Flood Risk Assessment



Site:
Farm, Barrier Bank, Peak Hill, Spalding PE6 0JL

Applicant:
J.W.E Banks Ltd

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Chartered Practice

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Introduction

Origin Design Studio Ltd have been appointed by J.W.E Banks Ltd to prepare a Flood Risk Assessment to accompany a planning application to South Holland District Council for a residential development.

The site is contained within all three flood zones, this is the basis upon which a Flood Risk Assessment is required. The approach to flood risk is set out in the National Planning Policy Framework (NPPF), refer to Appendix A with more local planning policy set out in the South East Lincolnshire Local Plan (SELLP), refer to Appendix B. This Flood Risk Assessment assesses the site in accordance with the policy requirements of the NPPF and the SELLP.

The Site

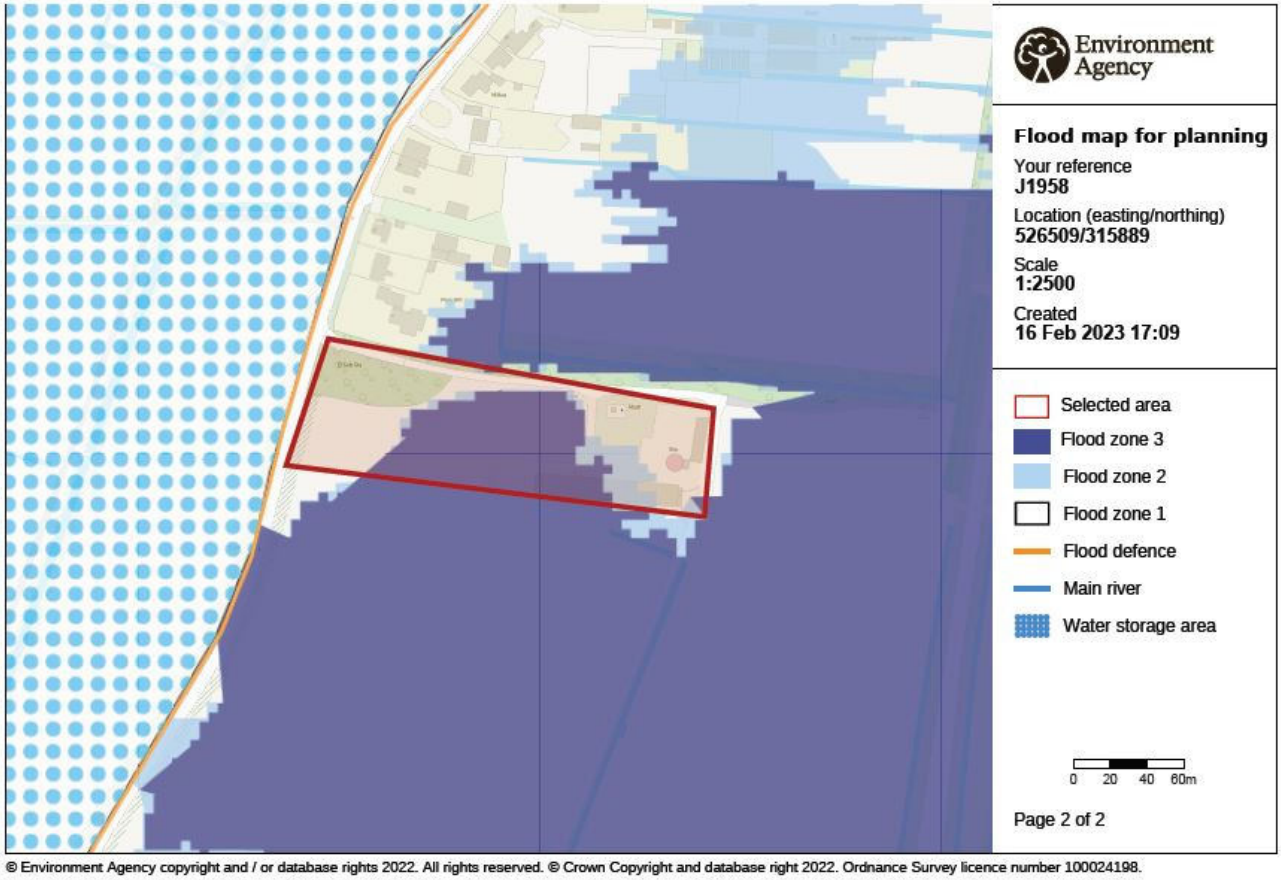
The site is located at Barrier Bank, Peak Hill, Spalding. The site is located at the end of an access track, approximately 100m long that junctions with Barrier Bank. The site has a number of agricultural buildings. These include a traditional red brick barn, a grain silo and a large grain store. To the north west of the site are a number of dwellings associated with the small settlement of Peak Hill. To the south and east of the site are agricultural fields.

Findings

Risk of Flooding from River and Seas

Flood Zone

The site is contained within a Flood Zone 1,2, & 3. However, for the purposes of this flood risk assessment the site is considered to be in a Flood Zone 3. Flood Zone 3 shows the area at risk of flooding for an undefended flood event with: a 1% or greater probability of flooding from rivers or 0.5% or greater probability of flooding from the sea.



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Figure 1: Flood zone map (the site is marked with a red line).

Historic Flooding

The Environment Agency (EA) have information about historical flooding near to the site, refer to Appendix E. The March 1947 flood on the River Welland near Cowbit may have lead to flooding on site if it were not for Barrier Bank which acts as a flood defence for the land to the east of the Welland.

Sequential & Exception Test

The proposed development is residential and will result in 4No. two storey dwellings new build dwellings. Therefore, flood risk is considered on this basis.

Developments need a sequential test when the development is in flood zone 2 or 3 and a sequential test hasn't already been done for a development of the type planned on the proposed site.

The purpose of the sequential test is to direct development to land of lower flood risk. The sequential test compares the proposed development site with other available sites to find out which has the lowest flood risk.

The residential use is classified as "more vulnerable" in accordance with Table 2 – Flood Risk Vulnerability Classification.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Figure 2 – Table 3 – Flood Risk Vulnerability and Flood Zone Compatibility (www.gov.uk)

In accordance with Figure 2 (Table 3) where a site is located in a Flood Zone 3 with a vulnerability classification of “more vulnerable” development is considered to be compatible providing the exception test is satisfied. Therefore, the development will need to pass both a sequential test and exception test.

In this case the scheme should be viewed in light of an established fallback position under Class Q of the GPDO. The prior approval application for the permitted development right allowed for the conversion of the existing agricultural building to form 5 single storey dwellings.

Here the new build scheme is for 4 dwellings and takes a sequential approach within the site. This involves siting the development where possible on land with lower flood risk within the confines of the site. Differences in the two schemes include for the reduction of the number of units from 5 to 4, a reduction in the amount of development contained in flood zones 2 & 3 and all proposed units will be two storey rather than single storey. On this basis it is considered that the sequential test is passed and the exception test is passed due to there being an element of flood risk betterment.

Site Levels

A topographical survey shows that levels on the site vary from +5.60mAOD at its highest point where the track joins the main road to +1.27mAOD at its lowest on land to the south of the existing agricultural buildings.

Calculating the Flood Level

Where possible all habitable floors should be above the flood level. Where the accommodation is proposed to be two storeys the 1 in 100/200-year flood level plus climate change will be used to ensure habitable floors are above the flood level. In the case where a single storey building is proposed habitable floors should be above the 1 in 1000-year flood level plus climate change. In both cases a safe point of refuge can be established and therefore provide protection to the inhabitants of the building.

In this case it is proposed to create a 4No. two-storey dwellings and therefore the 1 in 100/200 flood level plus climate change is to be used. To determine the flood level the fluvial and tidal sources will be looked at to determine the worst case and an appropriate floor level.

Tidal Flood Sources

The site is not at risk from tidal sources of flooding.

Fluvial Flood Sources

The site is at risk of fluvial flooding from main rivers. The main risk to the site is the River Welland located some 750m to the west of the site and Crowland-Cowbit Washes located 150m to the west of the site.

The site is protected by fluvial flood defences. These include Crowland-Cowbit Washes and embankment. They are in a fair condition and provide protection against flood event with a 1% chance occurring in any year. The Crowland-Cowbit Washes are considered to be a reservoir and are discussed in a later section of the report.

Given the site is protected by adequate defences, namely the embankment of the river and Barrier Bank the site is at risk from a residual risk of breaching of these defences. For the purposes of the breach analysis for the River Welland it is assumed that the Barrer Bank does not offer protection to the site, where in reality it would do.

Currently there is no EA fluvial hazard modelling that covers the site. The EA modelling appears to limit flooding to the east of Barrier Bank but does not consider a potential breach of Barrier Bank. Notwithstanding this the Strategic Flood Risk Assessment includes a combined Fluvial and Tidal extents map for both present day and climate change scenarios for 1:100/200-year events. Given the site does not suffer from Tidal flooding it is therefore assumed that the map shows the extents of fluvial flooding only.

