

Content details

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Audience
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Security marking

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Non-real time Hydraulic Model Review Template
Environment Agency, Defra
Template
LIT 17617
6.0
OFFICIAL

NTENT

NON-REAL TIME HYDRAULIC MODEL REVIEW



Type of review	Fluvial/tidal 1D-2D model
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Project	Barnham Eastergate Westergate BEW Parcel SC1 Barnham	Job Number		Required coastal standard (if applicable)	
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Model Type	1D/2D	Software	Other	2nd review	3rd review	4th review
Revision	1	Date	27/03/2023	08/06/2023		
Area Client		Reviewer	Jacobs	FT		

REVIEW SUMMARY/CONCLUSION	
Is the model suitable for intended use?	Second review (report dated 18/04/23): The majority of outstanding comments relate to ensuring that existing modelling used has been reviewed to ensure it is fit for site-specific use in this FRA. There is also limited information in the technical note supplied - submission of a hydraulic modelling report to accompany the technical note, detailing checks of the existing model and justifying approaches would help in demonstrating whether the model used is sufficiently detailed for use in this study. First review: The hydraulic model seems to build upon the Aldingbourne Flood Risk Mapping Study, completed by JBA consulting in 2015. The Consultant has updated the model with new LiDAR DTM and has not undertaken other changes to the Baseline model. A with scheme scenario has been represented using porous polygons to represent the proposed embankments of the bridge carrying the A29 over Lidsey Fife. A comparison between the baseline model results and the proposed with scheme scenario model results shows a maximum increase in flood depths of up to +45mm within the floodplain upstream of the road leading to Lidsey Oil Field (to the south of the proposed A29). No properties appear to be at an increased risk of flooding. The model is also showing a reduction in flood depths to the south of North Bersted Bypass, this area appears to be hydraulically disconnected from the area where the scheme is being proposed, this should be explained by the Consultant. The model was built for a flood risk mapping study and covers a large area of 98km². The main concerns with the Baseline model are the following: - The 2D model component uses a global roughness approach (however, some roughness zones have been included to cover small areas). The roughness approach should be modified to better represent manmade surfaces. - It is not possible to check the representation of 1D represented features (watercourses, drainage network) due to lack of survey data. While the data used seems sensible, there are cross sections used to represent watercourses with a Manning's 'n' roughness of 0, which is not expected. - There is no indication on whether the model has been calibrated/verified - No modelling report has been provided describing the history of the model and its assumptions and limitations The model was not built for the purpose of undertaking a flood risk assessment, however, its use has allowed the Consultant to obtain an indication on the relative change to flood risk due to the scheme. However, the magnitude of change is likely to be different if the model is updated/refined. The main concerns associated with the with scheme modelling are the following: - No data on the proposed development of the A29 has been provided, therefore, it is not possible to confirm that the proposed embankments for the road carrying the A29 have been placed as the right location. - Only the embankments for the road carrying the A29 over Lidsey Fife have been represented, however, the footprint of the proposed scheme appears to be much larger. It is unknown what changes will be made for other areas. - Model results have been provided only for the 1% AEP plus 35% climate change allowance, therefore, it is not possible to undertake an assessment on other magnitude events.

MODEL REVIEW PROCESS

Hydraulic Model reviews are an essential component of the Hydraulic Modelling Quality Assurance (QA) process that provides confidence in a model's suitability for its intended purpose. Evidence that the model has undergone QA may be requested by external parties and hence all reviews should be written with an expectation that they could be read externally.

Should any issue(s) be raised during the review process, which require attention, the reviewer should detail the action(s) required in sufficient detail to allow the modeller to complete the changes as appropriate. Completion of this Model Review document does not automatically constitute model approval. Once the suggested changes have been completed, the reviewer may require that the model be resubmitted for further review to establish whether the actions have been completed satisfactorily. Only once all the amendments have been completed satisfactorily, will the model be approved and the quality assured by the reviewer.

It is recommended that the reviewer makes good use of the fluvial design guide chapter 7 and the user manual/help guides for the appropriate modelling software.

Depending on the work being reviewed some questions or entire sections may not be relevant, in which case they can be deleted. On completion of the review the reviewer may choose to use the following colour coding system to alert the modeller to the priority of the actions required (if any).

Colour coding used:

OK – Good practice.
Minimum response: No minimum.
Maximum expected response: No maximum.
Planning: No Objection.

Green – Consider for future studies. Negligible impact on the results that is unlikely to change the outcome of the study.
Minimum response: Acknowledge the comment in the spreadsheet and update the limitation section of the report.
Maximum expected response: Actions done to address the issue identified.
Planning: No Objection.

