Technical Flood Risk Information for King's Lynn & West Norfolk January 2019

This information has been produced and aimed at flood risk consultants who are undertaking Flood Risk Assessments for proposed developments within the Borough of King's Lynn and West Norfolk. The aim of this guidance is to clarify what sources of flood risk and the information which are available and in what circumstances they should be used by flood risk assessors and developers to inform site specific Flood Risk Assessments.

As part of their roles as Risk Management Authorities (RMAs) the Environment Agency, the Borough Council of King's Lynn and West Norfolk (BCKLWN), Norfolk County Council (NCC), and the Internal Drainage Boards (IDBs) have undertaken numerous studies to determine the extent and level of flood risk within King's Lynn and West Norfolk.

It is worth noting at the start that no modelling will ever be 100% accurate and there are numerous uncertainties inherent within all modelling techniques. The mapping should therefore not be used as definitive evidence of flood risk and a freeboard[1] should be utilised within the designs to account for these uncertainties.

Available information:

Flood Map for Planning (Previously referred to as 'the Flood Map')

The Environment Agency maintains the Flood Map for Planning, which delineates the flood zones for planning. Shown on the map are the 1% (flood zone 3) and 0.1% AEP[2] (flood zone 2) flood extents for fluvial and 0.5% (zone 3) and 0.1% AEP for tidal sources. This mapping shows the flood extent assuming that there is no flood defences in place i.e. it delineates the natural floodplain. In areas where there are flood defences, their impact on the flood extent is illustrated through the presence of an Area Benefitting from Defences (ABD)[3].

It should be noted that the Flood Map for Planning and the THM extents do not always match up. The mechanism of a defence breach can cause flooding in areas outside of the natural floodplain. The Local Planning Authority requires a Flood Risk Assessment to be produced for any development located in an area of flood risk, including those within flood zone 1 but within the THM breach extent.

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[1] Freeboard is a buffer added to thresholds to take into account inherent uncertainties, we generally recommend 300mm freeboard but the FRA should determine a relevant freeboard given the conditions on site.

[2] Annual Exceedance Probability (AEP) – the chance a given event would occur in any one year.

[3] An area has to be protected to a 1% (fluvial) or 0.5% (tidal) AEP from all sources to be included in an ABD – this has to be demonstrated through detailed modelling.

There are numerous fluvial watercourses within BCKLWN. The Flood Map for Planning should be used to help determine whether the Sequential and Exception Test need to be passed. The Flood Map for Planning does not show the risk of flooding to watercourses with a catchment area of less than 3 km2 and does not provide information on flood depth, speed or volume of flow. It does not include other forms of flooding such as from highway drains, sewers, overland flow or rising groundwater.

https://www.gov.uk/prepare-for-a-flood/find-out-if-youre-at-risk

National Flood Risk Assessment (NaFRA)[4] – Risk of Flooding from Rivers and Sea

Nafra, illustrated on the Risk of Flooding from Rivers and Sea, estimates the risk of flooding to a particular area. This mapping takes into account the presence, standard of protection and condition of the defences that are present. The mapping classifies the risk of flooding into 4 categories, High, Medium, Low and Very Low. Nafra is predominately used by the Insurance industry to determine the cost and availability of flood insurance but is also used to determine the benefits of a flood defence scheme. Nafra is a strategic scale modelling system and should not be used as a replacement for a site specific Flood Risk Assessment.

When considering developing a location NaFRA should be reviewed to determine the availability of insurance and mortgages.

https://www.gov.uk/prepare-for-a-flood/find-out-if-youre-at-risk

Flood Map for Surface Water[5] (FMfSW)

The Environment Agency has produced a national flood map for surface water. This mapping highlights the areas that are potentially at risk of flooding due to surface water runoff. This is a strategic model that makes several assumptions in terms of ground conditions and does not include a full representation of the local drainage network. The most recent version has been calibrated using historical flood events. It should not be used on its own to determine the risk of flooding for a specific site.