The hazard maps show the site is not at risk from present day 1:100-year flood event. Further to this for the 1:100-year event plus climate change the site is shown to be contained in a range of depths, refer to Figure 3. Overlaying this with the building suggests that there would be a variety of flood depths experienced within the building, some locations where no flooding would occur to a small area shown to experience up to 1m in flood depth. However, this would appear to be non-sensical as the ground floor of the building is level. Overlaying the flood depth map with topographical survey could provide a way to analyse the predicted flood depth, however the scale of the mapping only provides a crude correlation between the topographical levels and flood depths. It is suggested that the maximum flood level for the 1:100-year event plus climate change would be around 0.5m.

The hazard mapping suggests a range of hazards onsite. The maximum hazard experienced onsite would be “Danger For Most” in the design event.

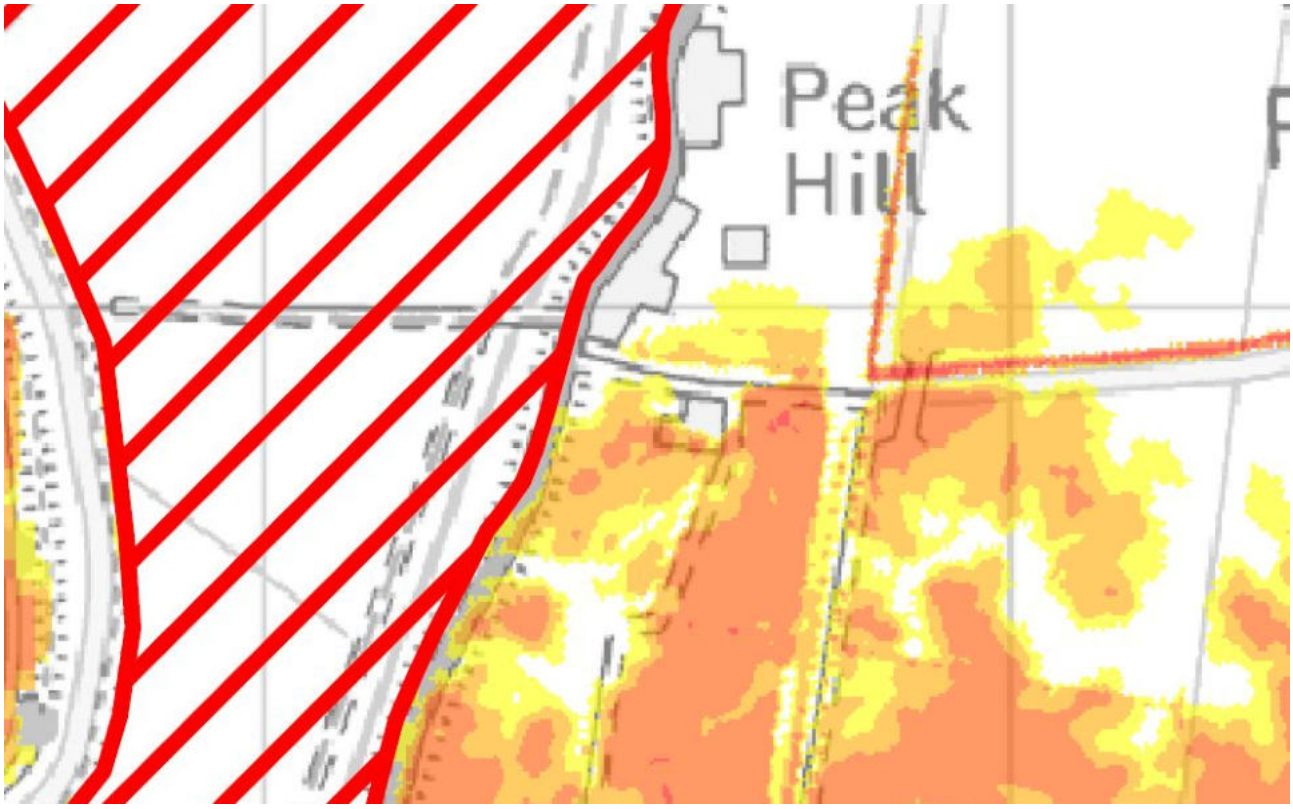


Figure 3 – Residual Peak Depth Map 1% fluvial/0.5% tidal event probability (2116)

Data from the Environment Agency includes in channel data for the River Welland and Washlands, refer to Appendix E. It does not contain Hazard mapping for modelled breaches or overtopping which may affect the site.

A simplistic breach model using the in-channel levels of the River Welland and Washlands offer the best way to establish a 1:100-year flood level including climate change for the site. The worst-case levels for the River Welland are from node WELLAND 21724 from the River Welland. A topographical survey profiling the watercourse has not been undertaken of the Welland however information available on OS maps suggest the embankment levels are around 5m and the Barrier Bank are around 6m. The simplistic model only considers an oncoming wave depth and assumes the land downstream of the breach to be taken down to 2.0m. The breach of the River Welland is discussed in this section whereas the breach for the Washlands is in the section that discusses reservoirs. However, for the purpose of design and setting the floor level it will be treated as a fluvial source of flooding.

Global warming is now recognised that it is likely to affect the frequency and severity of extreme events such as both tidal and fluvial flooding. The climate change allowances in the NPPF Guidance were updated on the 19th February 2016 and again on 17th December 2019. The site lies within the Welland Catchment and allowances for climate change should be made on the following basis. For a worst-case scenario, the site shall be considered to be in a Flood Zone 3a and the use classification is ‘more vulnerable’ therefore Peak River flows use the higher central and upper end to assess a range of allowances.

The adjustments for peak flows can be seen in the table below. For simplicity, for design a 28% increase to peak flow will be used to determine the 1 in 100-year flood level plus climate change and

the design will be tested for sensitivity using a 53% increase to peak flows for the 1 in 100-year event.

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Welland	Upper	22%	26%	53%
	Higher	10%	10%	28%
	Central	5%	4%	17%

Figure 4 - Table 1 peak river flow allowances by river basin district (use 1961 to 1990 baseline)

A flow discharge curve can be established using the increase in flow to calculate and establish in-channel levels of the River Welland for the additional climate change scenarios.

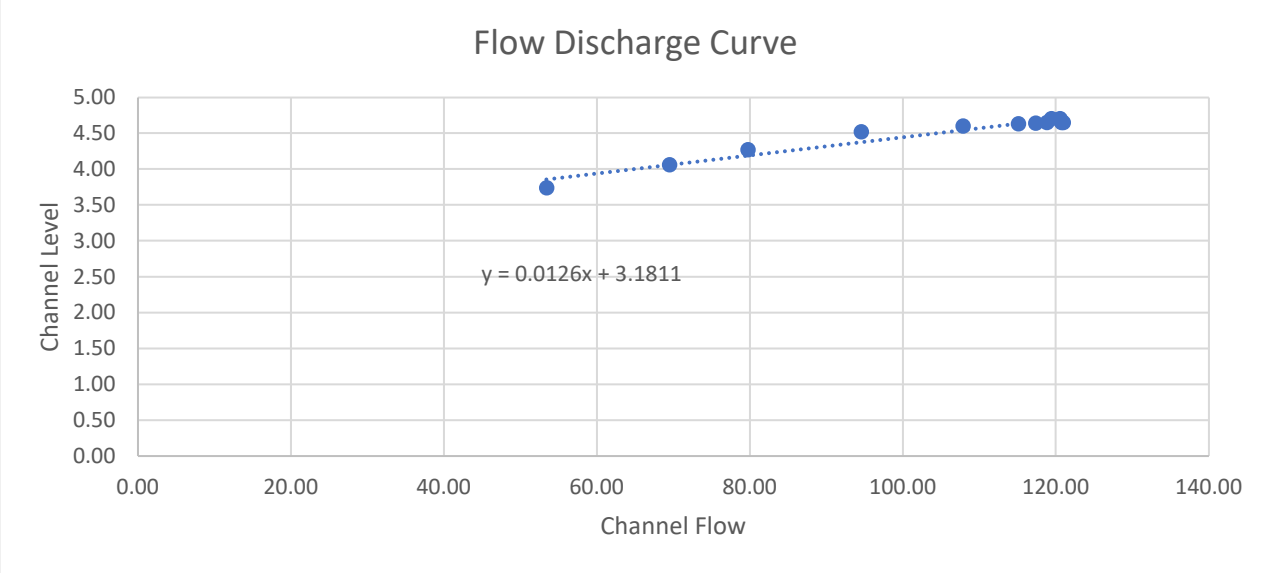


Figure 5 – Flow discharge curve for River Welland node 21724

Event & Climate Change (%)	Flow (m^3)	Level (m)
1% +28%CC	118.88	4.68
1% +53%CC	117.22	4.66

Figure 6 – Calculated Levels for Climate Change for Node 21724

Unusually the approach for establishing a growth curve/line results in reduced flow and reduced levels. For simplicity the worst-case level will be used in a breach analysis. This is from the 1 in 100-year level plus 20% climate change where the level is +4.70m in-channel. The distance from the flood source to the nearest dwelling within the Flood Zone will be used to establish the flood level for

the site. A breach analysis using data from this node is contained in Appendix C and the on plain 1:100-year level including adjustment for climate change for the site is +0.28m above existing ground level. It should be noted that this does not produce a worst-case result when compared to the hazard mapping for the 1:100-year event plus climate change or that of flooding from the reservoir.