Note: Taking action to address issues would be expected and some issues may be addressed coincidentally by work on others.

Amber – Follow recommendation. Potential impact on the results that may change the outcome of the study.
Minimum response: Comments justifying the approach taken and update the limitation section of the report if not sorted.
Maximum expected response: Actions done to address the issue identified.
Planning: Consider objecting to the application based on comments highlighted in this category.

Note: Taking action to address issues should be undertaken, some issues may be addressed coincidentally by work on others.

Red – Must do. Has an impact on the results that may have a significant impact on the outcome of the study.
Minimum response: Comments thoroughly justifying approach from applicant based on evidence and update the limitation section of the report if not sorted.
Maximum expected response: Actions done to address the issue identified.
Planning: Objection - Application to be objected if comments are highlighted in this category.

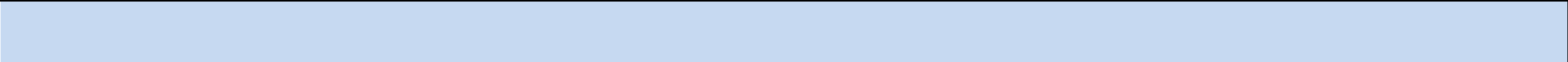
Note: If no action is taken the response must clearly demonstrate why the issue raised is not relevant and the approach employed is justified backed up with evidences. If issues highlighted red are ignored, then submissions should always be sent back.

PROJECT BACKGROUND AND APPROACH

PROJECT DESCRIPTION & REQUIREMENTS							
		HA/2022/123981/01 proposed building a clear span bridge over the River Arun. The Consultant has provided a model representing the existing situation (without the bridge) and a model representing the proposed bridge.					
MODEL APPROACH & SUMMARY							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/23)	RAG 2	2nd Review Comments
1.1	What model approach has been adopted? Is it appropriate? (e.g. new 1D/2D build, existing model truncation, 1d only?).	OK	Linked 1D-2D Model				
1.2	Software used, including versions?	OK	InfoWorks ICM version 2023.0 has been used.				
1.3	Model Version Reviewed	OK	Network reviewed: Aldingbourne Rifes and SWS - Design Network v188 Model Scenarios reviewed: Base Proposed Multi-span 1050 Culverts				
1.4	Are all model files provided?	Amber	Ground model was not provided with the latest transportable database.	All data including ground model should be provided in a single transportable database.	It is our understanding all model files were supplied. Full model files are to be provided with the re-submission. If any omissions are found, please contact us directly.	OK	Thank you - ground model received.
1.5	Does the model run?	OK	Model runs have been provided for the Baseline and Proposed bridge scenarios. A test run has been undertaken using the model data provided. The model ran successfully.				

EVENTS & SCENARIOS							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (DATE)	RAG 2	2nd Review Comments

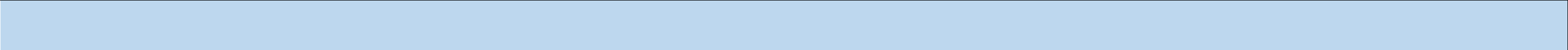
2.1	What events have been simulated (Q5, Q100, Q100CC, Q1000)? Are they sufficient to meet the project requirements?	Red	1% AEP event + 35% to account for climate change. It is not possible to assess the impact of the proposed scheme on other flood events.	The flood events to be used for the Flood Risk Assessment should be agreed with the Environment Agency. These flood events should be run and model results should be provided.	The 1%AEP event is considered the design event, used to test the principle of the bridge crossing as so considered the most appropriate to use within the site-specific FRA as per the PPG on Flood Risk & Coastal Change. Hydrological inputs for other events were also not supplied as part of the original model files, and hydrology could not be readily replicated.	Green	Confirmed with PSO that this is acceptable, however for future reference it is good practice to run a range of events, particularly where assessing off-site impact.
2.2	Is a development being modelled? If so are appropriate scenarios modelled to assess the impact?	OK	Yes, scheme scenario models have been provided.				
2.3	Flood Mapping scenarios?	N/A	These are not required.				
2.4	Have climate change runs been undertaken?	Red	See comment for item 2.1	The flood events to be used for the Flood Risk Assessment should be agreed with the Environment Agency. These flood events should be run and model results should be provided.	Climate change allowances were used in line with the guidance on climate change allowances. Actual values were modified in the guidance during the preparation of the work, and so the values presented as slightly conservative (higher) than current values, but would represent a negligible change to flows.	Amber	Please clearly state in modelling report e.g. which peak river flow allowance has been used and include mapping and discussion of results in reporting.
2.5	Has a study for quantifying uncertainty been undertaken? If yes, what are the results?	Amber	No model results regarding uncertainty analysis have been provided.	The Consultant should discuss and agree with the Environment Agency the approach for the uncertainty analysis.	Sensitivity analysis have been undertaken and are included in the results.	Amber	There is no discussion of uncertainty in the reporting - please add this.