If a site is identified to be at risk of surface water flooding, the FRA will need to consider the impacts on the drainage system and demonstrate that the risk can be safely managed on site without increasing the risk of flooding offsite. The FRA should also consider how the development could reduce the risk of flooding offsite through land management and the surface water drainage scheme.

[4] NaFRA reflects present day flood conditions only
[5] The Flood Map for Surface Water reflects present day flood conditions only.

https://www.gov.uk/prepare-for-a-flood/find-out-if-youre-at-risk

Risk of flooding from reservoirs

The Environment Agency has determined the areas that would be flooded if a large reservoir[6] were to fail. The associated floodplain generally follows the floodplain of the watercourse that feeds them but due to the quantity of water stored, the extent may extend beyond the flood map for planning. A FRA should consider Reservoir flooding as a residual risk unless the site is in close proximity to the dam and warning time would be short, in which case the FRA should fully evaluate the risk of a breach and its impacts.

https://www.gov.uk/prepare-for-a-flood/find-out-if-youre-at-risk

Detailed modelling studies

The Environment Agency and other RMAs have commissioned detailed flood models for individual watercourses. These are often produced to update the Flood Map for Planning and Nafra[7], but can be produced for other reasons such as to design new flood alleviations schemes. Detailed modelling studies take into account the major infrastructure in or over the river channel, the capacity of the channel and the impacts of climate change on flood flows.

There are numerous different modelling techniques available and we utilise the most appropriate method to for fill the scope of the project. Therefore the type and quantity of information available for each watercourse may vary. The outputs from these modelling studies can be requested in the form of 'products' from the Environment Agency.

The outputs of the detailed modelling should be used in determining the Sequential test and Exception test. Models produce flood level information. By comparing the flood levels with the topography of the site you can define the flood extents onsite and determine to what level flood resistance and resilience measures will need to be set at[8].

You can request the flood risk information held by the Environment Agency by sending your details and your request to enquiries@environment-agency.gov.uk.

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[6] >25,000m3 above ground storage

[7] The Flood Map for Planning and Nafra is only updated once a quarter so there is normally a lag between the availability of detailed modelling and the Flood Maps being updated.

[8] If applicable, the presence of flood resistance and resilience measures are not a determining factor in the sequential test.

Tidal Hazard Mapping (THM)

The Environment Agency commissioned a modelling study to determine the impacts of a series of breaches in the Tidal Defences of the Great Ouse and Nene. Initially this was limited to the demountable defences and locations adjacent to urban areas. This has recently been updated to include breaches equidistant along the entire length of the tidal river, and the coastline. The THM provides information on maximum depth, velocity and hazard rating[9].

Flood Risk Design Guidance for new dwellings and residential conversion schemes has been produced for sites located within the area covered by the THM. This guidance can be viewed on the borough council's website - https://www.west-norfolk.gov.uk/info/20173/information_for_planning_agents/390/flood_risk_design .

Residential development within the THM areas must accord with this guidance.

The maximum flood depth from the THM should be utilised to determine what level of mitigation measures are required for a particular development.

It is important to note that although there have been multiple breaches modelled, the THM does not include every possible breach location. A FRA for a site in close proximity of the defence may still require a site specific breach analysis to be undertaken to determine the residual risk of flooding.

The THM can be obtained by requesting a Product 8 from enquiries@environment-agency.gov.uk

A detailed explanation of the THM is available below.

Fenland Fluvial Breach Scenario Modelling

The Environment Agency commissioned a modelling study to determine the impacts of a series of breaches along the Ely Ouse, Relief Channel and the New Bedford/Delph systems.

The modelling study evaluates the impacts of a number of specific "failure scenarios" including the Earith control structure and potential breaches of raised defences at a number of location. The Fenland Breach Modelling provides information on maximum depth, velocity and hazard rating[10].