Risk of Flooding from Surface Water

The risk of flooding from surface water is very low on the site. The following map shows the Environment Agency's Risk of Flooding from Surface Water map:

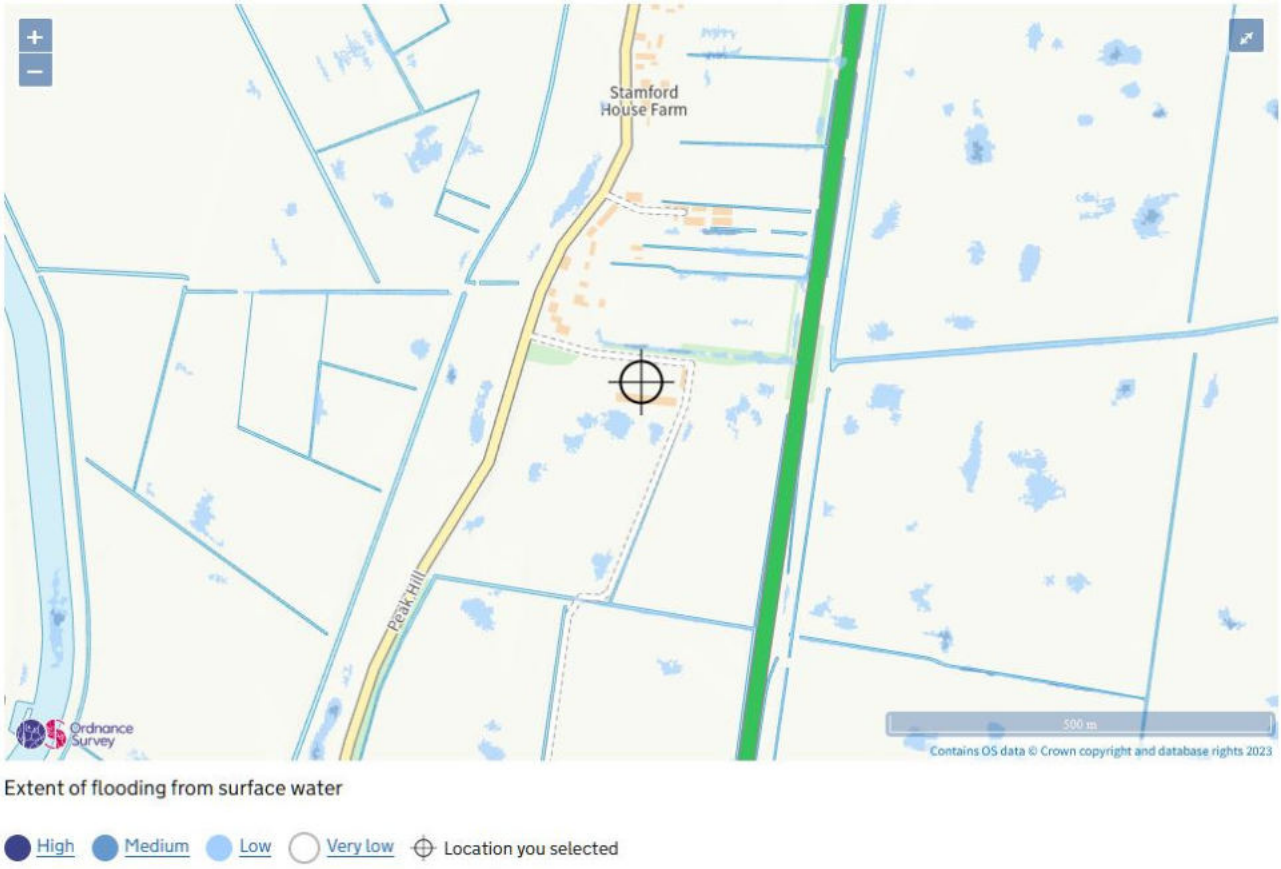


Figure 7: Surface Water Flood Map (www.gov.uk)

The site does not suffer from surface water flooding. No further action is required.

Risk of Flooding from Reservoirs

There is a risk of flooding from reservoirs when river levels are normal. The following map shows this on the Environment Agency's Risk of Flooding from Reservoirs map*:*

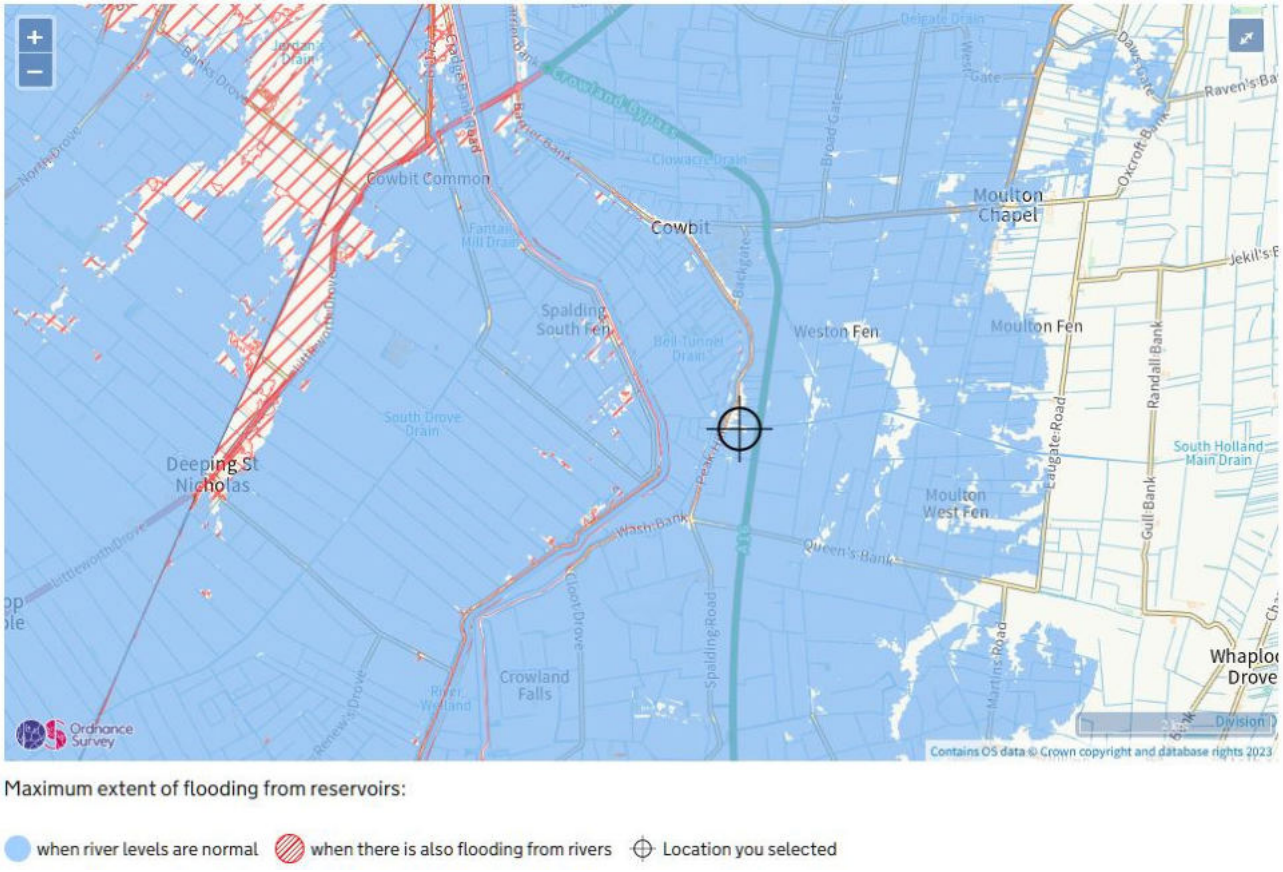


Figure 8: Reservoir Flood Map (www.gov.uk)

The flooding shown on the map above is the result of flooding from the Crowland and Cowbit Washes. This is designated as a large, raised reservoir under the Reservoirs Act 1975. There is the potential for overtopping or a breach of the flood defences to cause flooding to the site. "in-channel" levels of the reservoir are included within the flood data issued by the Environment Agency. The levels indicated are significantly below "in-channel" levels of the River Welland. A breach in the Barrier Bank would be a much closer flood source than a breach in the embankment of the River Welland, namely 150m compared to 750m. A breach analysis of the reservoir has been considered in Appendix C.

The worst-case flows and levels for the Crowland and Cowbit Washes are from nodes WASHLANDS 6100 (Levels) and WASHLANDS 6545.38 (Flows) from the River Welland. These have been used to create a flow discharge curve using the increase in flow to calculate in-channel levels of the Washlands for the additional climate change scenarios outlined in Figure 9 and 10.