This submitted model is part of an FRA.

dge over the Lidsey Rife, which is in Flood Zone 2 and 3. This included foundations for the bridge within the flood plain.

and with the bridge foundations. The purpose of the review is to review this incoming model which is being used to assess the impact of the proposeed bridge.



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)



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The peak river flow allowance used in the assessment is 35% climate change uplift. The central allowance for the 1% AEP for the 2050s epoch is 20% and for the 2070s epoch is 25%. Based on the lifespan and type of infrastructure, we deemed 35% as appropriate uplift.						
Discussion within the report is updated.						

1D MODEL BUILD

1D NETWORK							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
3.1	Model overview: Node Summary 1d length	OK	The model includes a total of 1526 nodes, 893 pipes and 253 river reaches. The model includes a total of 1759 cross sections.				
3.2	Have appropriate distances between sections and/or nodes been used (dx)?	OK	Yes as every section in InfoWorks ICM must be geo-referenced				
3.3	Are out of bank flows represented in 1d? If so, how has it been done and is it appropriate?	OK	Out-of-bank flows represented in the 2D model component.				
3.4	Is the model geo-referenced?	OK	Yes, this is an InfoWorks ICM requirement				
3.5	Do the cross sections and bed profiles look reasonable?	Amber	Cross sections checked in proximity to the proposed scheme. The cross sections and bed profiles are reasonable. However, it is not possible to verify these against survey data. The age of the survey data used to build the model is unknown. Therefore, it is not possible to confirm how representative these are of current channel conditions.	Survey data should be provided to verify the channel representation.	Topographicla inforation has been checked against site-specific survey and updated LiDAR information. The LiDAR is dated 2022.	Green	Please add a comment to the reporting to note any checks that have been undertaken.
3.6	Chainage – compared to surveyed sections	OK	In InfoWorks ICM chainage would be based on the geo-referenced cross sections. Therefore chainage is correct.				

3.7	Does conveyance look appropriate?	Amber	In the area in proximity to the proposed scheme, some conveyance curves show sudden breaks which will need to be corrected.	Include panel markers at locations where conveyance curves need to be corrected.	The cross-sections in proximity to the proposed channel upstream and downstream of the study area were audited and panel markers were added.	Green	Conveyance not completely smooth but acceptable.
3.8	If gauged flow is available, is there good flow reconciliation between the statistical estimates and the modelled, for given return periods?	N/A	The catchment appears to be ungauged (no gauges have been identified within the NRFA website), therefore, there are no gauged flows.				
3.9	Bank Markers. Are they used and if so, are they suitably located?	N/A	Bank markers are not used in InfoWorks ICM				
3.10	What approach to channel roughness has been used?	Red	Approach statement is not provided. In the area in proximity to the proposed scheme, Manning's 'n' values between 0.03 and 0.045 have been used. These values are generally reasonable, but it is not possible to verify them without photographs of the channel. Some sections include points with Manning's 'n' values set to zero which is not correct.	Further justification is needed regarding the choice of Manning's 'n' roughness values. Corrections should be undertaken at locations where the Manning's 'n' value has been set to zero. Alternatively, the use of a value of zero should be justified.	There are no newly surveyed cross-sections introduced to the hydraulic model, only interpolates. The Manning's n values for the new interpolates are based on the existing values within the incoming model of the upstream and downstream sections. This is considered a reasonable approach, and is in line with channel conditions observed during site visits by Pell Frischmann. 35 cross sections were found to contain points with zero Manning's n values. These sections are from the original incoming Aldingbourne model and were not modified by Pell Frischmann. The zero Manning's values were altered as per the review comment. The values used were based on existing roughness coefficients within the sections and also within the channel upstream and downstream.	Green	Some sections still look to have Manning's n values of 0. This is only in a handful of locations however please check that all sections, particularly in the area of interest have updated properly.
3.11	What manning's n value(s) have been used for the channel? If it is 1d only what values and how have they been applied in the flood plain?	Red	See item 3.10		Manning's values of the interpolate sections are based on the existing upstream and downstream roughness coefficients. No new channels or cross-sections were introduced. Zero roughness values from the incoming model were modified to match existing positive values and also correlated to the upstream and downstream channel roughness.	Green	Please note that when using existing modelling it should always be reviewed to check it is suitable for intended use.
3.12	What method has been used to estimate roughness (USGS, Chow, etc. based on survey, photographs)? Are they appropriate	Red	See item 3.10		It is assumed that the roughness values used within the incoming model have been estimated in accordance with best practice. Only zero values were altered to match upstream and downstream channel roughness.	Green	See above.



