HORIZON
NUCLEAR POWER

WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

Horizon Deadline 4 responses to actions set in Issue Specific Hearing on 11 January 2019

PINS Reference Number: EN010007

17 January 2019

Revision 1.0
Examination Deadline 4

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Horizon Internal DCRM Number: WN0902-HZDCO-PAC-REP-00133

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Appendices

List of Tables

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1 Horizon Deadline 4 responses to actions set in Issue Specific Hearing on 11th January 2019

1.1 Introduction

1.1.1 This document contains Horizon Nuclear Power Wylfa Limited's ("Horizon's") responses to actions set in the Issue Specific Hearing on 11th January 2019 that were set for Deadline 4.

1.1.2 This document also contains details of other actions set at the Issue Specific Hearing on 11th January 2019 set for subsequent Examination Deadlines.

1.2 Summary of Deadline 4 action responses

Effects on red squirrel habitat - additional information

1.2.2 Contained in Appendix 1-1 is Horizon's response to the action to provide more detail on its assessment of the effects of the Wylfa Newydd DCO Project on red squirrels. This also provides the references to the academic research referred to by Horizon during the hearing.

Additional clarification on radiological consequence analysis & Project flexRISK

1.2.3 Contained in Appendix 1-2 is Horizon's supplementary response to the Examining Authority regarding the suitability of applying Project flexRISK to the Wylfa Newydd DCO Project.

Analysis of Accidental Releases: comparison with information submitted under EURATOM Article 37

1.2.4 Contained in Appendix 1-3 is Horizon's response to the action for further information on accidental releases assessment in APP-234.

Valley Tidal Breach Modelling

1.2.5 Contained in Appendix 1-4 is Horizon's response to the action for Valley Tidal Breach Modelling report previously provided to Natural Resources Wales (NRW) to be provided into examination.

1.3 Action responses planned for subsequent Examination Deadlines

1.3.1 Table 1-1 summarises the responses to actions set at the ISH on 11th January 2019 that Horizon is planning to submit at subsequent deadlines.

Table 1-1 Summary of planned action responses

Action / Deliverable	Planned deadline
Additional reptile data relating to the WNDA	Deadline 5
Updated modelling for discharge of foul water from the WNDA	Deadline 5
Technical note on the construction and removal of temporary causeway and how pollutants are captured at removal	Deadline 5
WNDA – qualitative commentary on the impact of the 2018 Climate change projections on Environmental Statement	Deadline 5
WNDA – References to where details and assessment of sea level rises are detailed within the DCO application.	Deadline 5
Dalar Hir – Technical note on the identified flooded parking area, potential flooding of the spine road and existing topographical conditions of the site	Deadline 5
Dalar Hir – Updated modelling to include the possible blockage of culverts within Dalar Hir	Deadline 5
Afon Cafnan and flooding risk – A note outlining proposed flood risk measures relating to the Afon Cafnan	Deadline 6
A diagram explaining the interrelationship between the various control documents and subsequent plans, strategies and schemes.	Deadline 5

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Wylfa Newydd Project

Issue Specific Hearing: Biodiversity. Response to additional information request

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1 Issue Specific Hearing - Biodiversity

1.1 Request for additional information

1.1.1 During the Issue Specific Hearing on biodiversity, held on Friday 11 January, IACC raised concerns regarding Horizon's assessment of effects from the WNDA Development on red squirrel (*Sciurus vulgaris*), notably in relation to cumulative effects with the National Grid North Wales Connection project.

1.1.2 The main area of concern related to the amount of suitable habitat which would be available within the retained woodland at Dame Sylvia Crowe's Mound, and whether this would support any extant red squirrel population.

1.1.3 In response to IACC's concern, Horizon provided figures which gave a range of woodland size required to support a viable red squirrel population. The source of the areas quoted was requested by IACC and it was agreed that Horizon would submit this into Examination at Deadline 4 (17 January 2019).

1.1.4 The paper from which this information was taken is Stevenson-Holt, Claire D. (2008). *Modelling red squirrel population viability under a range of landscape scenarios in fragmented woodland ecosystems on the Solway plain, Cumbria*. University of Cumbria and PTES, UK. (Unpublished).

1.1.5 The document was downloaded from http://insight.cumbria.ac.uk/1565/

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WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

Note of additional clarification on radiological consequence analysis and Project flexRISK

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1 Assessment of radiological consequences

1.1 Introduction

1.1.1 Following the issue specific hearing on 11 January 2019, this post-hearing note provides a supplementary response to the Examining Authority regarding the suitability of applying Project flexRISK to the Wylfa Newydd DCO Project.

1.1.2 In the UK, radiological consequence analyses carried out to support applications for licenses and permissions are required to be performed on the basis of methodologies that are cautious (but realistic) and transparent, using data and models that have been verified and validated, to allow independent verification of assessment outcomes by interested parties. This criteria informed the assessment methodology and models adopted in assessing the potential radiological impacts of accidents for the proposed Wylfa Newydd DCO Project.

1.2 Purpose and scope of the assessments

1.2.1 The purpose, scope and methodology of the Project flexRISK assessments differs from the assessments performed to support the proposed Wylfa Newydd DCO Project ("Wylfa Newydd assessment"). Therefore, direct comparison of Project flexRISK with the Wylfa Newydd assessment is misleading.

1.2.2 The Wylfa Newydd assessment was carried out to support the licensing and permitting applications, including European Commission (EC) Article 37 requirements, for a specific nuclear technology (the UK Advanced Boiler Water Reactor (ABWR) design) at a specific nuclear site in the UK.

1.2.3 FlexRISK [RD1], on the other hand, is a strategic analysis carried out on behalf of the Climate and Energy Fund of the Austrian Federal Government to support policy decisions. It was aimed at demonstrating the geographical distribution of risk predicted to arise from postulated severe accidents from nuclear facilities across Europe. The objectives of the two assessments are completely different.

1.3 Source terms used in the assessments

1.3.1 In the UK, radiological consequence analyses carried out to support applications for licenses and permits are required to be performed on the basis of methodologies that are cautious (but realistic) and transparent, using data and models that have been verified and validated, to allow independent verification of assessment outcomes by interested parties. Thus under different theoretical accident scenarios the amount of radioactivity released into the environment was modelled using standard codes such as ORIGEN, MAAP and RADTRAD, which have been subject to rigorous testing and quality control and are consistent with UK regulatory requirements and expectations.

1.3.2 Project flexRISK project was not subject to these regulatory requirements; therefore the assessors were at liberty to adopt novel methodologies. Project flexRISK did not calculate source terms for the different facilities assessed and the project lacked access to facility-specific data, necessitating the use of arbitrary data derived from open literature. This is especially pertinent to the data relating to the amount of radioactivity released into the environment, which assumed that large fractions of the core inventories of key radionuclides (e.g. I-131 and Cs-137) are released to the environment unabated.

1.3.3 The limitations relating to source terms and data resulted in environmental releases that are several orders of magnitude higher than those calculated for the Wylfa Newydd DCO Project. Such magnitude of releases is not credible for the UK ABWR design, given the robust abatement systems incorporated into the design, as described in Appendix D14-2 of 6.4.98 ES Volume D [APP-234].

1.4 Atmospheric dispersion models used in the assessments

1.4.1 In assessing the potential transboundary impact of severe accidents at the Wylfa Newydd Power Station, the long range atmospheric dispersion model described in the NRPB-R124 report [RD2] was adopted. This model is an extension of the well-known Gaussian plume dispersion model for short duration releases and to distances >100km and provides a simple procedure for estimating activity concentration in air as a function of plume width and distance along the straightline plume trajectory. This model was selected on account of its simplicity, transparency (it is well understood, its limitations are known and it is publicly available), and consistency with UK regulatory requirements. This model was also used in the assessment performed to support the General Data Submission made by the UK Government to the EC under Article 37 of the Euratom Directive [RD3].

1.4.2 In contrast to the simple dispersion model described above, the atmospheric dispersion modelling for Project flexRISK was carried out using flexPART, a complex, state-of-the-art Lagrangian Particle Dispersion Model (LPDM) [RD4]. FlexPART was run using 10 years of meteorological data, performing thousands probabilistic calculations of potential risk across Europe. It is unusual for complex mesoscale models such flexPART to be used in assessments supporting licensing and other regulatory decisions.

1.4.3 In summary, whilst flexPART is a more advanced dispersion model than the NRPB-R124 model, there is little precedent for its use in assessments carried out for regulatory purposes. The NRPB-R124 is well understood and is considered suitable, adequate and in line with regulatory requirements for the cautious radiological consequence analyses performed to support the proposed Wylfa Newydd DCO Project.

1.5 Conclusion

1.5.1 The approaches to radiological consequence analyses – including the choice of atmospheric dispersion models – is determined by the purpose of the assessment it supports.

1.5.2 Calculations performed to inform regulatory processes are normally based on simple, cautious, established and transparent models such as the NRPB-R124 model, to allow scrutiny and independent verification of assessment outcomes by interested parties.

1.5.3 Calculations performed for purposes of scientific inquiry or to support strategic policy decisions are not constrained by regulatory requirements or expectations, and often deploy more novel, sophisticated modelling techniques such as flexPART. However, it is noted that the flexRISK assessment utilised hypothetical source terms which are several orders of magnitude higher than that calculated for the Wylfa Newydd DCO Project; this difference in the source terms has a significant impact on the assessment outcomes than the dispersion models that have been used by Horizon.

1.5.4 This note demonstrates that the purpose, scope and complexity of Project flexRISK are fundamentally different to the severe accident consequence assessment for the Wylfa Newydd DCO Project. For this reason, cursory comparison of the two assessments would lead to misleading conclusions.

1.5.5 The assessment and modelling approach adopted for the Wylfa Newydd DCO Project is appropriate for regulatory applications and has resulted in a positive opinion from the EC confirming that unplanned releases of radiological effluent will not result in radioactive contamination in another Member State [RD3].

Table 1-1 Schedule of references

ID	Reference
RD1	Petra Seibert et al (2013) flexRISK – Flexible Tools for Assessment of Nuclear Risk in Europe, Final Report (Preliminary Version, May 2013) http://flexrisk.boku.ac.at/en/index.html
RD2	Jones JA (1981). The fourth report of a Working Group on Atmospheric Dispersion - A Model for Long Range Atmospheric Dispersion of Radionuclides Released over a Short Period. Chilton, NRPB–R124.
RD3	European Commission, Commission Opinion of 4 June 2018 relating to the plan for the disposal of radioactive waste arising from the Wylfa Newydd nuclear power station (two UK-ABWR reactors) located in Wales, United Kingdom (2018/C 193/01). https://eur-

	lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOC_2018_193_R_0001&from=EN
RD4	Stohl et al. (2005): Technical note: The Lagrangian particle dispersion model FLEXPART version 6.2., Atmos. Chem. Phys., 5, 2461–2474

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Wylfa Newydd Project

Analysis of Accidental Releases: comparison with information submitted under EURATOM Article 37

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1 Analysis of Accidental Releases

1.1.1 Within the Draft DCO application, Appendix D14-2 of the Environmental Statement [APP-234] presented an analysis of accidental releases associated with the Wylfa Newydd DCO Project. Appendix D14-2 was finalised in early 2018. At the issue specific hearing on 11 January 2019, the Examining Authority requested clarification as to whether the assessment in Appendix D14-2 took into account the additional information requested by the European Commission in the context of Article 37 of the Euratom Treaty.

1.1.2 In accordance with Article 37 of the Euratom Treaty, the UK Government submitted general data relating to the plan for the disposal of radioactive waste arising from the Wylfa Newydd Power Station (two 1,350 MWe UK-ABWR reactors) on 20 October 2017 to the European Commission.

1.1.3 On the basis of this data and additional information requested by the Commission on 13 December 2017 and provided by the UK Government on 22 January 2018, and the complementary information provided by representatives of the UK Government at the meeting of the Group of Experts on 30 and 31 January 2018 and further information provided on 14 February 2018, the Commission arrived at the following opinion.

1.1.4 "*In conclusion, the Commission is of the opinion that the implementation of the plan for the disposal of radioactive waste in whatever form, arising from the two UK-ABWR reactors of the Wylfa Newydd nuclear power station, located in Wales, United Kingdom, both in normal operation and in the event of accidents of the type and associated magnitudes of unplanned releases of radioactive effluents as considered in the General Data, is not liable to result in a radioactive contamination, significant from the point of view of health, of the water, soil or airspace of another Member State, in respect of the provisions laid down in the Basic Safety Standards Directive.*"

1.2 Additional information under Article 37

1.2.1 As stated above, as part of the process of providing an opinion under Article 37, the Commission requested additional information. In response to this request, additional information was provided in to process and to the Article 37 Group of Experts in January 2018. This additional information provided clarity and answered questions raised by the expert panel on some technical aspects of the analysis, primarily relating to the atmospheric dispersion methodology used in the assessment and some clerical errors. The additional information did not change the basis of the Article 37 assessment.