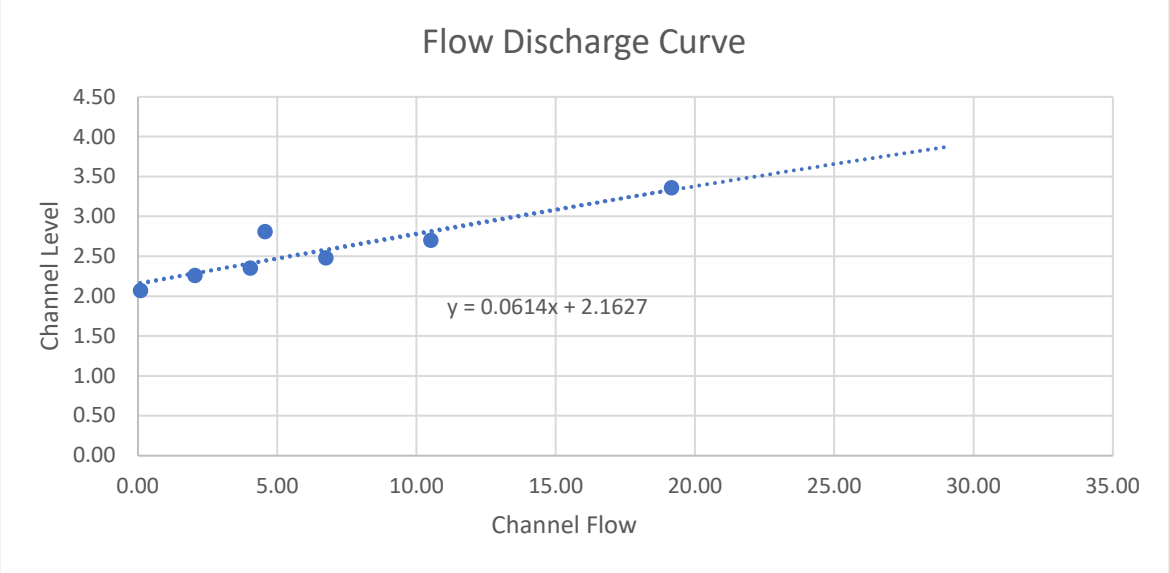


Figure 9 – Flow discharge curve for Crowland and Cowbit Washes

Event & Climate Change (%)	Flow (m^3)	Level (m)
1% +28%CC	4.76	2.13
1% +53%CC	5.42	2.20

Figure 10 – Calculated Levels For Climate Change

The results from the breach analysis, refer to Appendix C, do not produce a worst-case result when compared to the hazard mapping for the 1:100-year event plus climate change. For the design event the 1:100-year level including 28% climate change flood level for the site is +0.111m above ground level. The 1:100-year level including 53% climate change is +0.120m above ground level.

Risk of Flooding from Sewers

There are no known public surface water and foul water sewers that currently exist on the site that are known to suffer from sewer surcharging. All new infrastructures to service the dwellings shall be appropriately designed to the relevant standards to ensure failures do not present a problem.

Safe Access & Egress

The proposed ground floor level will be above the predicted worse case flood level and provide a safe refuge. The access track to Barrier Bank may be passable allowing for safe passage along Barrier Bank assuming the breach had not occurred in this embankment.

Setting the floor level

Standing advice requires finished floor levels (FFL) should be a minimum of whichever is higher of 300mm above the:

- Average ground level of the site
- Adjacent road level to the building
- Estimated river or sea flood level

The calculated 1 in 100-year flood level plus climate change is 0.28m above ground level. This results in a floor level of 580mm above the existing ground level. The average ground level is considered to be taken as +2mAOD setting a floor level to +2.58mAOD.

Further to the above the worst-case hazard mapping produces a flood depth of 500mm. Using the standard advice matrix for this case would results in a floor level of no less than 500mm above ground level. On this basis it is considered that the above measures are suitable for providing sufficient freeboard.

Conclusion

The proposed development is for 4No. two-storey dwellings. The site is contained within all 3 Flood Zones. A sequential approach onsite has been taken to limit development in Flood Zones 2 & 3.

The site is not at risk of tidal flooding but is at risk from fluvial flooding. The site is protected by adequate fluvial flood defences which are maintained by the Environment Agency. A residual risk to breaching of these defences exist.

The residential use falls within "more vulnerable" uses of land in Table 2 Flood Risk Vulnerability Classification and Table 3 shows that developments of this nature are appropriate in flood zone 3 subject to passing the Sequential Test and Exception Test.

In this case the proposed scheme should be viewed in the light of a fallback. It is considered the scheme provides a level of flooding betterment not available in the 'Change of Use' scheme. Therefore, it is considered this scheme passes the Sequential Test and Exception Test.

The predicted flood depth for the design event (1 in 100-year plus climate change) for the site is 0.28m. Standing advice requires ground floors to be set at a minimum of 300mm above the predicted flood level, resulting in a floor level of 580mm above ground level. Based on average ground levels it is considered that the floor levels be set at no less than +2.58mAOD. Flood resilient construction to a height 300mm above the predicted flood depth shall also be installed.

At the detailed design stage of the development advice contained in "Improving the Flood Performance of New Buildings - Flood Resilient Construction" should be followed.

Further to this the property will register to Floodline to receive advance warning of potential flooding.

New foul and surface water drains will be designed to the relevant standards.

Appendices

Appendix A – National Planning Policy Framework

PLANNING AND FLOOD RISK

159. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

160. Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.

161. All plans should apply a sequential, risk-based approach to the location of development–taking into account the current and future impacts of climate change[49] Except for applications for the repowering of existing wind turbines, a proposed wind energy development involving one or more turbines should not be considered acceptable unless itis in an area identified as suitable for wind energy development in the development plan; and, following consultation, it can be demonstrated that the planning impacts identified by the affected local community have been fully addressed and the proposal has their backing so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

    a) applying the sequential test and then, if necessary, the exception test as set out below;
    b) safeguarding land from development that is required, or likely to be required, for current or future flood management;
    c) using opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques); and
    d) where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.

162. The aim of the sequential test is to steer new development to areas with the lowest risk of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.

163. If it is not possible for development to be located in zones with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in national planning guidance.

164. The application of the exception test should be informed by a strategic or site-specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. For the exception test to be passed it should be demonstrated that:

    a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and
    b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

165. Both elements of the exception test should be satisfied for development to be allocated or permitted.

166. There planning applications come forward on sites allocated in the development plan through the sequential test, applicants need not apply the sequential test again. However, the exception test may need to be reapplied if relevant aspects of the proposal had not been considered when the test was applied at the plan-making stage, or if more recent information about existing or potential flood risk should be taken into account.

167. When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment[55]. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

    a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
    b) the development is appropriately flood resistant and resilient;
    c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
    d) any residual risk can be safely managed; and
    e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

164. Applications for some minor development and changes of use[56] should not be subject to the sequential or exception tests but should still meet the requirements for site-specific flood risk assessments set out in footnote 55.

165. Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

    a) take account of advice from the lead local flood authority;

[55] A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

[56] This includes householder development, small non-residential extensions (with a footprint of less than 250m2) and changes of use; except for changes of use to a caravan, camping or chalet site, or to a mobile home or park home site, where the sequential and exception tests should be applied as appropriate.

b) have appropriate proposed minimum operational standards;
c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
d) where possible, provide multifunctional benefits.

Appendix B – South East Lincolnshire Local Plan

POLICY 4: APPROACH TO FLOOD RISK

Development proposed within an area at risk of flooding (Flood Zones 2 and 3 of the Environment Agency's flood map or at risk during a breach or overtopping scenario as shown on the flood hazard and depths maps in the Strategic Flood Risk Assessment) will be permitted, where:

1. It can be demonstrated that there are no other sites available at a lower risk of flooding (i.e. that the sequential test is passed). The sequential test will be based on a Borough or District wide search area of alternative sites within the defined settlement boundaries, unless local circumstances relating to the catchment area for the development justify a reduced search area, i.e. there is a specific need for the development in that location. The sequential test is not required for sites allocated in the Local Plan, minor development1or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site).
2. It can be demonstrated that essential infrastructure in FZ3a & FZ3b, highly vulnerable development in FZ2 and more vulnerable development in FZ3 provide wider sustainability benefits to the community that outweigh flood risk.
3. The application is supported with a site-specific flood risk assessment, covering risk from all sources of flooding including the impacts of climate change and which:
    a) demonstrate that the vulnerability of the proposed use is compatible with the flood zone;
    b) identify the relevant predicted flood risk (breach/overtopping) level, and mitigation measures that demonstrate how the development will be made safe and that occupants will be protected from flooding from any source;
    c) propose appropriate flood resistance and resilience measures (following the guidance outlined in the Strategic Flood Risk Assessment), maximising the use of passive resistance measures (measures that do not require human intervention to be deployed), to ensure the development maintains an appropriate level of safety for its lifetime;
    d) include appropriate flood warning and evacuation procedures where necessary (referring to the County's evacuation routes plan), which have been undertaken in consultation with the authority's emergency planning staff;
    e) incorporates the use of Sustainable Drainage Systems (SuDS) (unless it is demonstrated that this is not technically feasible) and confirms how these will be maintained/managed for the lifetime of development (surface water connections to the public sewerage network will only be permitted in exceptional circumstances where it is demonstrated that there are no feasible alternatives);
    f) demonstrates that the proposal will not increase risk elsewhere and that opportunities through layout, form of development and green infrastructure have been considered as a way of providing flood betterment and reducing flood risk overall;
    g) demonstrates that adequate foul water treatment and disposal already exists or can be provided in time to serve the development;
    h) ensures suitable access is safeguarded for the maintenance of water resources, drainage and flood risk management infrastructure.

Development in all flood zones, and development over 1 hectare in size in Flood Zone 1, will need to demonstrate that surface water from the development can be managed and will not increase the risk of flooding to third parties.