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments



4th Review Response (DATE)

1D BOUNDARY CONDITIONS
1D BOUNDARY CONDITIONS

Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
4.1	1d boundary model domain; is there glass walling anywhere in the modelled reaches?	OK	No glass walling has been identified.				
4.2	How have the inflows boundaries been applied?	Green	2 inflow boundaries have been applied, however, these appear to be a sort of baseflow and are relatively small. Direct rainfall on mesh is applied (outside of subcatchments). This generates the runoff reaching the 1D representation of watercourses.	The use of the 2 inflow boundaries should be justified.		Green	Please add comment to reporting.
4.3	How is the downstream boundary(s) applied?	OK	Free flow boundary conditions are used, however, the downstream boundary is far away from the area of interest, therefore, this is not expected to impact on the area of interest.				
4.4	If tidal - how has the boundary been derived?	N/A	No tidal impacts are expected at the location of the proposed scheme. The area is more than 4km away from the coast.				
4.5	Have appropriate locations been chosen for the downstream model extents?	OK	Yes and the area of interest is far away from the downstream model extents.				



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments



4th Review Response (DATE)

1D STRUCTURES

1D STRUCTURES							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
5.1	Are all structures represented? If not have explanations for structures not modelled been given in the Log/report?	Amber	No modelling log/report provided. While all' structures in proximity of the proposed A29 appear to be included, there is no information available (e.g., survey data) that allows the reviewer to verify whether their representation is reasonable.	Modelling report and structures log should be provided, along with survey data used to build the model if available.	Modelling technical note provided along with the model, detailing the changes undertaken to the incoming Aldingbourne model	OK	Note model changes summarised in technical note.
5.2	Are invert levels correct compared to survey data?	Green	No survey data provided therefore it is not possible to undertake this check.	If available, please provide survey data.			No survey available.
5.3	Do bridges surcharge? If so has orifice flow been enabled?	N/A	Not applicable to InfoWorks ICM.				
5.4	Are there spills around the structure or over the top represented appropriately?	Green	Yes, however, due to lack of survey data, it is not possible to verify that these have been represented correctly.	If available, please provide survey data.			No survey available.
5.5	If there are any movable structures have they been modelled correctly?	N/A	There are no movable structures within the area of interest.				
5.6	Structure coefficients - Have they been changed from default values?	Green	The values used appear to be reasonable, but it is not possible to verify that these are correct due to lack of survey information.	If available, please provide survey data.			No survey available.



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1D RUN PARAMETERS

1D RUN PARAMETERS							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
6.1	What time step has been used for the 1D model? Is it appropriate?	OK	Initialisation start timestep : 6s Initialisation maximum timestep : 600s Phase-in time : 15min The above parameters and timestep control options are set to default. 2s is the The maximum timestep at which the hydraulic calculations will be carried out. Linking 1D and 2D minor timestep has been selected, therefore, the timestep is variable. The timestep approach is reasonable.				
6.2	What initial conditions have been used? Steady state, hotstart file?	OK	None specified however software determines appropriate initial conditions as part of simulation. The initial conditions in the area in proximity to the proposed scheme are reasonable.				
6.3	Have any of the parameters and advanced parameters been changed from the default. If so, has it been justified?	Amber	Max space step (m) changed from 100 to 50 Minimum number of computational nodes changed from 5 to 10 Maximum number of timestep halvings and iterations increased from 10 to 15	The change in default model parameters should be justified.	No changes to the 1D parameters were undertaken by Pell Frischmann. Maximum space step, minimum number of computational nodes and maximum number of timestep halvings have not been altered from the incoming model.	Green	Note that changes made are within error limits, however it would be helpful to understand why these parameters were changed from default. No action required but for future reference would recommend using default parameters or providing detail in reporting to explain why default parameters have not been used - this should be reviewed as part of adopting an existing model for use in another study.



