 35%) flood event:

Maidstone Borough Council boundary

Strategic site boundary

Hazard rating

- Very low hazard - Caution
- Danger for some
- Danger for most
- Danger for all



SuDS & the development site:

Note: no account is made in the assessment below of flood water being on the site during times of rainfall. This would be likely to influence the effectiveness of SuDS measures and should be considered when progressing schemes at the site.

SuDS Type	Suitability	Comments
Source Control		Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk of contaminated lands from designated landfill within the site boundary.
Infiltration		Infiltration may be suitable. Mapping suggests a low risk of groundwater flooding with freely draining soils. However, areas of the site have been designated as containing historic landfill, meaning that further site investigation should be carried out to assess potential for drainage by infiltration.
Detention		Mapping suggests that the site slopes are suitable for all forms of detention. If the site has contamination; a liner will be required.
Filtration		All filtration techniques are likely to be suitable. If the site has contamination issues; a liner will be required.
Conveyance		All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination issues; a liner will be required.

- The strategic site has areas within its boundary designated by the Environment Agency as being a landfill site. A thorough ground investigation will be required as part of a detailed FRA to determine the extent of the contamination and the impact this may have on SuDS. As such proposed SuDS should be discussed with the relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints.
- The strategic site is not located within any Environment Agency designated ground source protection zones.

Flood Defences:

The strategic site is not specifically protected by any formal flood defences. However, Leigh Flood Storage Area upstream is expected to provide some reduction in peak flows contributed from the River Medway in times of flood.

Flood Warning:

This strategic site is covered by an Environment Agency flood warning for the River Medway and The Bourne at East Peckham, including Little Mill and Hale Street.

Access & Egress:

Safe access and egress need to be considered when locating development within the site boundary. Potential access routes to the site include Hampstead Lane (B2162) and the small access track/road located along the site's southern boundary leading to Parsonage Farmhouse. However, access and egress via these routes in times of flood is likely to be limited due to the depths and extent of flood water predicted at these locations.

Climate Change considerations:

- Increased storm intensities
- Increased water levels in the River Medway, due to increased flows.

Flood Risk Implications for Development:

- At the planning application stage, a site-specific FRA will be required to address the flood risk from all potential sources.
- Mitigation measures will be required if buildings are situated in areas at risk of flooding. Any mitigation measures should be designed to ensure that the development remains safe throughout its lifetime.
- Green infrastructure should be considered with the mitigation measures for surface water runoff from any potential development.
- The peak flows of the River Medway, and potential for flooding of the site, should be considered when designing site drainage.
- Assessment of runoff should include allowance for climate change effects.
- New development or redevelopment should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Discharge rates from the site should not increase downstream.
- Safe access and egress would need to be demonstrated. This should include consideration of the effects of climate change to ensure that access and egress remains safe throughout the lifetime of the development.
- New development should seek opportunities to reduce the overall level of flood risk at the site and in surrounding areas. This may include:
    - reducing volume and rate of runoff;
    - relocating development to zones with lower flood risks; and
    - creating space for flooding.
- Consultation with the Local Authority and the Environment Agency should be undertaken at an early stage.

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