Change of use of existing buildings will be supported providing they do not pose an increase in risk to people. Change of use that would result in self-contained ground floor residential accommodation in areas of hazard rating 'danger for some', 'danger for most' and 'danger for all' will not be supported. In these areas unrestricted access to a habitable room above the flood level and an emergency evacuation plan will be required.

Caravans, mobile homes and park homes intended for permanent residential use will not be permitted in areas at risk of flooding. Caravan, chalet, log cabin, camping and touring sites at risk of fluvial flooding where there is a 'danger for most' and 'danger for all' will not be permitted. Occupancy of caravan, chalet, log cabin, camping and touring sites at risk of tidal flooding will not be permitted to open between 1st November in any one year and the 14th March in the succeeding year.

No development will be permitted within a 50m buffer from the toe of the raised Witham Haven Banks (flood defences), as shown on the indicative Plan contained in Appendix 10, to allow access for construction and maintenance.

Flood risk management infrastructure shall be provided at the strategic level, where development opportunities allow, to reduce the hazard and probability of flooding.

Appendix C – Breach Analysis

River Welland - 1:100-year event + 20% Climate Change (worse than 28% & 53%)

Defense Crest Levels (h1)	5	m
Average Ground Level behind defenses (h2)	2	m
1 in 100 year flood level plus climate change (h3)	4.7	m
Assumed length of breach (B)	40	m
Max head over breach (h)	2.7	m
Peak flow (Q) = $1.7xBxh^{3/2}$	301.7	m^3s^{-1}

Peak flow (Q)	301.7	m^3s^{-1}
Assuming Energy Grad (S)	0.001	-
Assume % obstructions to flow	0	-
Assuming mannings (n)	0.03	-

	Scenario					
	1	2	3	4	5	6
Distance from breach	0	250	500	625	750	1000
Perimeter of Flood Wave (Assumed Channel Width)	40	825.5	1611	2003.75	2396.5	3182
Effective perimeter (P)	40	825.5	1611	2003.75	2396.5	3182
Normal Depth y = $((Qn/(b \times S^{0.50}))^{0.6}$	3.257	0.530	0.355	0.311	0.279	0.236

Time to Reach Development

Distance from breach above plus 1.0m	1	251	501	626	751	1001
Perimeter of Flood Wave (Assumed Channel Width)	43.1	828.6	1614.1	2006.9	2399.6	3185.1
Normal Depth y = $(Qn/(bxS^{0.5}))^{0.6}$	3.112	0.528	0.354	0.311	0.279	0.236
Volume in Additional 1.0m	134.3	437.9	571.7	623.8	670.0	750.3
Speed to cover additional 1.0m (m/s)	2.25	0.69	0.53	0.48	0.45	0.40
Average time to reach radius (secs)	-	327.9	854.5	1164.9	1501.0	2240.7
Average time to reach radius (mins)	-	5.5	14.2	19.4	25.0	37.3

Crowland and Cowbit Washes - 1:100-year event + 28% Climate Change

Defense Crest Levels (h1)	5	m
Average Ground Level behind defenses (h2)	2	m
1 in 100 year flood level plus climate change (h3)	2.13	m
Assumed length of breach (B)	40	m
Max head over breach (h)	0.13	m
Peak flow (Q) = $1.7xBxh^{3/2}$	3.2	m^3s^{-1}

Peak flow (Q)	3.2	m^3s^{-1}
Assuming Energy Grad (S)	0.001	-
Assume % obstructions to flow	0	-
Assuming mannings (n)	0.03	-

	Scenario					
	1	2	3	4	5	6
Distance from breach	0	25	50	100	150	200
Perimeter of Flood Wave (Assumed Channel Width)	40	118.55	197.1	354.2	511.3	668.4
Effective perimeter (P)	40	118.55	197.1	354.2	511.3	668.4
Normal Depth y = $((Qn/(b \times S^{0.50}))^{0.6}$	0.212	0.111	0.082	0.057	0.046	0.039

Time to Reach Development

Distance from breach above plus 1.0m	1	26	51	101	151	201
Perimeter of Flood Wave (Assumed Channel Width)	43.1	121.7	200.2	357.3	514.4	671.5
Normal Depth y = $(Qn/(bxS^{0.5}))^{0.6}$	0.203	0.109	0.081	0.057	0.046	0.039
Volume in Additional 1.0m	8.8	13.3	16.2	20.4	23.6	26.3
Speed to cover additional 1.0m (m/s)	0.36	0.24	0.20	0.16	0.14	0.12
Average time to reach radius (secs)	-	97.3	233.0	581.7	1006.1	1489.9
Average time to reach radius (mins)	-	1.6	3.9	9.7	16.8	24.8

Crowland and Cowbit Washes - 1:100 year event + 53% Climate Change

Defense Crest Levels (h1)	5	m
Average Ground Level behind defenses (h2)	2	m
1 in 1000 year flood level plus climate change (h3)	2.2	m
Assumed length of breach (B)	40	m
Max head over breach (h)	0.2	m
Peak flow (Q) = $1.7xBxh^{3/2}$	6.1	m^3s^{-1}

Peak flow (Q)	6.1	m^3s^{-1}
Assuming Energy Grad (S)	0.001	-
Assume % obstructions to flow	0	-
Assuming mannings (n)	0.03	-

	Scenario					
	1	2	3	4	5	6
Distance from breach	0	50	100	150	200	250
Perimeter of Flood Wave (Assumed Channel Width)	40	197.1	354.2	511.3	668.4	825.5
Effective perimeter (P)	40	197.1	354.2	511.3	668.4	825.5
Normal Depth y = $((Qn/(b \times S^{0.50}))^{0.6}$	0.313	0.120	0.085	0.068	0.058	0.051

Time to Reach Development

Distance from breach above plus 1.0m	1	51	101	151	201	251
Perimeter of Flood Wave (Assumed Channel Width)	43.1	200.2	357.3	514.4	671.5	828.6
Normal Depth y = $(Qn/(bxS^{0.5}))^{0.6}$	0.299	0.119	0.084	0.068	0.058	0.051
Volume in Additional 1.0m	12.9	23.8	30.1	34.8	38.7	42.1
Speed to cover additional 1.0m (m/s)	0.47	0.26	0.20	0.17	0.16	0.14
Average time to reach radius (secs)	-	179.9	449.2	777.0	1150.6	1562.8
Average time to reach radius (mins)	-	3.0	7.5	12.9	19.2	26.0

Appendix D – Topographical Survey



NOTES

ABBREVIATIONS & SYMBOLS

AV	AIR VALVE	OHC	OVERHEAD CABLE
BH	BOREHOLE	PCP	PIPE CROWN
BOL	BOLLARD	PINV	PIPE INVERT LEVEL
CATV	CABLE TV MH	PM	PARKING METER
CCTV	CCTV CAMERA	PO	POST
CL	COVER LEVEL	PT	PIPE TOP LEVEL
CH	CHANNEL	P/R	POST & RAIL FENCE
COL	COLUMN	P/W	POST & WIRE FENCE
DC	CABLE TV C/D	RD	EDGE OF ROAD/NO KERB
DP	DRAIN PIPE	RP	REFLECTIVE POINT
DR	DRAIN	RL	RIDGE LEVEL
EL	EAVES LEVEL	RP	REFLECTIVE POST
ER	ELECTRIC RISER	SL	STREET LIGHT
ER	EARTH ROD	SLVL	STONE LEVEL
FB	FLOWER BED	SOFF	SOFFIT LEVEL
FH	FIRE HYDRANT	SW	SOIL WATER
FFL	FINISHED FLOOR LEVEL	SWV	SLUICE/GATE WATER
FP	FLAG POLE	TB	TACTILE PAVING
FW	FOUL WATER	TH	TRIAL HOLE
GV	GAS VALVE	TL	TRAFFIC LIGHTS
HL	HEDGE LEVEL	TP	TELEGRAPH POLE
IC	INSPECTION COVER	TOW	TOP OF WALL LEVEL
IL	I NVERT LEVEL	TP	TELEGRAPH POLE
KC	KERB CUT	UP	UTILITY POLE
KD	KERB DIFFLET	UTL	UNABLE TO LIFT
KT	KERB TOP	VP	VENT PIPE
LP	LAMP POST	WL	WATER LEVEL
LC	LIGHT COLUMN	WLVL	WATER LEVEL
MH	MANHOLE	WM	WATER METER
MP	MARKER POST	WO	WASH OUT POINT

FENCE, HEDGE, ELECTRIC, BANK EDGE, STORM LINE, FOUL LINE, TELECOM LINE, GAS LINE, LARSON PILES, CHANNELS, WATER MAIN, TREE, BOREHOLE, STATION, TRH, MANHOLE, GULLY, BATTER, WATER LVL, GATE

1. THE POSITION OF THIS SURVEY IS BASED ON GPS OSTN15 GRID
2. ALL LEVELS RELATE TO HGTS TAKEN USING TRIMBLE VRS NOW
3. TREES SPREADS ARE DRAWN TO SCALE AND SHOW THE GENERAL/AVERAGE CANOPY SPREAD.
4. ALL BELOW GROUND LEVEL INFORMATION INCLUDING VOIDS, DRAINAGE & SERVICES HAVE BEEN IDENTIFIED FROM THE SURFACE LEVEL ONLY, THEREFORE PIPE SIZES ETC ARE ESTIMATIONS ONLY. ALL CRITICAL DIMENSIONS SHOULD BE CHECKED PRIOR TO THE COMMENCEMENT OF ANY SITE WORKS
5. EVERY EFFORT HAS BEEN MADE TO LOCATE AND SURVEY ALL VISIBLE FEATURES. IT SHOULD BE NOTED THAT SOME ITEMS MAY HAVE BEEN OBSCURED AT THE TIME OF THE SURVEY AND THEREFORE NOT SHOWN ON THIS DRAWING.
6. PHYSICAL BOUNDARY FEATURES SHOWN ON THIS DRAWING DO NOT NECESSARILY REPRESENT THE ACTUAL LEGAL BOUNDARIES. BOUNDARIES SHOULD BE CONFIRMED WITH THE RELEVANT DOCUMENTATION.
7. THE CONTRACTOR MUST CHECK AND VERIFY ALL SITE LEVELS, DIMENSIONS, UTILITIES AND DRAINAGE DETAILS PRIOR TO THE COMMENCEMENT OF ANY SITE WORKS. ANY DISCREPANCIES MUST BE NOTIFIED TO CASTLE HILL SURVEYS LIMITED.
8. ALL SURVEY STATION CONTROL POINTS MUST BE CHECKED BY THE CONTRACTOR PRIOR TO STARTING ANY SITE WORKS.