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2D MODEL BUILD

DIGITAL TERRIAN MODEL							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
7.1	Number of domains?	OK	1 domain				
7.2	Area of 2d domain/s	OK	~ 98km ²				
7.3	What dataset has been used to define the DTM elevations? LiDAR, Photogrammetric DTM?	Amber	1m LiDAR DTM, however, the source and flown date of this data are not specified.	Provide source of data and flown date in the modelling report.	1m LiDAR resolution was used from the National Lidar Data Survey, accessed through the Defra website. The LiDAR information was dated as 2022.	OK	Thank you for detailing in reporting.
7.4	What grid resolution has been used? Is it suitable to accurately represent flow paths, e.g. between buildings?	OK	Maximum triangle area of 100m ² and minimum element area of 25m ² has been used. This mesh resolution is coarse. Buildings have been included as breaklines using porous polygons. However, the flood extent in proximity to the proposed road does not appear to reach properties. It is considered that the model resolution is acceptable for the purposes of a FRA for the proposed scheme.				
7.5	Has the DTM been rotated to optimise flow route representation?	N/A	Not applicable to InfoWorks ICM models.				
7.6	Is there any obstruction to flow?	OK	No, the model includes mesh zones, but these have been used to make the mesh definition coarser within rural areas. This seems reasonable.				
7.7	Has additional site specific topographic survey data been used?	Amber	It is not apparent.	The modelling report should specify if additional topographic survey data has been used to inform the modelled DTM.	1m LiDAR resolution was used from the National Lidar Data Survey, accessed through the Defra website. The LiDAR information was dated as 2022. Model report to include references as appropriate.	OK	No additional site-specific topographic survey used.

7.8	How have buildings been represented within the DTM?	Amber	Buildings has been represented as porous polygons with a 0.025 porosity (almost fully impermeable). It is not apparent how this is influencing flow paths in proximity of buildings.	The approach taken to represent buildings should be justified in the modelling report.	Modelling report updated accordingly.	Amber	Can't see any comment in reporting about building representation - please add.
7.9	Are defences/embankments/bank crests accurately represented?	N/A	No defences in the area of interest				
7.10	If post-development scenarios are required have the proposed ground levels and building been represented appropriately?	Red	The Flood Risk technical note provided some context information on the proposed A29 re-alignment. The information provided is limited and makes reference to model results that are not consistent with the model results made available for this review. Porous polygons (fully impermeable) have been used to represent the proposed embankments for the bridge. No design information has been provided to verify that these have been placed at the right location. A multi-span scenario has also been provided, but there is no reference or description of this in the Flood Risk Technical Note. The proposed scheme site boundary indicates other works being proposed (Including near Lidsey Road and the road leading to Lidsey Oil Field). No information is provided for the rest of the scheme and therefore, it is not possible to confirm if the post-development scenario has been represented correctly.	More information on the proposed development needs to be provided (e.g., technical drawings) in order to confirm the representation of the scheme,	The location and elevation of the bridge abutments for the single-span scenario are based on drawing 13394-PEF-ZZ-XX-M2-S-000002 prepared by Pell Frischmann. The location of the bridge pillars for the multi-span design is based on drawing 13394-PEF-ZZ-M2-S-000003, prepared by Pell Frischmann. The purpose of the study is to assess the impact of the abutments and pillars of the two bridge scenarios on the flood extents in regards to depth and coverage. The two scenarios are compared against the baseline model which has been provided by the EA	OK	Porous polygons on left and right banks to represent embankments in proposed scenario. Multi-span scenario includes bridge piles set to an elevation of 7.306mAOD with east and west banks set to 8.430mAOD. Note that 8.43mAOD corresponds with the bridge deck, 7.306mAOD corresponds with the soffit level as per technical drawings. Distance between piles aligns with technical drawings.

2D ROUGHNESS							
Item No.	Item Checked	RAG	1st Review Comments	1st Review Actions	1st Review Response (DATE)	RAG	2nd Review Comments
8	What manning's n values have been used to define floodplain roughness? Have they been applied correctly?	Amber	A global roughness of 0.06 has been used. Roughness zone polygons have been used sparsely. This definition is considered to be too coarse and does not take into account the roughness of roads and other manmade surfaces.	Roughness should be refined to represent manmade features.	The model is based on the existing Aldingbourne model, provided by the EA. The purpose of the proposed model is to compare the impact of the proposed bridge crossing to the existing baseline modelling, hence the baseline model, provided by the EA has not been altered. Only roughness zones, relating to the proposed scheme have been added.	Green	Even if an EA model is being used, this should be reviewed to check it is suitable for use in a site-specific FRA. It would be helpful to include further comment on results of sensitivity testing to demonstrate that this does not have a material impact on results.
8.1	What methods have been used to estimate roughness?	Amber	This is not described in the provided Flood Risk technical note.	Provide a modelling report with details on the approach adopted.	See note 8	Green	Comment should be included in reporting.

8.2	Is the representation of different roughness areas sufficiently accurate and detailed?	Amber	No, see item 8		See note 8	Green	Acceptable for use in this study but please provide comment in reporting to demonstrate results of sensitivity testing to roughness.
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2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)

The buildings are represented as porous polygons with porosity of 0.025.						