1.3 Consistency between DCO and Article 37

1.3.1 Given the nature of the changes, Horizon can confirm that the analysis of accidental releases in Appendix D14-2 of the Environmental Statement [APP-234] remains consistent with the information provided in the Article 37 submission (including additional information provided), on which the UK Government received a positive opinion from the Commission.

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Wylfa Newydd Project

Valley Tidal Defence Breach Modelling

PINS Reference Number: EN010007

17 January 2019

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Technical note:
207672-0013-AA40-TLN-0003:
Valley Breach 2D Model files package

1. Introduction

This note provides information on Valley breach modelling input and output files that have been packaged up for transmittal to National Resources Wales (NRW). The files and information in this note should be read together with technical note (Doc ref: 207672-0013-AA40-TLN-0001 [207672-0013-AA40-TLN-0001 Valley Tidal Breach Modelling 09-11-18 FINAL]) that was issued in November 2018. The report contained a detail methodology of the 2D hydraulic modelling methodology carried out for various tidal flood defence beach scenarios at Valley. This supplementary note provides details of the model files and outputs so that a suitably qualifies person (SQEP) can reproduce the results or extend current 2D model further.

The model files are provided in the accompanying zip file ref: 207672-0013-AA40-DAT-0003.zip and are catalogued in the following sections.

1.1 Model files

Following sections provide information on the 2D model input parameter files, various output files including output figures and maps. The 2D breach modelling was carried out using TUFLOW software tool which are listed in following sections for clarity.

Input files

Input files for 2D simulation that consist of topography, roughness, channel alignments, breach openings, tidal stage and various model parameter are listed in Table 1.1 below

Table 1.1 TUFLOW input file listings

File Type	File name	Explanation / Information
Topography	Valley_1m_LiDAR_050416_trim.asc	Existing topography from NRW LiDAR
	sh282930_1m.asc	NRW LiDAR for extended domain
	valleytrig_junev2_topo_comparea.asc	topography with bypass and compensation storage area
Surface Roughness	2d_mat_Vall_003.mif	from OS MasterMap
	2d_mat_Channel_2d_001.mif	roughness for 2d channel elements
	2d_zsh_along_channel_002.mif	channel incision through 2D grid

File Type	File name	Explanation / Information
Channels/culvert/drain	2d_zln_Vall_Drai03.mif	drain alignment and levels
	2d_zln_Vall_Drai05.mif	drain alignment and levels
	2d_zln_Vall_Drai08.mif	drain alignment and levels
	2d_zln_Vall_Drai09.mif	drain alignment and levels
	2d_zln_Vall_Maes_001.mif	channel representation for Maes Y Wrach
Geometry control	Vall_Base_037_TBr50m_001.tgc	Base case, geometry control file for 50m breach
	Vall_Bypass_037_TBr50m_001.tgc	Bypass, geometry control file for 50m breach
	Vall_Base_037_TBr20m_001.tgc	Base case, geometry control file for 20m breach
	Vall_Bypass_037_TBr20m_001.tgc	Bypass, geometry control file for 20m breach
Run configuration	Vall_Base_Breach50m_2D47_Flv0cc_T200_2115_001.tcf	Base case, 50m breach run parameters
	Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115_001.tcf	Bypass, 50m breach run parameters
	Vall_Base_Breach20m_2D49_Flv0cc_T200_2115_001.tcf	Base case, 20m breach run parameters
	Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115_001.tcf	Bypass, 20m breach run parameters
Boundary condition database	bc_dbase_Vall_006_T200_2115.csv	Tidal stage time series (1:200 Years, cc 2115)
	Vall_03.tmf	Roughness type listings
MapInfo model files within folder : '\\TUFLOW\model\mi\'	2d_bc_Vall_Base_032_2Donly.mif 2d_loc_Vall_002.mif 2d_po_Vall_002.mif 2d_code_Vall_009.mif 2d_zsh_Vall_Bridge_004.mif 2d_zln_Vall_Culv_002.mif 2d_zsh_Vall2dOnly_001.mif 2d_zsh_Vall_DTM_001.mif 2d_zsh_Vall_DEF_002.mif 2d_zsh_Vall_DefBrch20m_002.mif 2d_zsh_Vall_DefBrch50m_002.mif 2d_fcsh_Vall2dOnly_002.mif 2d_zsh_along_channel_002.mif	2D boundary condition Grid orientation direction Plot Output locations Computation domain Bridges/culvert levels Culvert invert Bridge/culvert opening sizes DEM elevation correction Tidal defence embankment: Breach geometry (20m opening): Breach geometry (50m opening): Flow constriction layers: channel incision through 2D grid

Output files

With inputs as described in preceding section, model results/outputs for the simulation carried out for tidal event 1:200 AEP (plus climate change, epoch 2115 AD) are given in Table 1.2

Table 1.2 Model output files

File type	File name	Explanation / Information
ASCII grid	Vall_Base_Breach20m_2D49_Flv0cc_T200_2115_001_d_Max.asc	Maximum depth, base case, 20m breach
	Vall_Base_Breach20m_2D49_Flv0cc_T200_2115_001_h_Max.asc	Maximum flood level, base case, 20m breach
	Vall_Base_Breach20m_2D49_Flv0cc_T200_2115_001_V_Max	Maximum velocity, base case, 20m breach
	Vall_Base_Breach20m_2D49_Flv0cc_T200_2115_001_ZUK0_Max.asc	Maximum hazard, base case, 20m breach
	Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115_001_d_Max.asc	Maximum depth, bypass, 20m breach
	Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115_001_h_Max.asc	Maximum flood level, bypass, 20m breach
	Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115_001_V_Max.asc	Maximum velocity, bypass, 20m breach
	Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115_001_ZUK0_Max.asc	Maximum hazard, bypass, 20m breach
	Vall_Base_Breach50m_2D47_Flv0cc_T200_2115_001_d_Max.asc	Maximum depth, base case, 50m breach
	Vall_Base_Breach50m_2D47_Flv0cc_T200_2115_001_h_Max.asc	Maximum flood level, base case, 50m breach
	Vall_Base_Breach50m_2D47_Flv0cc_T200_2115_001_V_Max.asc	Maximum velocity, base case, 50m breach
	Vall_Base_Breach50m_2D47_Flv0cc_T200_2115_001_ZUK0_Max.asc	Maximum hazard, base case, 50m breach
	Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115_001_d_Max.asc	Maximum depth, bypass, 50m breach
	Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115_001_h_Max.asc	Maximum flood level, bypass, 50m breach
	Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115_001_V_Max.asc	Maximum velocity, bypass, 50m breach
	Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115_001_ZUK0_Max.asc	Maximum hazard, bypass, 50m breach
Line graphs/figures	TidalBreach20m_PO_Stage_Temporal_Variation_2Donly.xlsx	Temporal stage comparison graphs POs 2, 22 and 25
	TidalBreach50m_PO_Stage_Temporal_Variation_2Donly.xlsx	Temporal stage comparison graphs POs 2, 22 and 25

File type	File name	Explanation / Information
PDF maps	35989-Lon650_Fig_8_14a_PO_ZOOM_002.pdf	PO location map (zoomed)
	35989-Lon651_Fig_8_10_Vall2D_base_peak_depth50mTidalbreach.pdf.pdf	Inundation depth map for base case 50m breach
	35989-Lon652_Fig_8_11_Vall2D_bypass_peak_depth50mTidalbreach.pdf	Inundation depth map for bypass 50m breach
	35989-Lon653_Fig_8_12_Vall2D_base_flood_hazard50mTidalbreach.pdf	Hazard map for base case 50m breach
	35989-Lon654_Fig_8_13_Vall2D_bypass_flood_hazard50mTidalbreach.pdf	Hazard map for bypass 50m breach
	35989-Lon655_Fig_8_14_Vall2D_depth_diff50mTidalbreach.pdf	Depth difference map – between bypass and base case considered, 50m breach
	35989-Lon656_Fig_8_15_Vall2D_base_peak_depth20mTidalbreach	Inundation depth map for base case 20m breach
	35989-Lon657_Fig_8_16_Vall2D_bypass_peak_depth20mTidalbreach	Inundation depth map for bypass 20m breach
	35989-Lon658_Fig_8_17_Vall2D_base_flood_hazard20mTidalbreach	Hazard map for base case 20m breach
	35989-Lon659_Fig_8_18_Vall2D_bypass_flood_hazard20mTidalbreach	Hazard map for bypass 20m breach
	35989-Lon660_Fig_8_19_Vall2D_depth_diff20mTidalbreach	Depth difference map – between bypass and base case considered, 20m breach
Depth difference grid	DepthDiff20.gdb	Inundation depth difference between bypass and base case, 20m breach
	DepthDiff50.gdb	Inundation depth difference between bypass and base case, 50m breach
Time series spreadsheet data for selected POs	TidalBreach20m_PO_Stage_Temporal_Variation_2Donly TidalBreach50m_PO_Stage_Temporal_Variation_2Donly	Time series data output for POs and embedded line graph as reported (ref doc: 207672-0013-AA40-TLN-0001)

All files as listed in above tables have been supplied with this summary note in compressed *zip* file format.

The files have been organised as below within the zipped file *'207672-0013-AA40-DAT-0003.zip'*.

i. TUFLOW = TUFLOW Model Input files

ii. TUFLOW_Results = TUFLOW Model results (ascii files, depth difference and Spreadsheets)

iii. Maps_Figures (Pdf maps and line graphs in excel)

iv. PO_Spreadsheets (time series results for POs)

The *zip* file containing inputs and outputs as listed in the tables above have been transferred using secure file transfer system. The supplied *zip* pack is a complete 2D model files that can also be run stand alone on a computer installed with software tool TUFLOW.

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Technical Note: 207672-0013-AA40-TLN-0001
Hydraulic modelling of tidal defence breach at Valley

1. Introduction

The DCO application for Wylfa Newydd project comprises a number of associated development sites including the A5025 bypass at Valley. The proposal includes the construction of a bypass connecting the A5 Road (Holyhead Road) and the A5025 Road, approximately at 500m to the east of Valley railway station in Anglesey, Wales. The Valley A5025 bypass development site is in close vicinity of a tidal defence (1km approx. To the south.), therefore a future extreme flooding scenario for a breach of the defence has been explored.

This Technical Note outlines the hydraulic modelling task carried out based on Task Sheet 13 as part of supporting documents for Defensive Brief 16 [Item 11]. The Valley hydraulic modelling report submitted with the DCO (Doc ref: 207017-0000-AA40-RPT-0002_004) considered a number of fluvial and tidal events separately and in combination. The DCO modelling did not though consider an extreme event where the tidal defence fails. This Technical note presents the flooding predictions associated with defence failure under extreme tidal conditions. The purpose of this modelling is to identify if the proposed bypass at Valley and associated earthworks have the potential to exacerbate the flood risk to people and property under a tidal defence failure scenario. To this end it has been necessary to develop two sets of model scenarios representing the baseline (i.e. no highway development) and a with development scenario (i.e. with highway) both with a breach simulated. The 1:200yr tide (plus climate change to 2115) was simulated through both scenarios and for both scenarios a 20m and 50m breach was simulated.

The structure of this Technical Note is as follows:

- Section 1 – Introduction, description of the breach location, failure mode and the events being simulated
- Section 2 – Description of the input data used in this modelling task
- Section 3 – Details of how the DCO model (ref 207017-0000-AA40-RPT-0002_004) has been modified to enable this extreme tidal flooding scenario to be simulated
- Section 4 – The modelled results
- Section 5 - Summary

1.1 Breach location

The only associated tidal flood defence in the vicinity of Valley is the manmade structure at the edge of the Afon Cleifiog Estuary, which is the narrow tidal straight separating Anglesey from Holy Island, see Figure 1.1. There has been a defence of sorts here since 1776, with the first tidal gates constructed in the 1830's to allow the river to discharge whilst protecting the hinterland from tidal flooding. In 2009/2010 NRW extended the culvert arrangement to allow vehicle access for future maintenance, replaced the tidal flaps and built a new penstock, the seaward face was also repaired and the crest of the embankment was raised from 4.3 to 4.8m AOD.

The deepest section on the discharging channel and estuary mouth has been taken as the breach location. The flood defence is an embankment structure (NGR: SH 28960 78260) which is understood to be:

- trapezoidal in section
- Assumed composite formation of hard and soft material, but the exact internal composition is unknown.

Figure 1.1 Location of breach on the tidal defence embankment

1.2 Approach to representing the breach

The defence embankment currently includes within it three parallel culverts as drainage outlet structures, discharging into the Afon Cleifiog Estuary. As the outlets are flapped, they are assumed to be blocked during extreme events and so these have been removed from the model. The breach is not represented as a dynamic failure. The breach (both 20m and 50m) are represented in the model from the initiation of the simulation.