Point	Easting	Northing	Elevation
s1	526407.252	315941.206	5.600
s2	526389.680	315877.074	5.648
s3	526547.648	315910.763	2.545
s4	526520.789	315863.773	1.974

SURVEY DATE: 20 / 02 / 2023 INITIALS: SRW

Rev	Amendments	Drn	Date

Client: ORIGIN DESIGN STUDIO

Project Title: LAND EAST OF PEAK HILL, SPALDING, LINCOLNSHIRE

Drawing Title: TOPOGRAPHICAL SURVEY

Scale @ A0:	Date:
1 : 250	20 / 02 / 2023

Drawing No: **CHS 23-35-01** Rev:

C.A.D. Title: ods peak hill spalding\topo (chs 23-35-01).mp

Drawn By:	Checked By:
SRW	CT

Castle Hill Surveys Limited
Land Surveying & Site Setting Out Services
Commerce House, Carlton Boulevard,
Lincoln, LN2 4WJ Tel : 07710649549
E-mail : castlehillsurveys@outlook.com
Website : www.castlehillsurveys.co.uk

Appendix E – Environment Agency Flood Data

Michael Orridge
michael@origindesignstudio.co.uk

Our ref: CCN-2022-293334

Date: 20/01/2023

Dear Michael

Provision of Flood Risk Information for Peak Hill near Spalding

Thank you for your request for our flood risk information for the above site. The information is set out below and attached. It is important you read any contextual notes on the maps provided.

If you are preparing a Flood Risk Assessment (FRA) for this site, please note this information may not be sufficient by itself to produce an adequate FRA to demonstrate the development is safe over its lifetime. Additional information may be required to carry out an appropriate assessment of all risk, such as consequence of a breach in defences.

We aim to review our information on a regular basis, so if you are using this data more than twelve months from the date of this letter, please contact us again to check it is still valid.

Please read the letter in full as the information covered has been updated in **January 2023.**

1. Flood Map

The attached map includes the current Flood Map for your area. The Flood Map indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding. It also shows the extent of the Extreme Flood Outline which represents the extent of a flood with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

In some locations, such as around the fens and the large coastal floodplains, showing the area at risk of flooding assuming no defences may give a slightly misleading picture in that if there were no flood defences, water would spread out across these large floodplains. This flooding could cover large areas of land but to relatively shallow depths and could leave pockets of locally slightly higher land as isolated dry islands. It is important to understand the actual risk of the flooding to these dry islands, particularly in the event of defence failure.

The Flood Map also shows the location of formal raised flood defences and flood storage reservoirs. It represents areas at risk of flooding for present day only and does not take account of climate change.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered flooding may occur from other sources such as surface water sewers, road drainage, etc.

2. Historic Flood Event Outlines

A copy of the Historic Flood Event Outlines Map showing the extent of previous recorded flooding in your area is attached. This only covers information we hold and it is possible recent flooding may have occurred which we are currently investigating, therefore this information may be subject to change. It is possible other flooding may have occurred which other organisations, such as the Lead Local Flood Authority (ie top tier council), Local Authority or Internal Drainage Board (where they exist), may have records.

3. Schemes in the area

There are no ongoing capital projects to reduce or sustain the current flood risk to this site.

4. Fluvial Flood Risk Information

The site may be at risk from main rivers in the form of residual risk due to the failure of flood management infrastructure such as a breach of a raised flood defence. You may need to undertake further assessment of this residual risk using the data provided.

The site may be at risk from local ordinary watercourses for which other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist) have responsibility.

4.1 Fluvial Defence Information

The existing fluvial defences reducing the risk of flooding to this site consist of Crowland-Cowbit Washes and embankment. They are in fair condition and provide protection against a flood event with a 1% chance of occurring in any year (1 in 100). We inspect these defences regularly to ensure that any potential defects are identified early.

4.2 Fluvial Modelled Levels and Flows

Available modelled fluvial flood levels and flows for the model nodes shown on the attached map are set out in the data table attached. This data is taken from the model named on the data table, which is the most up-to-date model currently available.

Please note these levels are “in-channel” levels and therefore may not represent the flood level on the floodplain, particularly where the channel is embanked or has raised defences.

Our models may not have the most up to date climate change allowances. In time we will update our models for the latest allowances. You should refer to 'Flood risk assessments: climate change allowances' to check if the allowances modelled are appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.

4.3 Fluvial Modelled Flood Extents

Please find attached a map showing available modelled flood extents, taking into account flood defences, for your area. This data is taken from the model named on the map, which is the most up-to-date model currently available.

In some cases the flood extents shown may not be from main river, but may be from other sources such as IDB lowland drainage networks.

4.4 Fluvial Hazard Mapping

For certain locations we have carried out modelling to map the maximum values of flood depth, velocity and hazard rating (danger to people) resulting from overtopping and / or breaching of defences at specific locations for a number of scenarios.

At present this information is available for fluvial flood risk in Northampton, Lincoln, Wainfleet and some isolated rural locations.

The number of locations we have this information for is expected to increase in time.

At present this site is not covered by any Environment Agency fluvial hazard mapping.

Detailed Hazard Mapping is available within the 2017 Update of South Holland Strategic Flood Risk Assessment. This can be downloaded via the following link: http://www.southeastlincslocalplan.org/water/.

5. Tidal Flood Risk Information

This site is not considered to be at risk from tidal flooding.

6. Development Planning

If you would like local guidance on preparing a flood risk assessment for a planning application, please contact our Sustainable Places team at LNplanning@environment-agency.gov.uk. It will help if you mention this data request and attach your site location plan.

We provide free preliminary advice; additional/detailed advice, review of draft FRAs and meetings are chargeable at a rate set to cover our costs, currently £100 (plus VAT) per hour of staff time. Further details are available on our website at https://www.gov.uk/guidance/developers-get-environmental-advice-on-your-planning-proposals.

General advice on flood risk assessment for planning applications can be found on GOV.UK at https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

Climate change will increase flood risk due to overtopping of defences. Please note, unless specified otherwise, the climate change data included has an allowance for 20% increase in flow. Updated guidance on how climate change could affect flood risk to new development - 'Flood risk assessments: climate change allowances' was published on GOV.UK in **July 2021**. The appropriate updated climate change allowance should be applied in a Flood Risk Assessment.

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

7. Data Licence and Other Supporting Information

We respond to requests for recorded information we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

This information is provided in accordance with the Open Government Licence which can be found here: http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Further information on flood risk can be found on the GOV.UK website at: https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

8. Other Flood Risk Management Authorities

The information provided with this letter relates to flood risk from main river or the sea. Additional information may be available from other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist).

I hope we have correctly interpreted your request. If you have any queries or would like to discuss the content of this letter further please contact Rachael Storey using the email address below and quoting our CCN reference number above.