It is important to note that although there have been multiple breaches modelled, the modelling does not include every possible breach location. A

[9] Hazard Rating as defined by FD2321 Flood Risk to People Methodology
[10] Hazard Rating as defined by FD2321 Flood Risk to People Methodology

FRA for a site in close proximity of the defence may still require a site specific breach analysis to be undertaken to determine the residual risk of flooding.

The Fenland Breach modelling can be obtained by requesting a Product 4 and 8 from enquiries@environment-agency.gov.uk

King's Lynn and West Norfolk Settlements Surface Water Management Plan (2012)

Norfolk County Council and BCKLWN have undertaken an assessment of the surface water flood risk. This includes an analysis of flood risk from ordinary watercourses. The surface water flood maps produced are a local assessment of flood risk and will be more accurate than the national scale Flood Map for Surface Water, although they will still contain some assumptions about the surface water drainage network.

If the site is in an area identified as being at risk of flooding then consideration of appropriate flood risk mitigation measures should be included within the FRA. The SWMP has identified a series of actions needed to mitigate the risk of flooding. The FRA should identify whether the development can contribute to these actions.

https://www.west-norfolk.gov.uk/info/20098/water_management_and_flooding/173/surface_water

King's Lynn Ordinary Watercourses Study

BCKLWN commissioned a more specific study of fluvial flood risk in King's Lynn. This was completed in October 2015 and can be used to determine the risk of flooding from ordinary watercourses and surface water flooding within King's Lynn. The study also recommends a series of actions that could be undertaken to reduce the flood risk. The FRA should consider whether the proposed development could enact these recommendations.

https://www.west-norfolk.gov.uk/info/20098/water_management_and_flooding/173/surface_water

Summary

King's Lynn and West Norfolk is an area of high and varied flood risk. A flood risk assessment for this area needs to review all the sources of information available to determine the risk of flooding from all sources.

The Strategic Flood Risk Assessment (SFRA) now provides a single location where all the flood risk information can be found.

Once a clear understanding of the flood risk is achieved, the FRA should demonstrate that the site would be safe from all sources of flooding without increasing the risk of flooding elsewhere. The FRA should also identify how the development could contribute to the reduction of flood risk.

Tidal Hazard Mapping

The Environment Agency commissioned a modelling study to determine the impacts of a series of breaches in the Tidal Defences of the Rivers Great Ouse and Nene. Initially this was limited to the demountable defences and locations adjacent to urban areas. This has recently been updated to include breaches equidistant along the entire length of the tidal river, and the coastline. The THM provides information on maximum depth, velocity and hazard rating[11].

Modelling Techniques

The THM is a 1D-2D linked model where both the channel (1D) and the floodplain (2D) were modelled in detail. This means that we can provide peak flood depths and velocities from within the floodplain rather than having to interpolate the information from the in-channel levels. By modelling the way the water travels across the floodplain in greater detail we can more accurately predict the impacts of topography and physical structures on the depth of flood water as it travels further from the channel.

2D mapping divides the floodplain into a grid. For each grid cell the model contain a single elevation value and produces a single value for the peak water depth and velocity. Due to the size of the floodplain of the Great Ouse and River Nene, the grid cells have to be relatively large ($30m^2$ for rural areas and $5m^2$ for King's Lynn and Heacham). This means that it is not recommended to be used for a site specific FRA by itself. There are several issues that may arise resulting from the large grid size:

- Flood depths can be overestimated due to the presence of localised low spots like drainage ditches or ponds. The typical rural grid size is 30m by 30m, so a drainage ditch will result in at least a 30m wide strip of deep flooding.

- Similarly, flood depths can be underestimated due to the presence of localised high spots.

- In the urban areas the grid cells are 5m by 5m. Pathways smaller than 5m wide may not be represented within the model (or be over widened), especially when flood depths are less than 300mm i.e. when

[11] Hazard Rating as defined by FD2321 Flood Risk to People Methodology

the model assumes that the building will block the flow of water. For depths greater than 300mm water will flow over the building stubs and this will have less of an impact. This could divert or remove flow paths within the floodplain.