The defence embankment is understood to be of a composite formation, containing both hard and soft earthen material; therefore, two breach scenarios are modelled and the results are presented in this report for both 20m width (for hard formation) and 50m width (for soft formation) breach as recommended in the NRW Guidance (Ref 2).

1.3 Simulated tidal event

Table 4 of NRW Guidance (Ref 2) relating to section A1.14 of TAN15 (Ref 1), advices, however not prescriptive, the threshold frequency for design events for General Infrastructure other than Emergency Services as:

(i) 1% AEP+CC for Fluvial event

(ii) 0.5% AEP+CC for Tidal event.

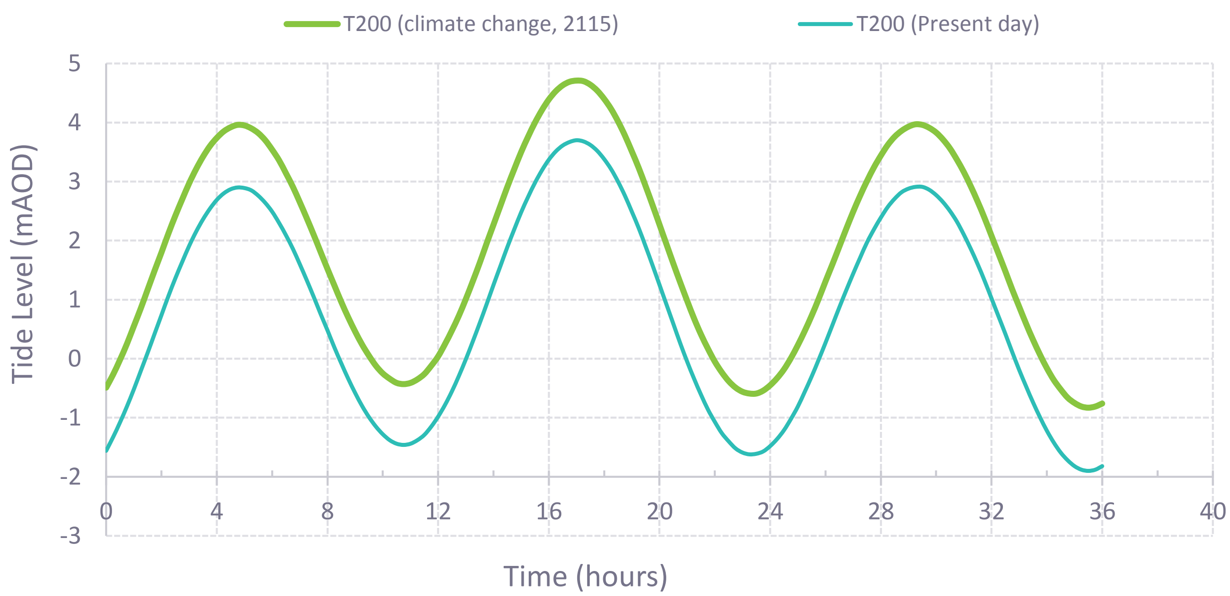
For this modelling study, the objective was to study the breach of a tidal-defence, so only tidal component is considered in the modelling and there is not any fluvial flow component.

2. Data used

In this modelling study, the same LiDAR topographic data that as was used in the previous hydraulic modelling study (Doc ref: 207017-0000-AA40-RPT-0002_004) has been used for consistency. Additional LiDAR data has been used to extend the 2D computation domain. The extent of computation domain has been updated to reflect the flow paths and peak tidal levels commensurable with the extreme event. A preliminary model run was also carried out to eliminate any boundary effect within the 2D computation domain.

As explained in previous section, only tidal component is simulated in this study and no fluvial flow component is included in the analysis. The tidal stage level curve has been taken directly from previously used boundary condition for the hydraulic model which was supplied by NRW for use in modelling. The tidal water level taken for the simulation for epoch 2115 AD shows the peak level higher by 1.015mAOD compared to present day 1:200 AEP event. The peak levels for 1:200 AEP present day and climate change epoch corresponding to year 2115 are 3.7mAOD and 4.71mAOD respectively, as shown below in Figure 2.1.

Figure 2.1 Tidal water level at the estuary (climate change epoch: 2115)



The tidal water level data as shown above was supplied by NRW for DCO modelling study.

3. Model update

3.1 2D Model build:

Model update overview:

In this modelling study existing coupled 1D-2D (Flood modeller - TUFLOW) hydraulic model has been adapted and a decoupled 2D-only model in TUFLOW has been used as a conservative approach to compare the breach scenario with and without the proposed bypass. The tidal water level is directly applied at the downstream end of 2D model domain and the flow is computed through the 2D grid (2m x2m) cell elements.

Channels and drainage structures

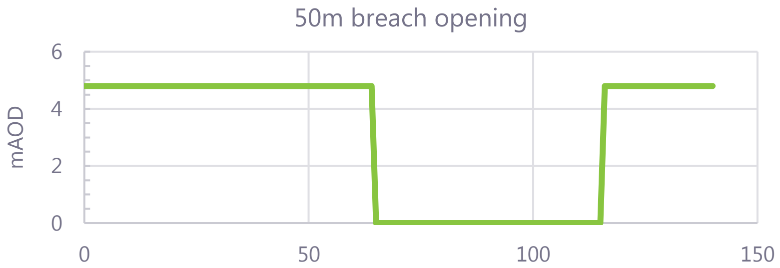
The adapted 2D-Only model has undergone topographical refinements for a reasonable representation of channel elements and hydraulic structures within the computational domain. The channel elements have been represented by linear feature (zsh-shape layer) representing channel centreline combined with their bed levels taken from existing 1D-2D model to inform preferential flow routes within 2D only TUFLOW model.

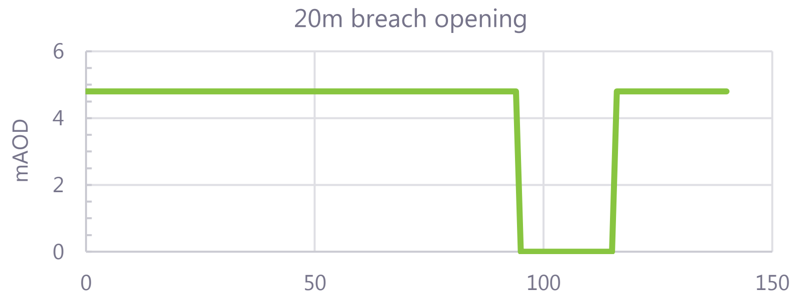
The existing hydraulic structures have been represented using flow constriction layers (fcsh- shape layer) within 2D only TUFLOW model. In this approach, flow opening size of the drainage structures are represented by a blockage proportion parameter called ‘pBlockage’.

Breach representation

At the location of defence embankment, the 2D model grid was amended with the opening widths of 50m and 20m separately. The rectangular opening was provided fully open from the start of the simulation for a more conservative representation i.e. a scenario in which the breach has already been there at the start of the simulation of event (i.e. an open flood passage scenario). This approach is likely to give bigger inundation extent and higher flood depth than a ‘breach at peak’ or ‘rapid inundation’ approach. As the opening is provided from the start of the simulation, it should not be confused with a sudden or an abrupt breach of any parts of the embankment. The term breach here should be taken as an existing breach opening from the beginning of the simulation. The sectional elevations through the embankment that were represented in the model are shown in **Error! Reference source not found.**.

Figure 3.1 Breach opening applied in model (50m and 20m openings as indicated)





3.2 Model Simulation

To understand the scale of changes in flood risk that may be posed by the proposed bypass at Valley, it has been necessary to compare scenarios with and without bypass and its associated development. Hence two sets of mode scenarios were simulated representing the baseline (i.e. no highway development) and a with development scenario. The 1:200 AEP tide (plus climate change to 2115) was simulated through both scenarios for both 20m and 50m breach size.

The adapted 2D model was run with the updates as described in section 3.1. The duration of model run was taken to be 36 hours as recommended in the guideline (Ref: 2) which recommends a duration of three tidal cycles and it has been assumed that there is no subsequent repair of breach during this time. The peak tide level of 4.71mAOD at the estuary has been accommodated in the middle of the tide cycle time domain as shown in section 2. Summary tables for input files and events simulated are given in Table 3.1 and Table 3.2 for baseline considered for this study and bypass development scenario respectively.

Table 3.1 Tidal breach baseline model runs

Item	Model run event	Input files
2D only Model run 50m	T200cc: Tidal 1:200 years AEP plus climate change 2115	Vall_Base_Breach50m_2D47_Flv0cc_T200_2115_001.tcf 2d_zsh_Vall_DefBrch50m_002.MIF 2d_fcsh_Vall2dOnly_002.MIF
2D only Model run 20m	T200cc: Tidal 1:200 years AEP plus climate change 2115	Vall_Base_Breach20m_2D49_Flv0cc_T200_2115_001.tcf 2d_zsh_Vall_DefBrch20m_002.MIF 2d_fcsh_Vall2dOnly_002.MIF
Model Run parameters and settings	Model run 3 tide cycles i.e 36 hours	Vall_Tide2D_001.csv

Table 3.2 Tidal breach bypass (with development) model runs

Item	Model run event	Input files
2D only Model run 50m	T200cc: Tidal 1:200 years AEP plus climate change 2115	Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115_001.tcf 2d_zsh_Vall_DefBrch50m_002.MIF 2d_fcsh_Vall2dOnly_002.MIF valleytrig_junev2_topo_comparea.asc
2D only Model run 20m	T200cc: Tidal 1:200 years AEP plus climate change 2115	Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115_001.tcf 2d_zsh_Vall_DefBrch20m_002.MIF 2d_fcsh_Vall2dOnly_002.MIF valleytrig_junev2_topo_comparea.asc
Model Run parameters and settings	Model run 3 tide cycles i.e 36 hours	Vall_Tide2D_001.csv

The only difference between the scenarios in above two tables is the representation of topography before and after the proposed bypass and associated developments including compensatory storage area.

4. Model Results

The model results have been presented in the form of inundation extents with depth classification and associated depth difference maps for grid cell to grid cell comparison of flood depth. Hazard maps for both baseline and proposed bypass scenario have been prepared for comparison. For this modelling study baseline and the bypass developed scenario both relates the open breach effects before and after the bypass construction.

The maps are shown in appendices A and B for each of 50m and 20m breach scenario respectively, as listed below:

In Appendix A:

Inundation maps

- Figure 8.10: A5025 Valley baseline peak depth (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, climate change 2115)
- Figure 8.11: A5025 Valley bypass peak depth (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, climate change 2115)
- Hazard maps
- Figure 8.12: A5025 Valley baseline flood hazard map for 50m wide tidal breach (tidal 1:200 year AEP, climate change 2115)
- Figure 8.13: A5025 Valley bypass flood hazard map for 50m wide tidal breach (tidal 1:200 year AEP, climate change 2115)

Depth difference map

- Figure 8.14: A5025 Valley peak depth difference (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, climate change 2115)

In Appendix B:

Inundation maps

- Figure 8.15: A5025 Valley baseline peak depth (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, climate change 2115)
- Figure 8.16: A5025 Valley bypass peak depth (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, climate change 2115)

Hazard maps

- Figure 8.17: A5025 Valley baseline flood hazard map for 20m wide tidal breach (tidal 1:200 year AEP, climate change 2115)
- Figure 8.18: A5025 Valley bypass flood hazard map for 20m wide tidal breach (tidal 1:200 year AEP, climate change 2115)

Depth difference map

- Figure 8.19: A5025 Valley peak depth difference (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, climate change 2115)

A comparison of water level and velocity has been made for modelled result for both the baseline condition (developed for the purposes of this breach analysis) and with bypass (i.e. with development) scenarios (see section 3.2) for each of the breach conditions. Table 4.1 and Table 4.2 show the differences between such water levels and velocities for 50m and 20m breach case respectively, at plot output (PO) points (see Fig 8.14a for PO points locations).