2nd Review Response (DATE)	RAG	3rd Review Comments	3rd Review Response (DATE)	RAG	4th Review Comments	4th Review Response (DATE)

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2D BOUNDARIES

2D BOUNDARY CONDITIONS							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
9.1	Have any boundaries been used in the 2D domain? If so detail.	Amber	Normal depth boundary condition applied to the 2D zone boundary. Infiltration zones have been used to represent soil infiltration losses. The method used is Horton.	The infiltration method adopted should be justified as this could have a significant impact on model results.	The infiltration method has not been altered by Pell Frischmann and is taken from the incoming model. No alterations were made to the incoming baseline model and it has been assumed that the modelled boundaries are appropriate and QC'ed.	Green	Although an existing EA model has been used, this should still be reviewed to ensure it is suitable for site-specific use. Detail should be added to reporting to demonstrate this and that the infiltration method is suitable for use in this study.
9.2	Is the model boundary suitably large? i.e. the flood extent should not reach the boundary.	OK	Yes, it is.				
9.3	Has rainfall been applied directly to the 2d model domain?	OK	Yes, applied outside of sub-catchments to avoid double counting.				
9.4	Coastal - How has the wave overtopping been applied?	N/A	This has not been considered which is ok as the site is far from coastal influence.				



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments



4th Review Response (DATE)

2D STRUCTURES

2D STRUCTURES							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
10.1	Have any structures been included in the 2D domain? If so how have they been represented?	Amber	There are no 2D structures within the 2D domain. Has a site visit being undertaken to confirm that that 2D structures are not required? For example, along the railway embankment to the north?	Describe in the modelling report why there is no need to represent structures in the 2D domain.	The model uses terrain-sensitive flexible meshing, hence changes to ground levels within the 1m resolution LiDAR have been represented within the 2D zone. There were no specific 2D structures modelled within the incoming baseline model on which the proposed model is based.	Green	Please add comment to reporting to detail checks undertaken on existing modelling to ensure this adequately represents areas such as embankments.
10.2	Are invert levels correct compared to survey data?	N/A	No survey has been provided.				
10.3	How have defences been represented? Zline? If there are flood zone scenarios have the defences been excluded adequately?	N/A	No flood zone scenarios have been represented. No defences have been represented using 2D model features. There are no linear defences present in the area of interest.				
10.4	Have appropriate loss coefficients and roughness values been used?	N/A	There are no 2D structures in the model provided.				



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2D RUN PARAMETERS

INITIAL CONDITONS & OTHER RUN PARAMETERS							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
11.1	What time step has been used for the 2D model? Is it appropriate?	OK	Variable timestep used with a maximum of 2s.				
11.2	Have initial water levels been applied? Are they correct?	N/A	There are no 2D initial water levels applied to the 2D model component. Within the area of interest, there is no need to 2D				
11.3	Are the other 2D model parameters reasonable (e.g. flooding & drying, eddy viscosity). Are they different from default?	Amber	See comment 6.3 Parameters in the timestep control are set to default.		Parameters are based on the runs within the incoming transportable database.	Green	See comment 6.3.



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4th Review Response (DATE)

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1D/2D MODEL LINKS

MODEL LINKS							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
12.1	How have the 1D/2D models been coupled, is it appropriate?	Amber	Using river reaches banklines with discharge coefficient of 0.9 and modular limit of 0.6. These values are generally acceptable for natural banks. There is no information on the source of banktop levels, at some locations, the levels appear to be interpolated from a handful of cross sections. It does not appear that banktop levels are extracted from LiDAR DTM.	A justification for the use of these coefficients should be provided in the modelling report. More information on the source of banktop elevation data should be provided in the report.	No alterations were made to the banktop levels as no new cross-sectional survey was presented. Some interpolates were introduced to help with model stability. Levels have been kept as-is within baseline model since it has been assumed that these have been checked and audited and are based on known survey information.	OK	Adopted values are reasonable/typical.
12.2	Is the digitisation of the links acceptable?	OK	Yes, this is acceptable				
12.3	Is the 2d representation of the river channel comparable in width with the 1d model cross sections?	OK	Yes, as the model is fully geo-referenced.				
12.4	Representation of 1D output in 2D domain	N/A	This is not applicable for InfoWorks ICM models.				
12.5	Have any default link parameters been changed (i.e. to improve stability)?	N/A	No default link parameters have been modified.				