Model Assumptions

The model includes a representation of the flood defences. To model a breach in these defences a hole is created (within the model) and the model is run. The model allows us to set the parameters of the breach. There are a large range of potential breach scenarios

The model makes a series of assumptions on what would occur during a breach of the defences. These include:

- The base level of the breach is set as close to the landward ground level as is feasible. However, modelling constraints mean that it cannot be set lower than the bed level of the watercourse. This leads to an artificially raised breach invert level in perched sections of the tidal river system.
- The breach widths range from 200 and 20m depending upon the location and type of defence being breached.
- The breach is open for 72 hours
- The breach opens to its full width and depth instantaneously upon the triggering of a breach.
- To represent the impact of buildings on the flow of flood water, 300mm building stubs were included within the Digital Terrain Map i.e. the topographic survey used within the model.

We based these assumptions on the best available information but it is important to note that a real life event may differ. We have carried out a sensitivity analysis to determine which of these assumptions would have the greatest impact on the extent, depth and velocity of the flooding. It was found that the most important factor is the duration of the breach[12] as this controls the volume of water entering the floodplain. The full report[13] on the sensitivity testing can be provided on requested.

Through the update of the THM it was clear that the location of the breach is another important factor in the extent of flooding. The tidal floodplain in this area is compartmentalised by the road, rail and IDB networks. This can result in flood extents for breaches only 500m apart to vary significantly.

Overtopping

[12] Depending upon the depth of the breach and the water level within the floodplain, water may only enter during the high tide or during the whole tidal cycle.
[13] Tidal Great Ouse breach modelling – final report October 2015

The THM also identifies where the defences will be overtopped. The flood defences provide a high Standard of Protection (SoP) for the Tidal River. The THM indicates that overtopping would only occur during the more extreme events i.e. the 0.5% AEP + climate change scenario. The coastal defences however, have a comparatively low SoP so overtopping is predicted to occur for much smaller events. The overtopping outlines can be requested as part of a product 4.

Using the THM to design a development

We would recommend that a design flood elevation is determined for a site at the start of the FRA process. This will allow you to determine the appropriate finished floor level and other design considerations.

1. Appropriateness of the THM

The FRAs should review the breach locations of the THM to determine whether its outputs are relevant for the specific site.

For sites that are a significant distance away from the defence, the location of the breach will have limited impact so it would likely be appropriate to utilise the THM data.

For sites close to the defence, the location of the breach has a greater influence. If there are no existing breaches close to the site, and there is a potential for a breach to occur close to the site, then the FRA should consider carrying out a site specific breach analysis.

Please note that the breach location that would produce the worst flooding may not necessarily be the closest. There may be a location further away that has a preferential flow path to the site. Our LiDAR data, which we now provide for free[14], can be used to determine whether there is such a flow path.

2. Design Flood Level

A site specific topographic survey should be undertaken and compared against estimated depth range. By adding the highest and lowest elevations to the lowest and highest (respectively) flood depths you can determine whether the topography controls the estimated flood depth.

If they match (or are close) then you can use that figure (topographic height + flood depth) as the design flood level on site.

If they vary significantly then the FRA will need to evaluate the local conditions to determine what other factors could be impacting the flood depths i.e. the presence of a raised road or drainage ditch could cause flood depths to

[14] https://data.gov.uk/search?filters%5Btopic%5D=Environment

increase or decrease. If there are no obvious factors that are influencing the flood depth then you could request clarification from us.

Once a design flood level has been determined then the resistance and resilience measures will need to be designed – please see the guidance on resistance and resilience measures for further information.

Challenging the THM

As the THM was designed for the evaluation of flood risk at a strategic scale, a site specific FRA's conclusion may differ from that of the THM. We will accept the results of the FRA if they are fully supported by sufficient evidence. If the FRA does challenge the THM we would recommend that it is submitted to us prior to formal submission of planning permission to ensure sufficient evidence has been provided.