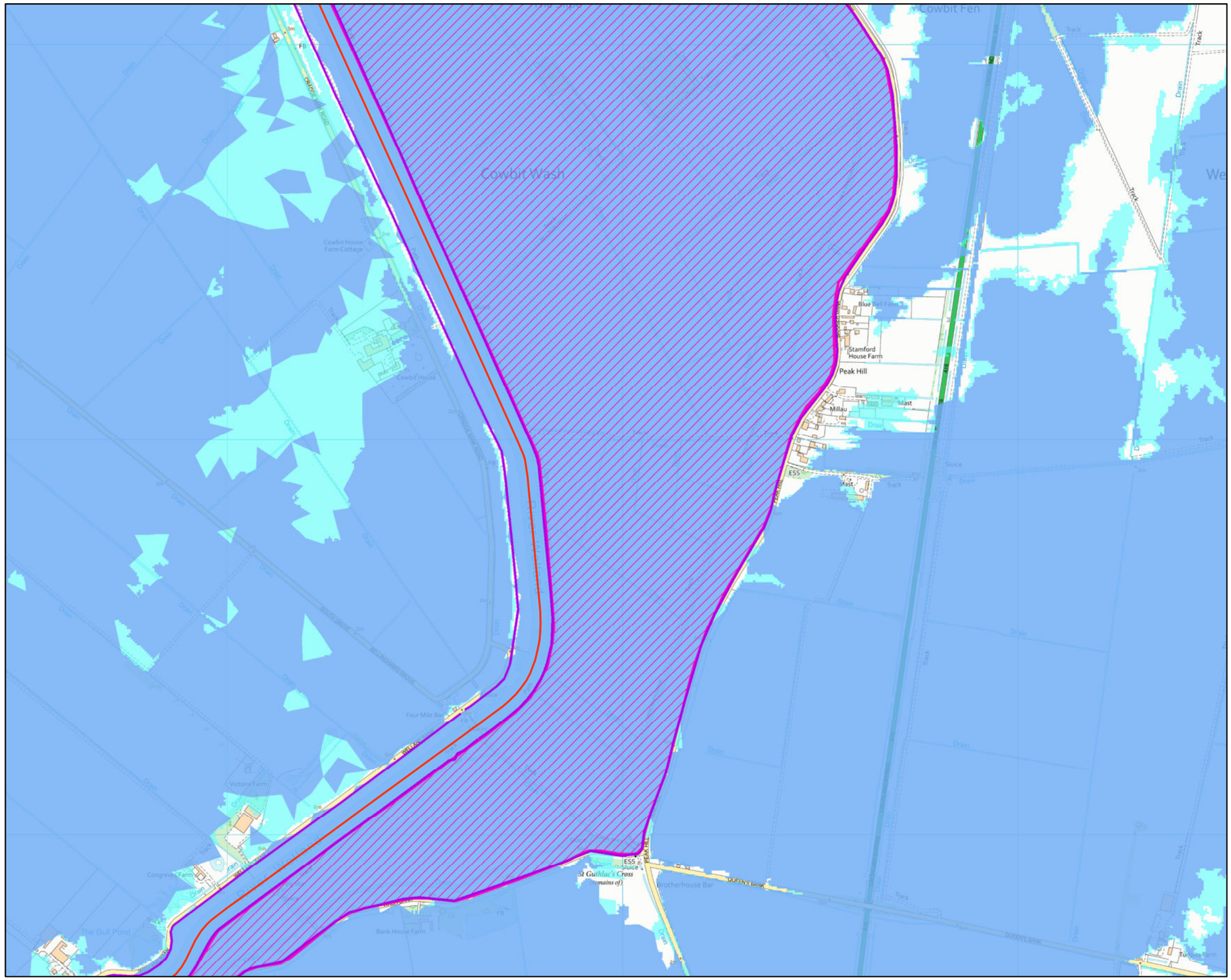
Yours sincerely,



for Alastair Windler
Welland and Nene Partnerships and Strategic Overview Team Leader
e-mail PSOWN@environment-agency.gov.uk
Phone 02030253535

Enc.
Flood Map
Historic Flood Event Outlines Map
Modelled Node Points Map
Modelled Fluvial Levels and Flows Data Sheet
Modelled Flood Extent Maps

Flood Map centred on TF 26548 15872 - created January 2023 [Ref: CCN-2023-293334]



Environment Agency

Scale 1:10,000

N

Legend

- Main Rivers
- Raised Defences
- Flood Storage Areas
- Areas at Risk of Flooding from Rivers or the Sea
- Extreme Flood Outline

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.

- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

Light blue shows the extent of the Extreme Flood Outline, which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

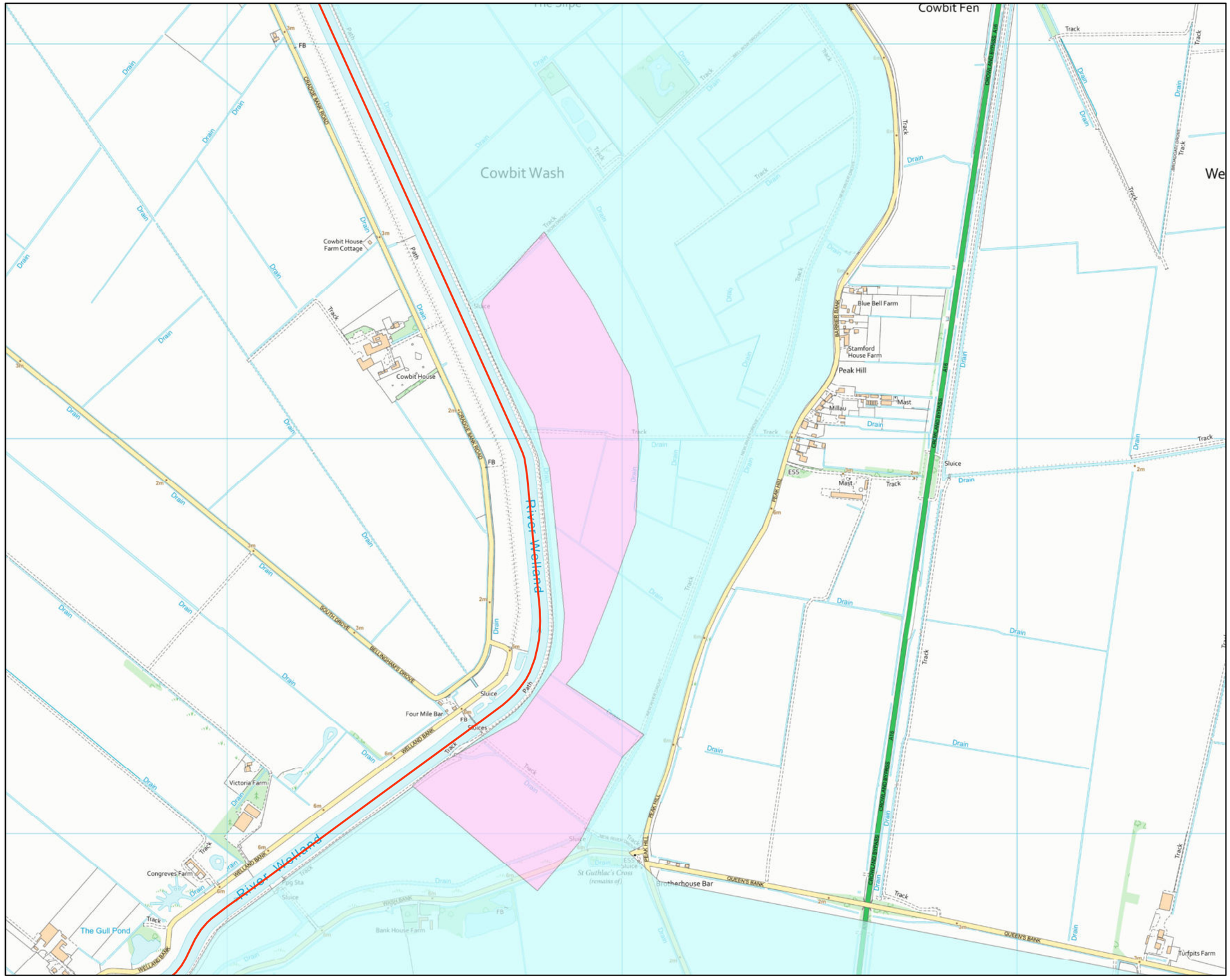
These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Sites outside the two extents, but behind raised defences, may be affected by flooding if the defences are overtopped or fail.

Created by the Partnerships and Strategic Overview Team, Kettering

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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Histotic Flood Map centred on TF 26548 15872 - created January 2023 [Ref: CCN-2023-293334]