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)

MODEL STABILITY

1D MODEL STABILITY

Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
13.1	Errors/Comments/Warnings?	Amber	There are some warnings, some of these are expected.	A justification for these warnings should be provided in the modelling report.	Comment provided	Green	Comment in reporting about warning messages stating no changes made to model - would expect these to be reviewed as part of review of model when adopting for site-specific use.
13.2	Convergence	Amber	Appears to be acceptable in the area of interest.	Model convergence should be discussed in the modelling report.	Comment provided	OK	Thank you for providing comment in reporting.
13.3	Does a basic check of animations and graphed outputs give an indication of good model stability?	OK	Yes				

2D MODEL STABILITY

Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (DATE)	RAG 2	2nd Review Comments
14.1	Is mass balance within tolerable limits?	OK	Yes				
14.2	Are CE and dV values relatively stable and remain so once the run has got going.	N/A	Not applicable to InfoWorks ICM models.				
14.3	Errors/Comments/Warnings?	Amber	There are some warnings, some of these are expected.	A justification for these warnings should be provided in the modelling report.	Comment provided	Green	Comment in reporting about warning messages stating no changes made to model - would expect these to be reviewed as part of review of model when adopting for site-specific use.
14.4	Negative Depths	OK	None				
14.5	Does a basic check of animations and graphed outputs give an indication of good model stability?	OK	Yes				

14.6	2d extents and outputs	OK	These appear to be ok based on comparisons against flood zone 3.				
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2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)

2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)

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MODEL OUTPUTS & CALIBRATION

CALIBRATION/VERIFICATION							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
15.1	Have calibration runs been completed? Is data for calibration available? Gauge data, extents, anecdotal etc.	Amber	No data provided.	Information should be provided to confirm whether or not the model has been calibrated.	No calibration has been undertaken for the model as no data is available	Green	Note that there do not appear to be any gauges close to the site of interest meaning calibration is not possible. Worth considering whether results can be verified using existing flood extents, or against previous modelling studies.
15.2	Are the simulated hydrograph peaks reasonably similar to the recorded peaks?	Amber	see item 15.1	Information should be provided to confirm whether or not the model has been calibrated.	No calibration has been undertaken for the model as no data is available and the hydrological inputs have not been altered from the incoming model.	OK	Note that there is no gauge data available for calibration.
15.3	Is the shape of the simulated hydrograph and therefore the volume suitably similar?	Amber	see item 15.1	Information should be provided to confirm whether or not the model has been calibrated.	See response 15.2	OK	Note that there is no gauge data available for calibration.
15.4	Are simulated floodplain extents similar to recorded extents? Are flow routes similar?	Amber	see item 15.1	Information should be provided to confirm whether or not the model has been calibrated.	See response 15.2	Green	It would be helpful to compare results to any recorded extents or previous modelling.
15.5	Has suitable effort been made to attempt and improve calibration. Have attempted changes been documented with a quantification of impact?	Amber	see item 15.1	Information should be provided to confirm whether or not the model has been calibrated.	See response 15.2	OK	Note that there is no gauge data available for calibration.
15.6	If no historic data is available, are the simulated flood outputs similar or very different from past modelling in the area? If there is a large difference, does it seem sensible?	Amber	Fluvial flood extents appear to match relatively well flood zone 3, Surface water flood extents are much larger than those shown in the available RoFSW maps.	Justification for discrepancies against RoFSW should be provided in the modelling report.	Comment provided within the modelling technical note	Amber	Can't see any comment in reporting - please include.



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)
Amended within the technical note.						

MODEL SENSITIVITY

SENSITIVITY TESTING & UNCERTAINTY							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
16.1	Have appropriate model parameters been chosen for sensitivity testing? Typical tests include: ☐ Sensitivity to roughness $\pm 20\%$ (Manning's "n" both in 1D and 2D) ☐ Sensitivity to flows $\pm 20\%$ (From central estimate) ☐ Sensitivity to downstream boundary ☐ Key structure blockage(s)	Amber	No model results provided.	Undertake sensitivity testing for model	Sensitivity test undertaken and provided for the area of the proposed model.	Amber	Appears that sensitivity testing has only been undertaken for Manning's roughness values. Particularly in the absence of updated hydrology, it would be useful to assess sensitivity to flow.
16.2	Do the results of the tests show the models to be particularly sensitive to certain parameters?	Amber	See item 16.1		No	Green	It would be helpful to include further detail in reporting, particularly results in the area of interest.
16.3	Have confidence limits for model results (+/- mm) been presented? How were they derived and does this seem sensible?	Amber	See item 16.1		No confidence limits were defined as the model is based on the incoming baseline.	Green	Do results of sensitivity testing give an indication of model confidence/uncertainty? Please discuss in reporting.