Table 4.1 Comparison of peak water level and peak velocity achieved at each PO point, in the 50m wide tidal defence breach scenario

Result at PO points	**Baseline**		**With Bypass**		**Difference (bypass minus baseline)***	
	Velocity (m/s)	**Water level (mAOD)**	**Velocity (m/s)**	**Water level (mAOD)**	**Velocity (m/s)**	**Water level (mAOD)**
1	1.312	3.323	1.468	3.316	0.156	-0.007
2	0.283	3.323	0.273	3.316	-0.010	-0.007
3	0.061	3.323	0.056	3.316	-0.006	-0.007
4	0.105	3.323	0.125	3.316	0.020	-0.007
5	0.028	3.323	0.026	3.316	-0.002	-0.007
6	0.552	3.324	0.557	3.317	0.006	-0.007
7	3.313	3.325	3.276	3.318	-0.037	-0.007
8	2.359	3.323	2.122	3.315	-0.237	-0.007
9	0.073	3.323	0.027	3.316	-0.046	-0.008
10	0.108	3.323	0.121	3.316	0.014	-0.008
11	0.091	3.323	0.077	3.316	-0.013	-0.008
12	0.050	3.323	0.040	3.316	-0.010	-0.008

13	0.256	3.323	0.263	3.316	0.006	-0.008
14	0.090	3.323	0.091	3.316	0.001	-0.008
15	0.027	3.323	0.030	3.316	0.003	-0.008
16	0.057	3.323	0.058	3.316	0.001	-0.007
17	0.091	3.324	0.088	3.316	-0.003	-0.008
18	0.044	3.323	0.039	3.316	-0.005	-0.008
19	0.055	3.324	0.052	3.316	-0.002	-0.008
20	0.082	3.324	0.082	3.316	0.000	-0.008
21	0.026	3.324	0.028	3.316	0.001	-0.008
22	0.100	3.324	0.095	3.316	-0.005	-0.008
23	0.050	3.324	0.047	3.316	-0.004	-0.008
24	0.029	3.323	0.030	3.316	0.001	-0.008
25	0.093	3.323	0.093	3.316	0.000	-0.008
26	0.061	3.323	0.069	3.316	0.008	-0.008
27	0.143	3.323	0.155	3.316	0.013	-0.008
28	0.054	3.323	0.051	3.316	-0.003	-0.007
29	0.070	3.323	0.085	3.316	0.016	-0.008
30	0.323	3.323	0.316	3.316	-0.008	-0.007
31	0.109	3.323	0.101	3.316	-0.008	-0.007
32	0.188	3.323	0.177	3.316	-0.011	-0.007
33	0.013	3.323	0.013	3.316	0.000	-0.008
34	0.008	3.323	0.007	3.316	-0.001	-0.007
35	0.011	3.323	0.010	3.316	0.000	-0.007
36	0.011	3.323	0.010	3.316	-0.001	-0.007
37	0.032	3.323	0.031	3.316	-0.001	-0.007
38	0.014	3.323	0.013	3.316	-0.001	-0.007
39	0.052	3.323	0.052	3.316	0.000	-0.007
40	0.019	3.323	0.020	3.316	0.001	-0.007

* negative value indicates reduction from baseline

Table 4.2 Comparison of peak water level and peak velocity achieved at each PO point, in the 20m wide tidal defence breach scenario

Result at PO point	**Baseline**		**With Bypass**		**Difference (bypass minus baseline)***	
	Velocity (m/s)	**Water level (mAOD)**	**Velocity (m/s)**	**Water level (mAOD)**	**Velocity (m/s)**	**Water level (mAOD)**
1	1.304	3.297	1.471	3.290	0.166	-0.007
2	0.280	3.297	0.269	3.291	-0.011	-0.006
3	0.060	3.297	0.053	3.290	-0.007	-0.006
4	0.106	3.297	0.123	3.290	0.017	-0.006
5	0.027	3.297	0.026	3.290	-0.001	-0.006
6	0.553	3.298	0.551	3.290	-0.002	-0.009
7	3.313	3.299	3.265	3.291	-0.049	-0.008

8	1.974	3.296	2.340	3.290	0.365	-0.006
9	0.067	3.297	0.031	3.290	-0.037	-0.007
10	0.106	3.297	0.120	3.290	0.014	-0.007
11	0.095	3.297	0.088	3.290	-0.007	-0.007
12	0.052	3.297	0.048	3.290	-0.004	-0.007
13	0.256	3.297	0.262	3.290	0.006	-0.007
14	0.089	3.297	0.090	3.290	0.001	-0.007
15	0.027	3.297	0.032	3.290	0.005	-0.007
16	0.058	3.297	0.063	3.290	0.005	-0.007
17	0.089	3.297	0.090	3.290	0.001	-0.007
18	0.046	3.297	0.042	3.290	-0.004	-0.007
19	0.055	3.297	0.052	3.290	-0.002	-0.007
20	0.082	3.297	0.082	3.290	0.000	-0.007
21	0.023	3.297	0.026	3.290	0.003	-0.007
22	0.099	3.297	0.095	3.290	-0.004	-0.007
23	0.050	3.297	0.046	3.290	-0.003	-0.007
24	0.029	3.297	0.030	3.290	0.001	-0.007
25	0.093	3.297	0.093	3.290	0.000	-0.007
26	0.059	3.297	0.069	3.290	0.009	-0.007
27	0.149	3.297	0.152	3.290	0.003	-0.007
28	0.053	3.297	0.051	3.290	-0.002	-0.007
29	0.070	3.297	0.085	3.290	0.015	-0.007
30	0.320	3.297	0.313	3.290	-0.007	-0.007
31	0.108	3.297	0.098	3.290	-0.010	-0.006
32	0.186	3.297	0.173	3.290	-0.013	-0.006
33	0.014	3.297	0.013	3.291	0.000	-0.006
34	0.007	3.297	0.007	3.290	0.000	-0.007
35	0.009	3.297	0.009	3.291	-0.001	-0.006
36	0.009	3.297	0.009	3.291	0.000	-0.006
37	0.032	3.297	0.031	3.291	-0.001	-0.006
38	0.012	3.297	0.013	3.291	0.001	-0.006
39	0.053	3.297	0.052	3.291	-0.002	-0.007
40	0.019	3.297	0.019	3.291	0.000	-0.007

* negative value indicates reduction from baseline

Temporal variations of flood water level at various result observation points were also analysed. The rising and falling of flood water levels show a correspondence with the downstream tidal boundary. Figure 4.1 and Figure 4.2 show the temporal change of water levels. The figures show the water surface levels for PO IDs 22 and 25 are higher for 'bypass' at 5.5 hour and 16.5 hour simulation time, however, the maximum water surface level occurs at later simulation time 18 hour, commensurable with the peak tidal level. The difference in water surface levels for PO IDs 22 and 25 at this elevation for both breach scenarios (20m and 50m) are approximately 3cm and 2cm respectively for the simulation times 5.5 hour and 16.5 hour. The discrepancy at these earlier simulation times can be attributed to slight changes in floodplain flow between the two areas of floodplain (east and west of the proposed bypass), in the location of the proposed new roundabout. The differences in predicted flood hazard in Valley are considered negligible.

Figure 4.1 Temporal variation of water level at PO points 2, 22 and 25 (50m breach)

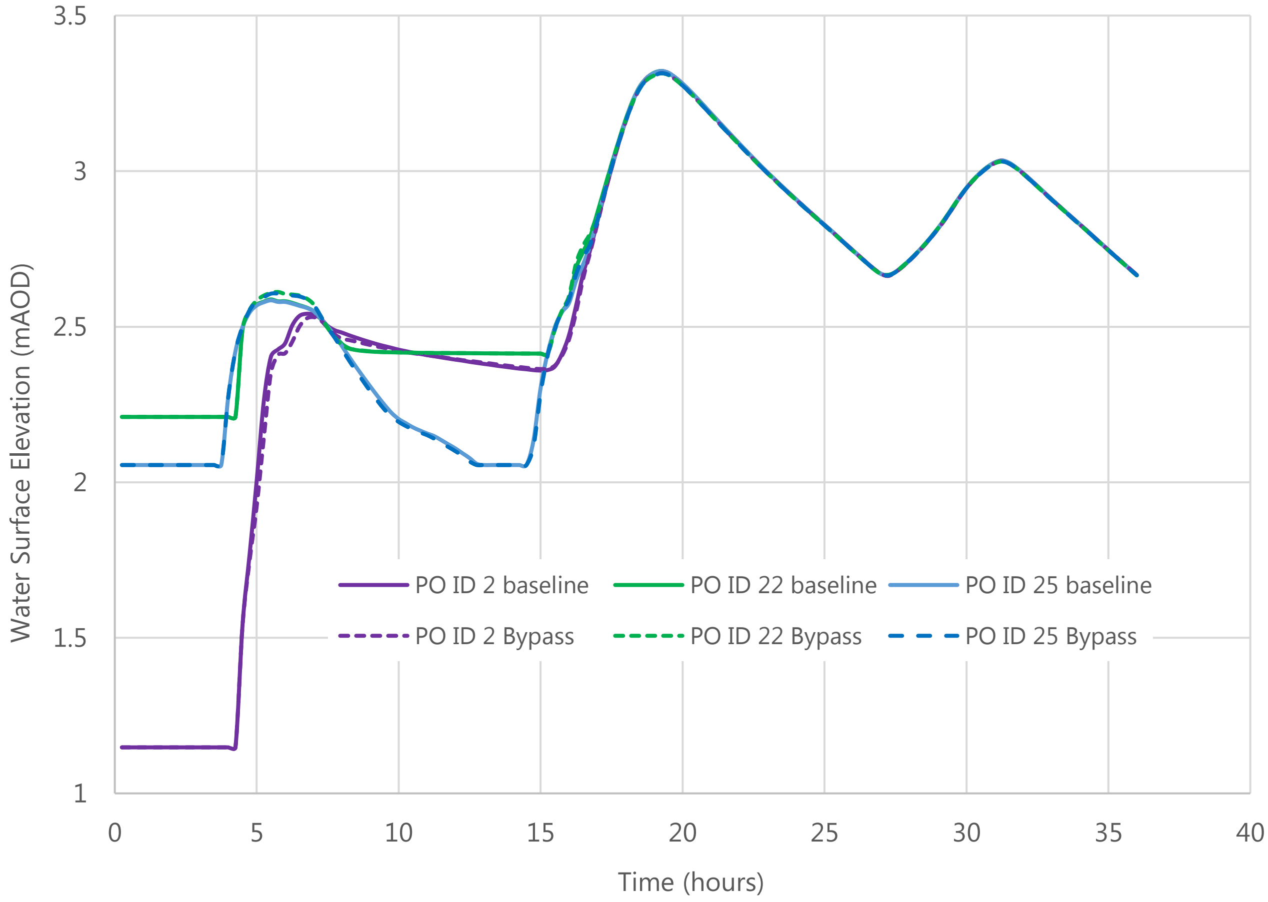
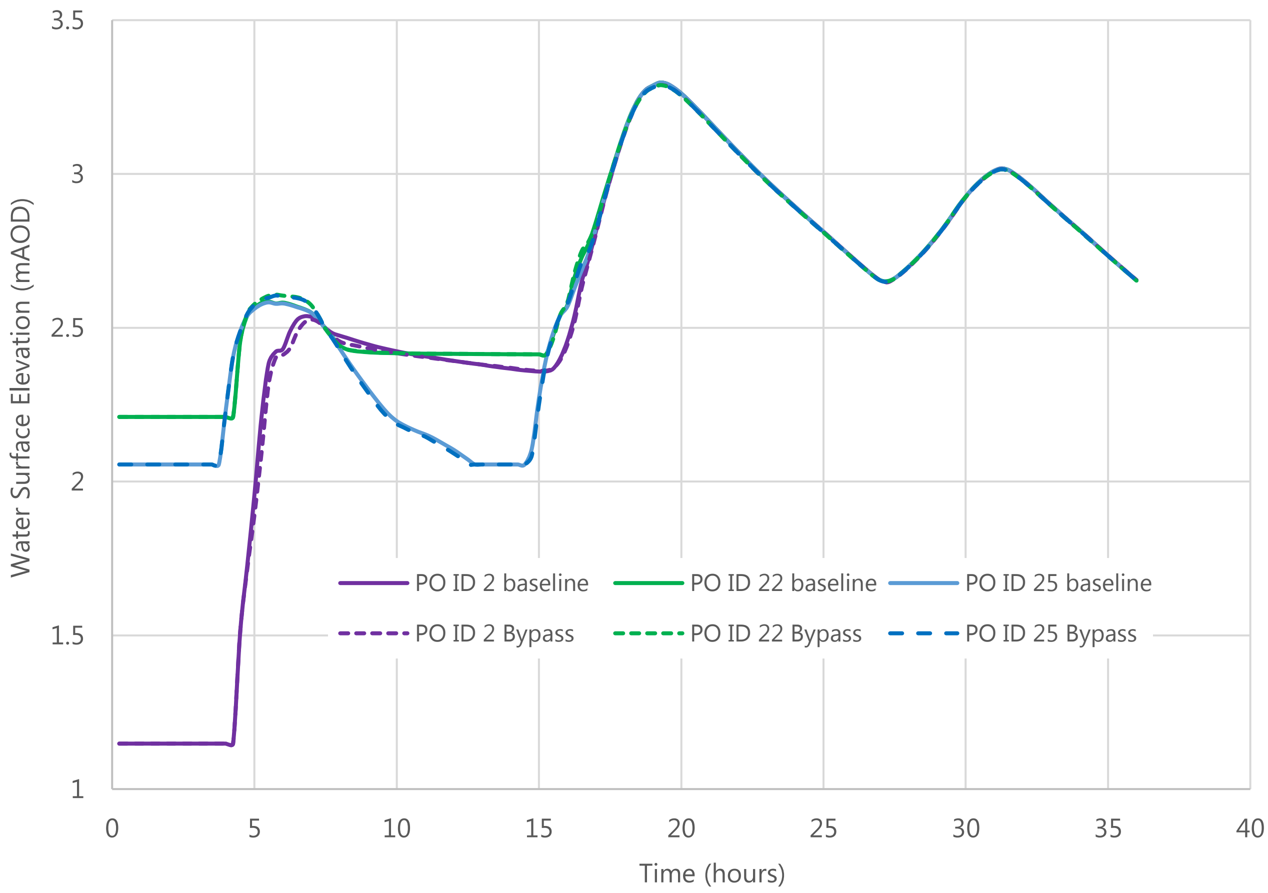


Figure 4.2 Temporal variation of water level at PO points 2, 22 and 25 (20m breach)



5. Summary

This Technical Note presents flood risk predictions from a revised baseline model. This revised model has its origins in the DCO Valley hydraulic model (ref 207017-0000-AA40-RPT-0002_004) but has been simplified for the purpose of this tidal breach sensitivity test. The simplification has involved removing the 1-Dimensional elements from the DCO model and thereby creating a 2-Dimensional only model. These simplifications have been necessary to enable the model to simulate the extreme tidal boundary being applied without suffering unacceptable instabilities. The purpose of this Technical Note is to present the resultant differences in risk to local properties, under a breached scenario, between the revised baseline and a scenario in which the proposed bypass and associated earthworks are represented.