Environment Agency

Scale 1:10,000

N

Legend

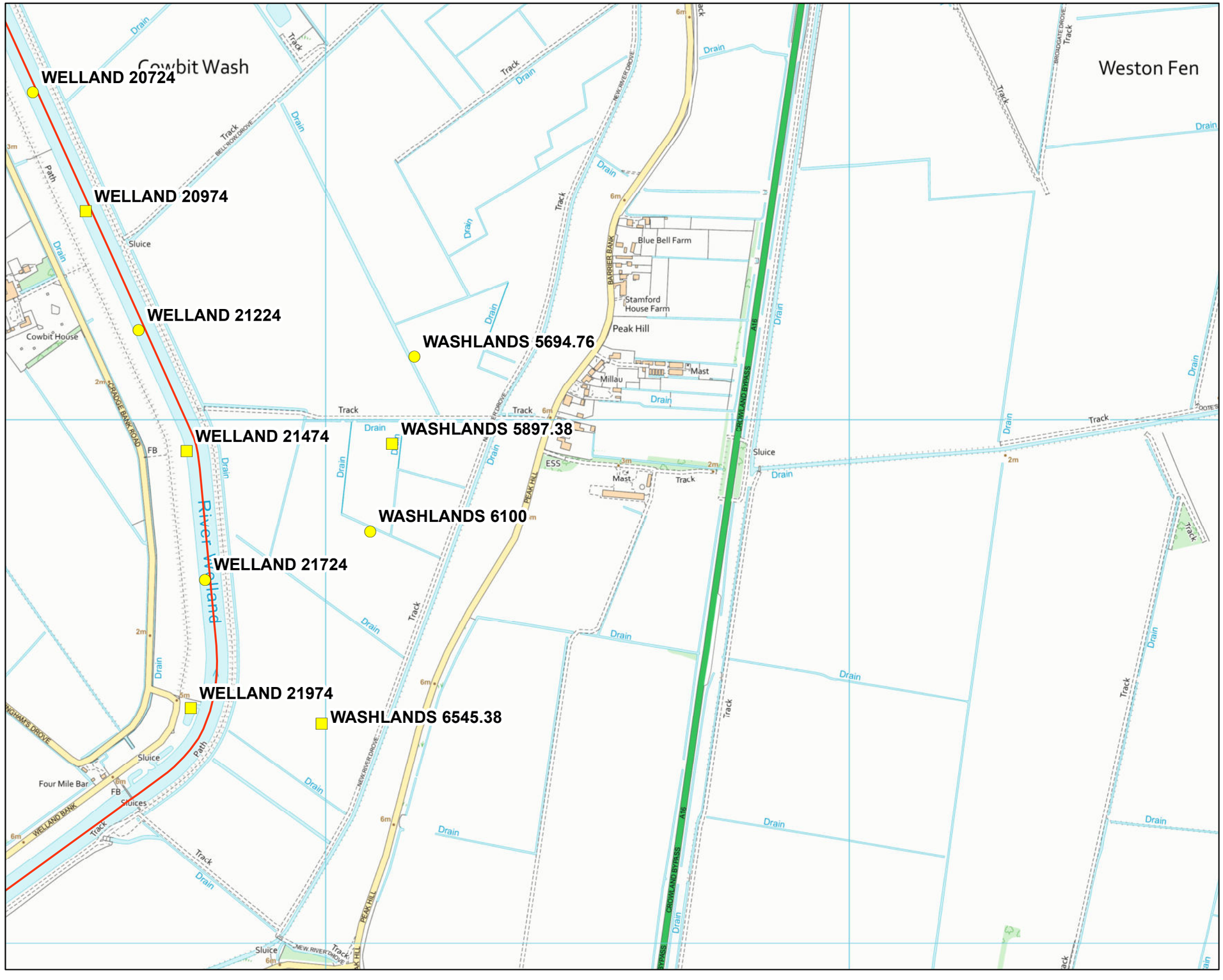
- Main Rivers
- Easter 1998 on the River Welland
- March 1947 on the River Welland near Cowbit

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Node Map centred on TF 26548 15872 - created January 2023 [Ref: CCN-2022-29334]



Environment Agency

Scale 1:7,500

N

Legend

- Modelled Nodes - Levels
- Modelled Nodes - Flows
- Main Rivers

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Fluvial Flood Levels (mODN)

The fluvial flood levels for the model nodes shown on the attached map are set out in the table below. They are measured in metres above Ordnance Datum Newlyn (mODN).

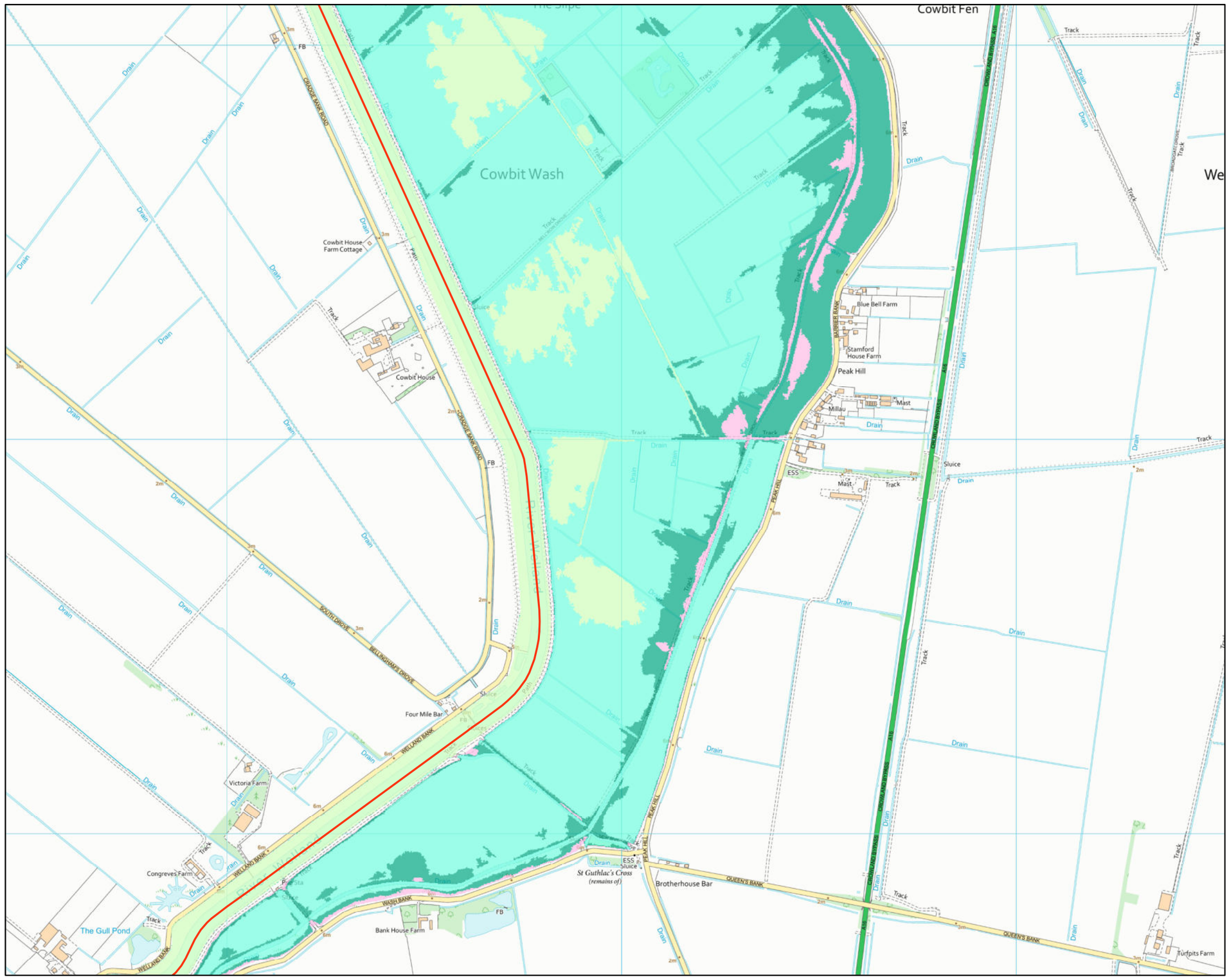
			Annual Exceedance Probability - Maximum Water Levels (mODN)											
Node Label	Easting	Northing	50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	3.33% (1in 30)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
WASHLANDS 5694.76	526170	316120	0.90	0.90	1.12	1.66	1.85	2.07	2.26	2.35	2.81	2.48	2.70	3.36
WASHLANDS 6100	526086	315785	0.90	0.90	1.08	1.63	1.82	2.06	2.26	2.35	2.80	2.47	2.70	3.36
WELLAND 20724	525441	316625	3.74	4.04	4.25	4.50	4.57	4.60	4.61	4.61	4.68	4.62	4.62	4.68
WELLAND 21224	525643	316170	3.74	4.05	4.26	4.51	4.59	4.61	4.63	4.63	4.69	4.63	4.64	4.69
WELLAND 21724	525770	315694	3.74	4.06	4.27	4.52	4.60	4.63	4.64	4.65	4.70	4.65	4.65	4.70

Fluvial Flood Flows (m^3/s)

The fluvial flood flows for the model nodes shown on the attached map are set out in the table below. They are measured in metres cubed per second (m^3/s).

			Annual Exceedance Probability - Maximum Flows (m^3/s)											
Node Label	**Easting**	**Northing**	**50% (1 in 2)**	**20% (1 in 5)**	**10% (1 in 10)**	**5% (1 in 20)**	**3.33% (1in 30)**	**2% (1 in 50)**	**1.33% (1 in 75)**	**1% (1 in 100)**	**1% (1 in 100) inc 20% Climate Change**	**0.5% (1 in 200)**	**0.1% (1 in 1000)**	**0.1% (1 in 1000) inc 20% Climate Change**
WASHLANDS 5897.38	526128	315953	0.00	0.00	0.00	0.00	0.00	0.00	1.65	3.44	3.63	5.94	9.32	17.33
WASHLANDS 6545.38	525993	315418	0.00	0.00	0.00	0.00	0.00	0.08	2.04	4.02	4.55	6.74	10.50	19.15
WELLAND 20974	525542	316397	54.58	70.63	80.96	95.06	106.92	113.40	115.39	118.32	117.23	118.67	116.71	117.44
WELLAND 21474	525735	315940	53.95	70.05	80.34	95.12	107.81	115.09	117.35	120.12	119.26	120.60	118.80	119.35
WELLAND 21974	525743	315449	53.40	69.49	79.72	94.54	107.83	115.07	117.33	120.74	119.41	120.94	118.81	120.54

Modelled Flood Extents (with defences) Model: Welland Strategic (2016) centred onTF 26548 15872 - created January 2023 [Ref: CCN-2023-293334]



Environment Agency

Scale 1:10,000

N

Legend

- Main Rivers
- 5% (1 in 20) fluvial event
- 1% (1 in 100) fluvial event
- 1% (1 in 100) inc 20% climate change fluvial event
- 0.1% (1 in 1000) fluvial event
- 0.1% (1 in 1000) inc 20% climate change fluvial event

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