Model results have been presented for both 50m and 20m breaches in this study. The results show that there is no increase in flood depth, rather a majority of area shows a decrease, albeit not significant, in flood depth; especially the area east of railway track which seems to have been benefitted from the development, as the depth difference map shows a reduction of water depth in a range of 5mm to 10mm (see Figures 8.14 and 8.19).

The model run results for both baseline and developed scenarios have been produced in terms of inundation depth and hazards maps. Depth difference maps were also prepared for grid to grid comparison. The difference maps showed there is no increase in flood risk with respect to the tidal breach for existing baseline case. The reduction in flood depth for areas east of the railway track can be attributed to the provision of compensatory storage area in bypass ('with development') case. The plots for temporal water level variations at selected result observation (PO) points show a correspondence with the downstream tidal water level ensuring model stability.

References:

1. Technical Advice Note (TAN) 15: Development and Flood Risk, Welsh Assembly Government, 2004.
2. Flood Risk Management: Modelling blockage and breach scenarios, Natural Resources Wales, OGN Reference Number: OGN100, February 2015.

Appendix A

Figures
8.10 ~ 8.14 and 8.14a

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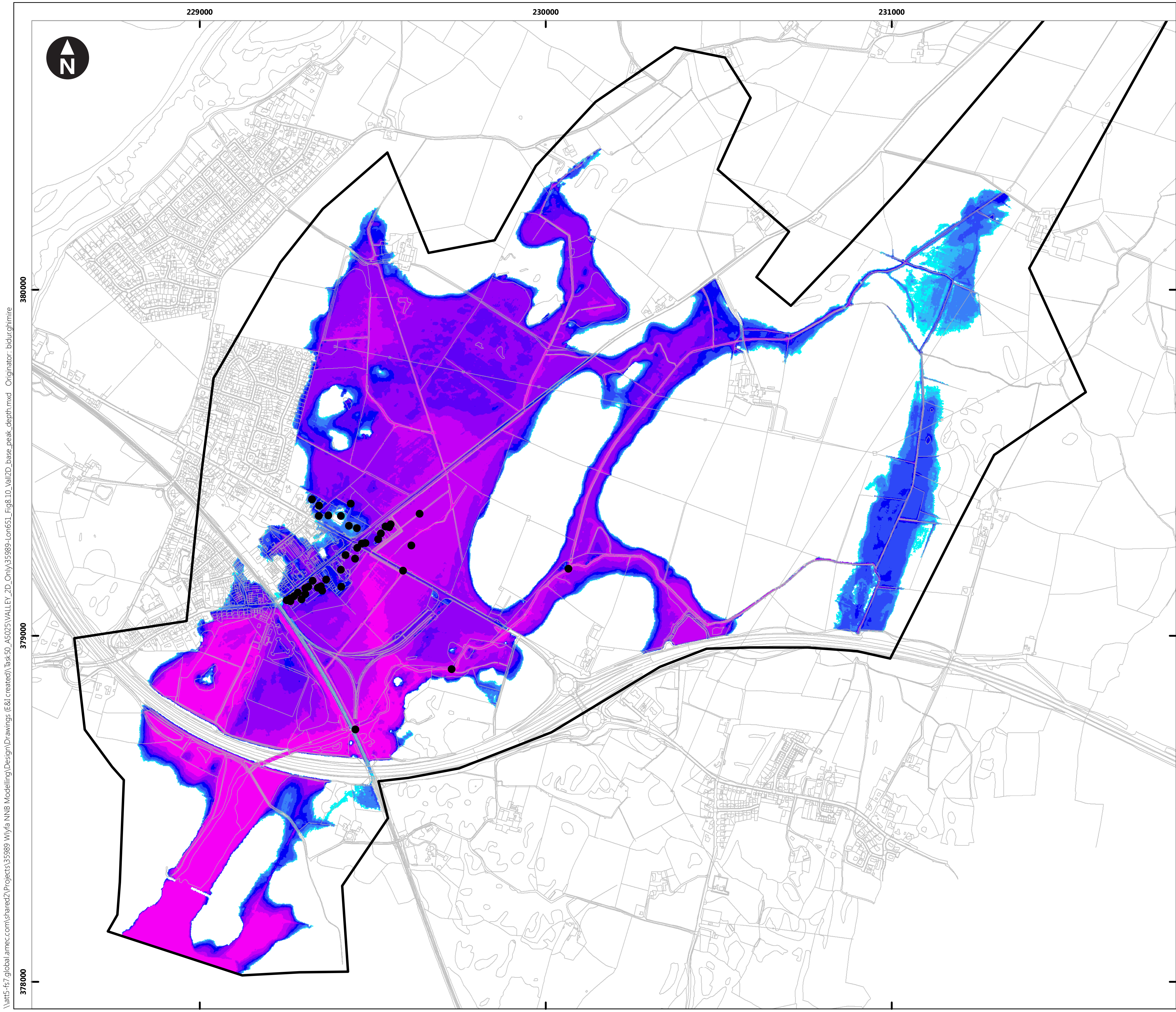

Key

- ● Results point
- Model boundary

Peak flood depth (m) - Baseline

- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Notes:
The depths represent the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Model run date: 06/09/2018
Corresponding data:
Vall_Base_Breach50m_2D47_FlvOcc_T200_2115

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.10
A5025 Valley baseline peak depth (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, 2115)

September 2018

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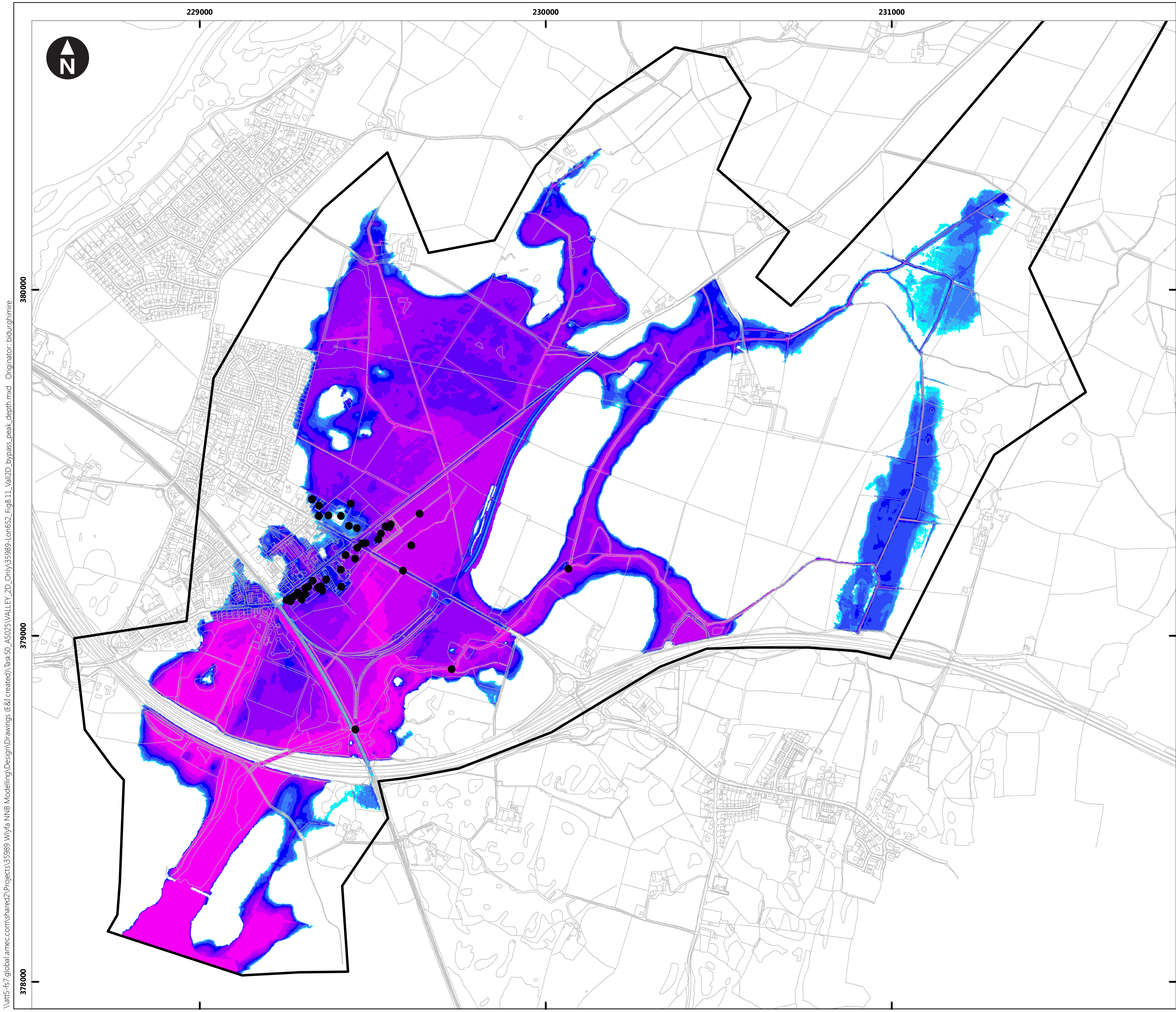

Key

- Results point
- Model boundary

Peak flood depth (m) - Bypass

- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Notes:
The depths represent the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Model run date: 06/09/2018
Corresponding data:
Vall_Bypass_Breach50m_2D48_Flv0cc_T200_2115

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.11
A5025 Valley bypass peak depth (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, 2115)

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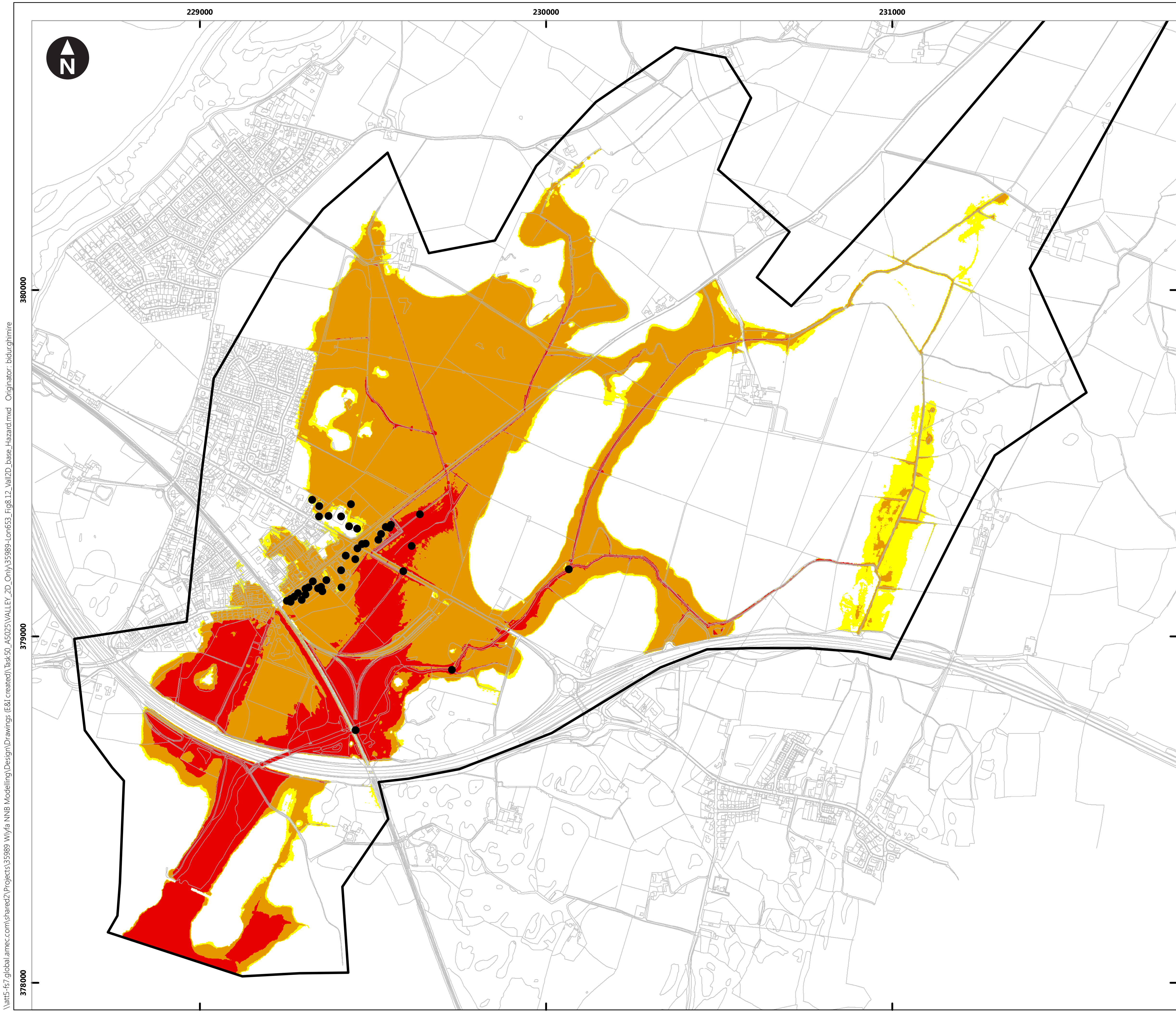

Key

● Results point

Peak flood hazard (HR) - Baseline

(white)	< 0.75	Very low hazard - caution
(yellow)	0.75 - 1.25	Danger for some - includes children, the elderly and the infirm
(orange)	1.25 - 2.00	Danger fpr most - includes general public
(red)	> 2	Danger for all includes the emergency services

Notes:
The flood hazard rating is based on the formula and classification documented in the DEFRA Flood Risks to People guidance (FD2321)

Model run date: 06/09/2018

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.12
A5025 Valley baseline flood hazard (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, 2115)

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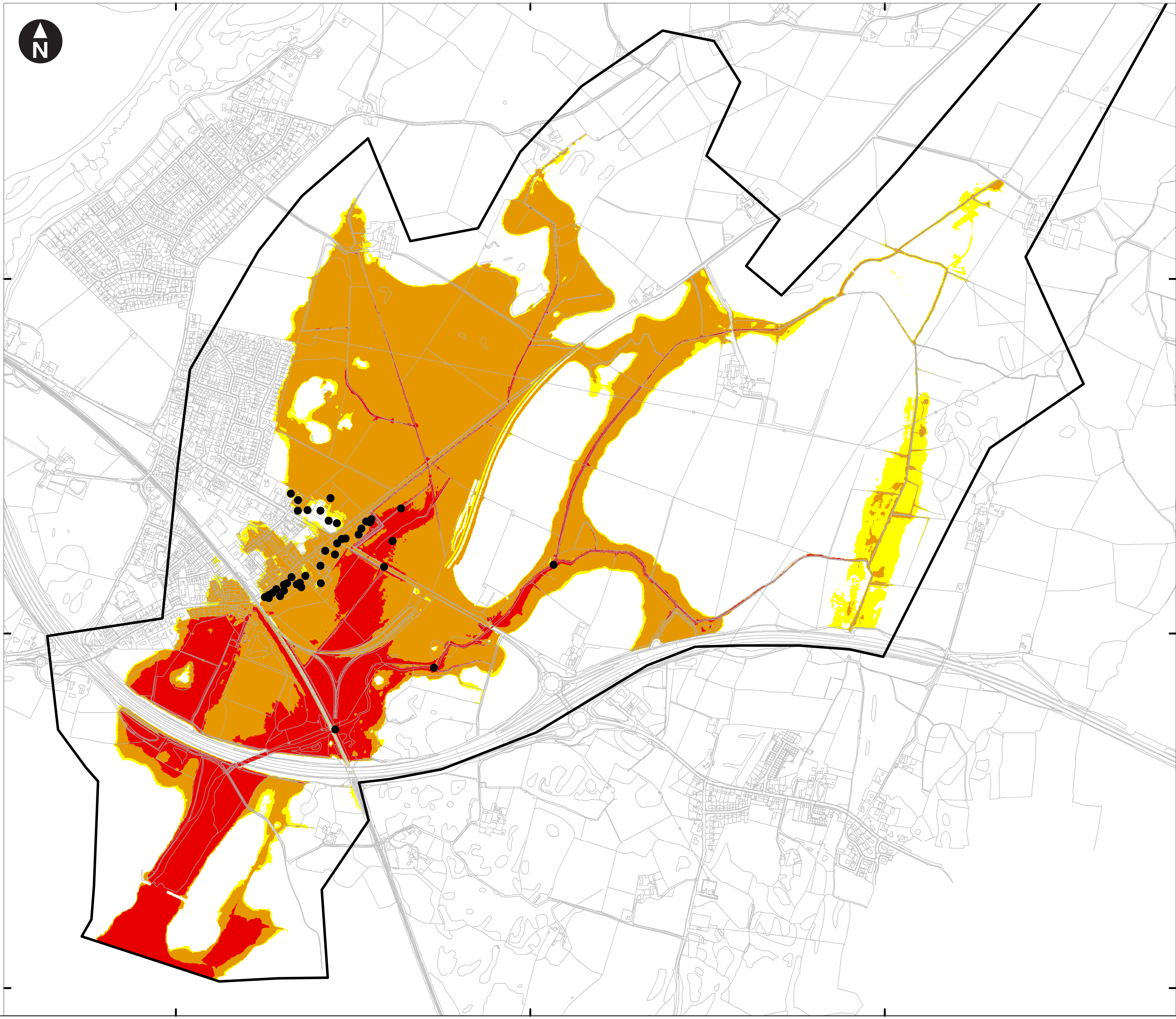

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Key

● Results point

Peak flood hazard (HR) - Bypass

White	< 0.75	Very low hazard - caution
Yellow	0.75 - 1.25	Danger for some - includes children, the elderly and the infirm
Orange	1.25 - 2.00	Danger fpr most - includes general public
Red	> 2	Danger for all includes the emergency services

Notes:
The flood hazard rating is based on the formula and classification documented in the DEFRA Flood Risks to People guidance (FD2321)

Model run date: 06/09/2018

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.13
A5025 Valley bypass flood hazard (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, 2115)

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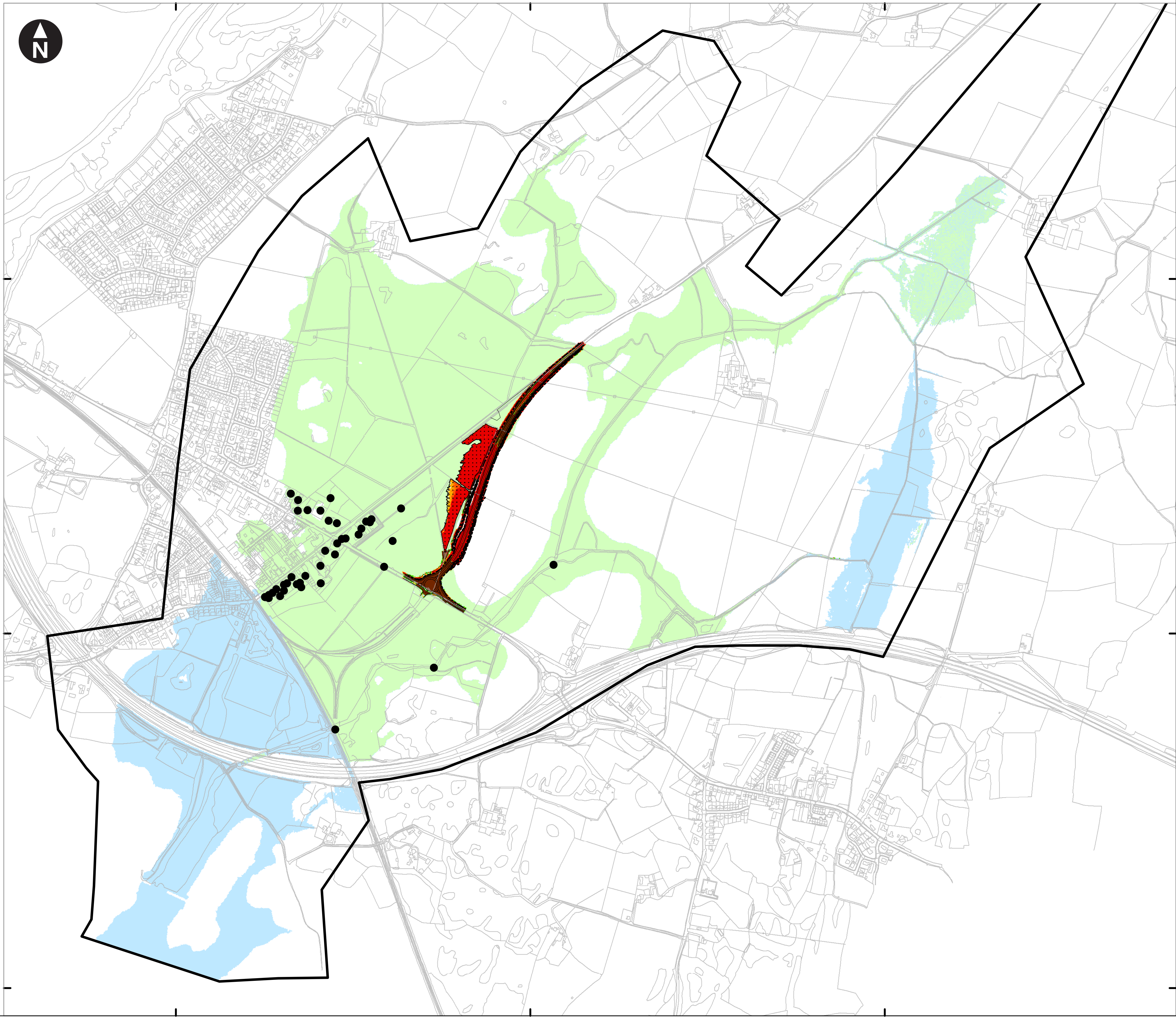

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Key

Peak flood depth difference (m)
Tidal 1:200 year AEP tidal
plus climate change (2115)

- Results point
- Model boundary
- Proposed compensatory storage area

depth difference (m)

- < -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to -0.005
- No Change
- 0.005 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- > 0.1

Notes:
The depths compared use the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Where positive values represent an increase in peak flood depth, and negative values represent a decrease in peak flood depth with respect to baseline, as a consequence of the proposed bypass i.e. bypass minus baseline.

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.14
A5025 Valley peak depth difference (2D model) for 50m wide tidal breach (tidal 1:200 year AEP, 2115), bypass minus base.

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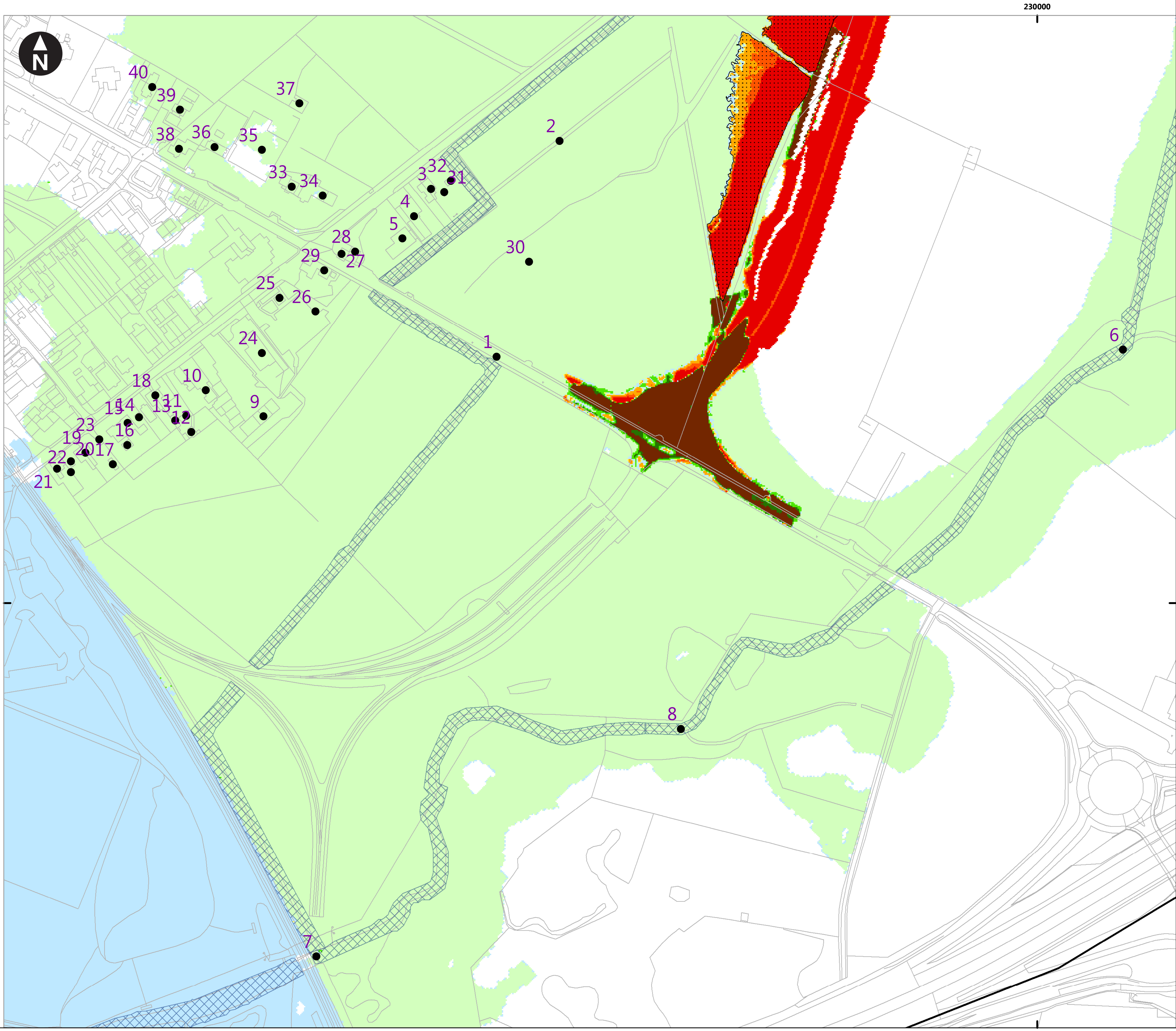

Key

Peak flood depth difference (m)
1:200 year AEP tidal climate change (2115)

- Results point
- Proposed compensatory storage area
- Model boundary

depth difference (m)

- < -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to -0.005
- No Change
- 0.005 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- > 0.1

Notes:
The depths compared use the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Where positive values represent an increase in peak flood depth, and negative values represent a decrease in peak flood depth with respect to baseline, as a consequence of the proposed bypass i.e. bypass minus baseline.

0 100 m
Scale at A3: 1:2,843

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Figure 8.14a
A5025 Valley Tidal Breach (50m wide) depth difference for Tidal 1:200 AEP climate change (2115) [PO Zoomed]

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Appendix B

Figures
8.15 ~ 8.19

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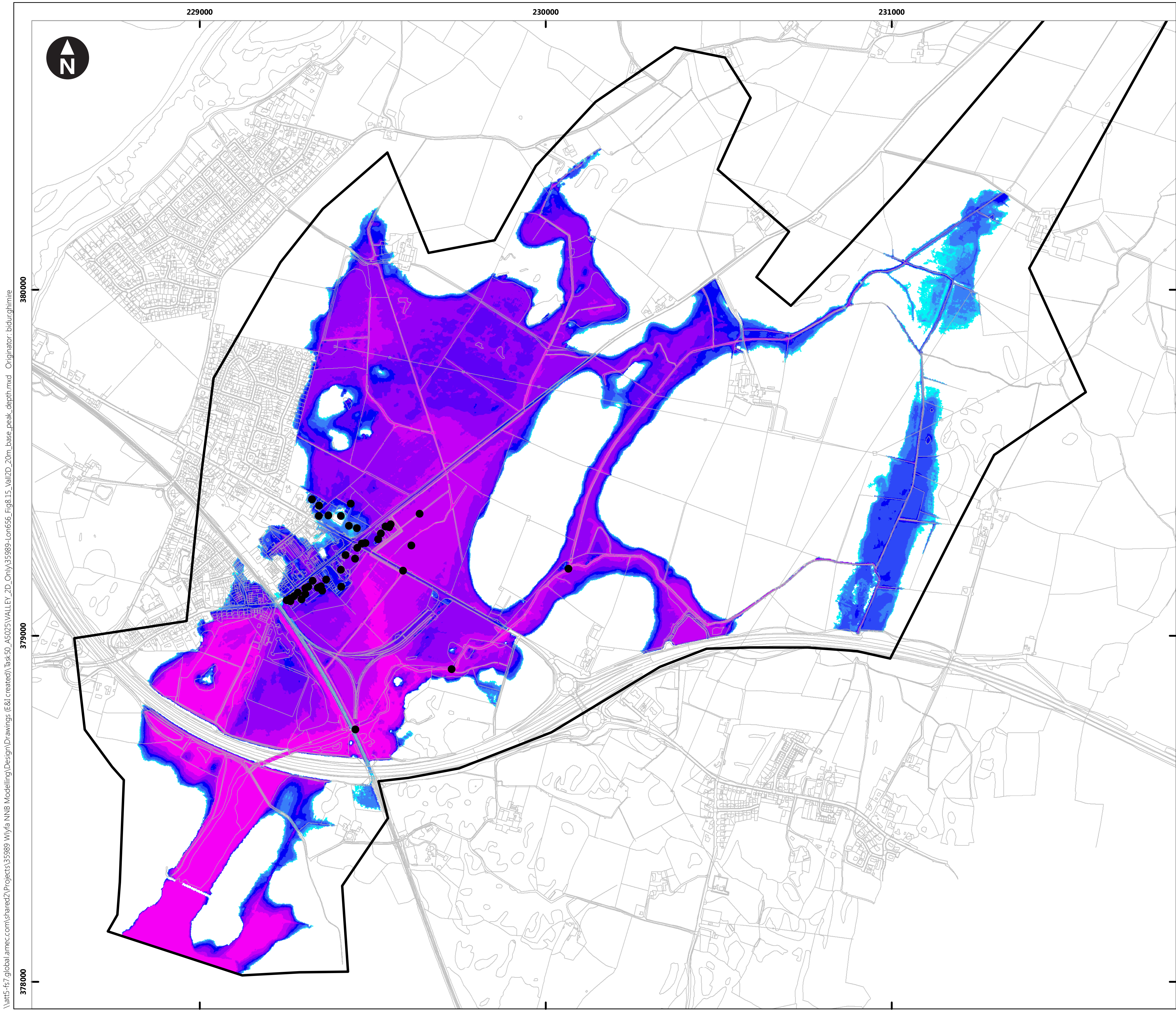

\\att5-fs7.global.amec.com\shared2\Projects\35989 Wylfa NNB Modelling\Design\Drawings (E&I created)\Task50_A5025\VALLEY_2D_Only\35989-Lon656_Fig8.15_Vall2D_20m_base_peak_depth.mxd Originator: bidur.ghimire

Key

- Results point
- Model boundary

Peak flood depth (m) - Baseline

- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Notes:
The depths represent the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Model run date: 06/09/2018
Corresponding data:
Vall_Base_Breach20m_2D49_FlvOcc_T200_2115

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.15
A5025 Valley baseline peak depth (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, 2115)

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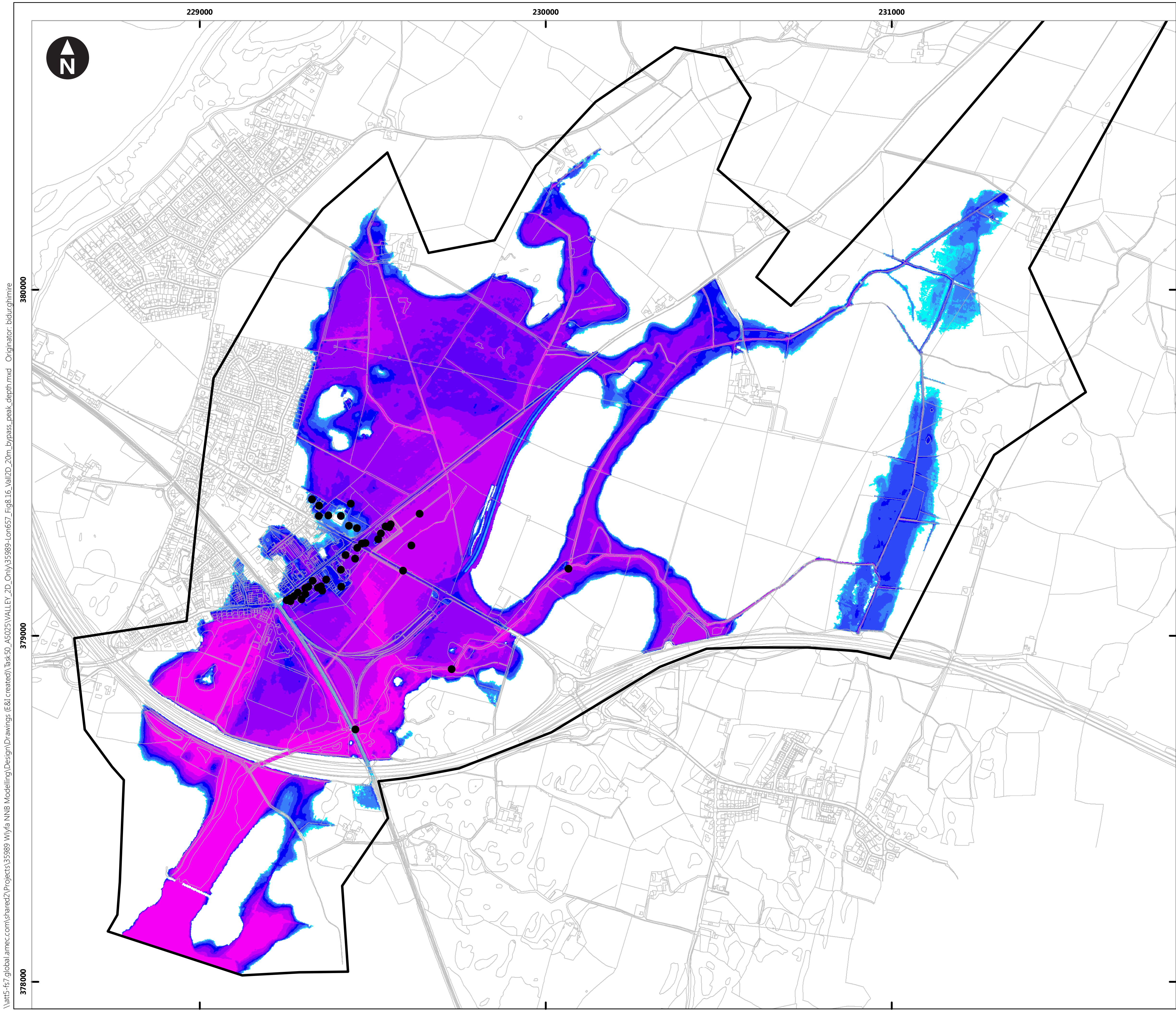

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Key

- Results point
- Model boundary

Peak flood depth (m) - Bypass

- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Notes:
The depths represent the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Model run date: 06/09/2018
Corresponding data:
Vall_Bypass_Breach20m_2D50_Flv0cc_T200_2115

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.16
A5025 Valley bypass peak depth (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, 2115)

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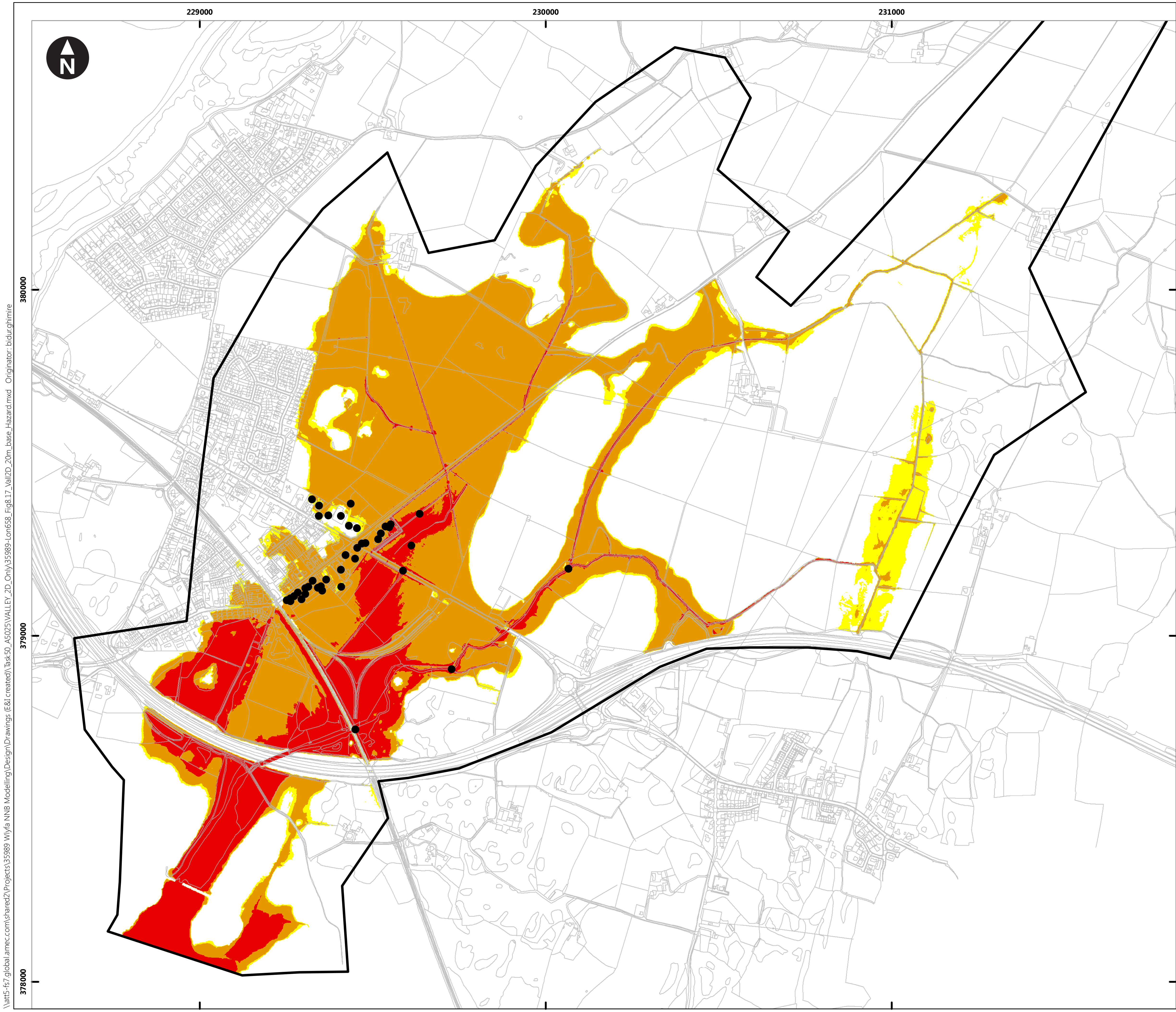

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Key

● Results point

Peak flood hazard (HR) - Baseline

(white)	< 0.75	*Very low hazard - caution*
(yellow)	0.75 - 1.25	*Danger for some - includes children, the elderly and the infirm*
(orange)	1.25 - 2.00	*Danger fpr most - includes general public*
(red)	> 2	*Danger for all includes the emergency services*

Notes:
The flood hazard rating is based on the formula and classification documented in the DEFRA Flood Risks to People guidance (FD2321)

Model run date: 06/09/2018

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.17
A5025 Valley baseline flood hazard (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, 2115)

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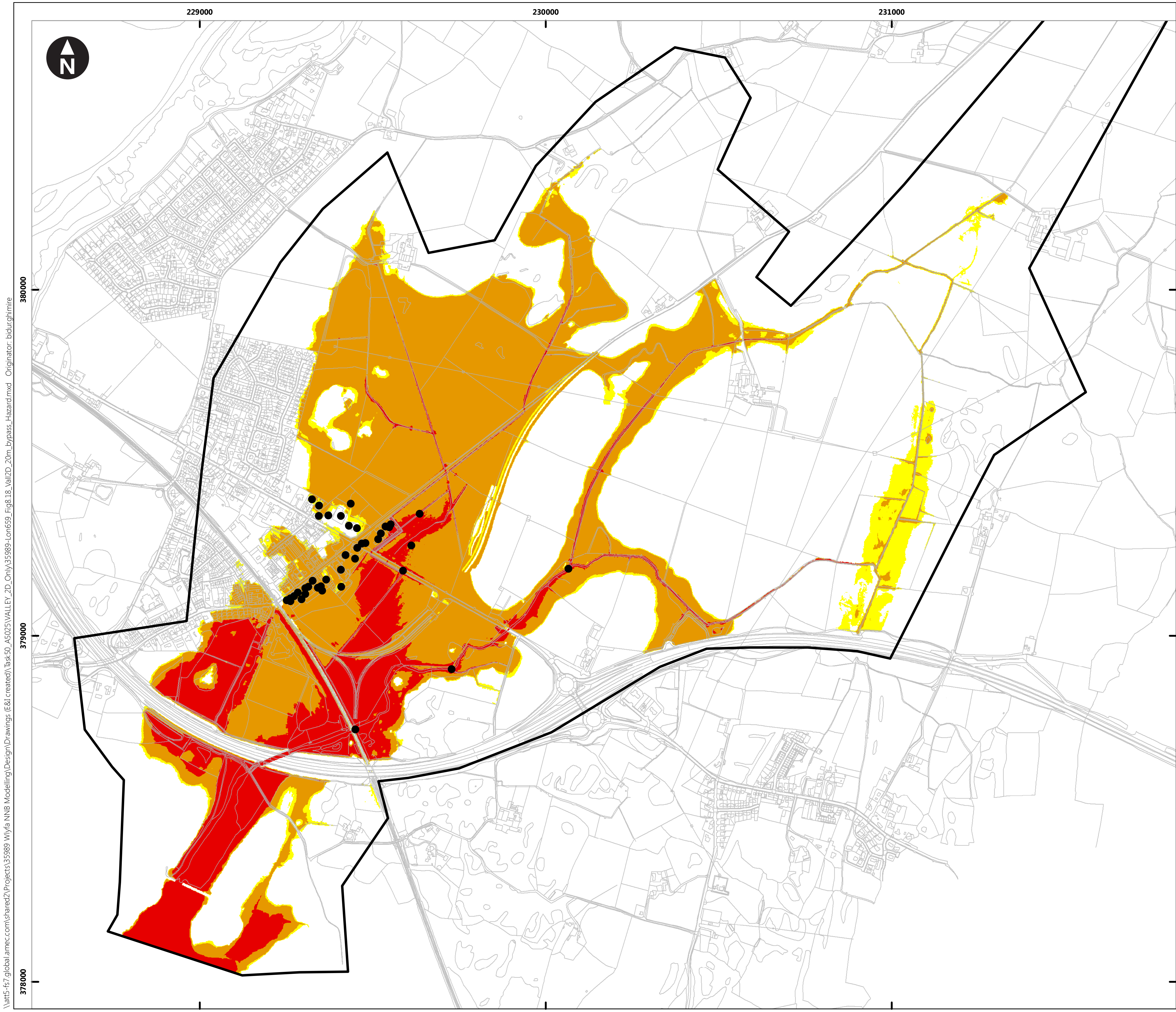

Key

● Results point

Peak flood hazard (HR) - Bypass

(white)	< 0.75	*Very low hazard - caution*
(yellow)	0.75 - 1.25	*Danger for some - includes children, the elderly and the infirm*
(orange)	1.25 - 2.00	*Danger fpr most - includes general public*
(red)	> 2	*Danger for all includes the emergency services*

Notes:
The flood hazard rating is based on the formula and classification documented in the DEFRA Flood Risks to People guidance (FD2321)

Model run date: 06/09/2018

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.18
A5025 Valley bypass flood hazard (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, 2115)

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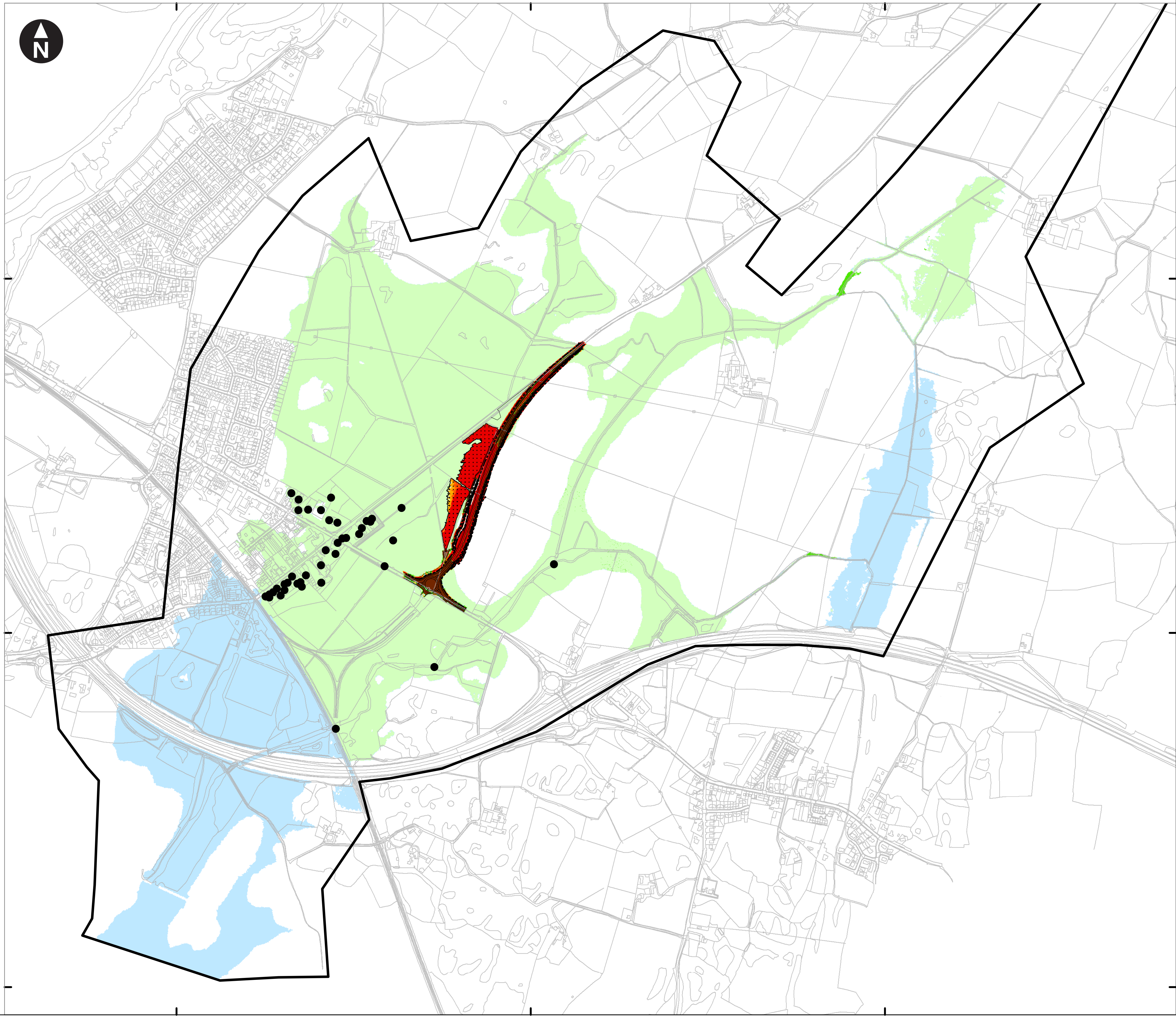

Key

Peak flood depth difference (m)
Tidal 1:200 year AEP tidal
plus climate change (2115)

- Results point
- Proposed compensatory storage area
- Model boundary

depth difference (m)

- < -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to -0.005
- No Change
- 0.005 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- > 0.1

Notes:
The depths compared use the maximum depth achieved. The flood prediction does not represent a moment in time as maximum depths can be achieved at different times.

Where positive values represent an increase in peak flood depth, and negative values represent a decrease in peak flood depth with respect to baseline, as a consequence of the proposed bypass i.e. bypass minus baseline.

0 100 200 300 400 500 600 m
Scale at A3: 1:10,500

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Figure 8.19
A5025 Valley peak depth difference (2D model) for 20m wide tidal breach (tidal 1:200 year AEP, 2115), bypass minus base.

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