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)
Sensitivity runs undertaken for +20%/-20% flow						

AUDIT TRAIL

AUDIT TRAIL							
Item No.	Item Checked	RAG 1	1st Review Comments	1st Review Actions	1st Review Response (14/04/2023)	RAG 2	2nd Review Comments
17.1	Was a model run log provided?	Amber	No	Please provide run log.	Model log provided	OK	
17.2	Was a suitable file naming, structure & management system used?	Amber	2 model networks were provided, the scenarios should be in a single network.	Improve data management system.	Single network provided	OK	Noted, thank you.
17.3	Were check files provided?	N/A	Not applicable to InfoWorks ICM models.				
17.4	Were comments provided within the model?	Amber	No	Reporting is required to undertake model review.	Technical note summarises the changes made to the model	OK	
17.5	Was there good version control? Is the model history detailed where applicable?	Amber	No modelling report has been provided .	Modelling report is required to understand model history.	Technical note summarises the changes made to the model	OK	Model development log supplied and reporting includes comment on updates to model.
17.6	Were Errors / comments / warnings made available?	Amber	No	Reporting is required describing these.	Technical note summarises the changes made to the model	OK	
17.7	Was a technical overview of the model and its background provided	Amber	The information provided is not sufficient.	A modelling report should be provided.	Technical note summarises the changes made to the model	Amber	Reporting notes that it is assumed that the EA model has been quality checked but this doesn't mean that it is suitable for site specific use - it should still be reviewed to ensure it is fit for use in this study.
17.8	Were notes on how the model operates under different flow conditions provided?	Amber	The information provided is not sufficient.	A modelling report should be provided.	The model was not tested for different flow conditions	Green	It is good practice to assess how the model performs under different flow conditions to help in identifying uncertainties and limitations of the model.
17.9	Was an explicit statement of any concerns about the accuracy of the model or its ability to represent reality provided?	Amber	No	A modelling report should be provided with this information.	Technical note summarises the changes made to the model	Amber	There is no discussion of limitations or concerns about accuracy of the model. Please include discussion of checks undertaken to ensure the EA model is suitable for use and any limitations, assumptions and uncertainties.
18	Is there anything else missing or are there suggestions for additional information or clarification?	Amber	More detailed information on the represented scheme is needed to confirm if this has been represented appropriately.	Technical drawings for example or other data for the proposed development should be provided.	Technical note summarises the changes made to the model	Green	See comments throughout review spreadsheet.

18.1	Comment on the quality of the reports:	Amber	No modelling report has been provided. The Flood Risk technical note does not provide enough information.	A modelling report should be provided.	Technical note summarises the changes made to the model	Amber	Limited information in the reporting to understand whether the existing model has been reviewed and determined to be suitable for site-specific use. Please provide sufficient reporting to demonstrate that the EA model used has been reviewed as part of adopting it for use in this study.
18.2	is a freeboard analysis necessary? If yes have you review the report? What are is the agreed freeboard?	N/A	No freeboard analysis is necessary.				



2nd Review Response (DATE)	RAG 3	3rd Review Comments	3rd Review Response (DATE)	RAG 4	4th Review Comments	4th Review Response (DATE)
It is assumed that EA model provides an accurate representation of the catchment-scale modelling and that does not carry over inherent instabilites. The required site-specific use analyses large-scale infrastructure and catchment-wide impact to the floodplan, hence the model is deemed suitable. The assumption covers QC for the catchment-wide model, provided by the EA with no inherent instabilities.						
Included in the report						

The purpose of the study is to assess the imapct of the proposed bridge and supporting infrastructure to the wider catchment and floodplain, hence the resolution of the existing model is deemed suitable for the purposes. The model was rerun and any instabilities were addressed, by adding lidar sections and interpolates for example. Updated within the report and detailed within the model log.						

Additional information

Additional information			
Item No.	Item Checked	RAG 1	1st Review Comments
100.1			
100.2			
100.3			
100.4			
100.5			
100.6			
100.7			
100.8			
100.9			
101			



1st Review Actions	1st Review Response (DATE)	RAG 2



2nd Review Comments	2nd Review Response (DATE)	RAG 3



3rd Review Comments	3rd Review Response (DATE)	RAG 4



4th Review Comments	4th Review Response (DATE)

[Return to 1D model build](#)

[Return to 2D model build](#)

Manning's n for Channels (Chow, 1959).

Type of Channel and Description	Minimum	Normal	Maximum
Natural streams - minor streams (top width at floodstage < 100 ft)			
1. Main Channels			
a. clean, straight, full stage, no rifts or deep pools	0.025	0.03	0.033
b. same as above, but more stones and weeds	0.03	0.035	0.04
c. clean, winding, some pools and shoals	0.033	0.04	0.045
d. same as above, but some weeds and stones	0.035	0.045	0.05
e. same as above, lower stages, more ineffective slopes and sections	0.04	0.048	0.055
f. same as "d" with more stones	0.045	0.05	0.06
Chainage – compared to surveyed sections	0.05	0.07	0.08
h. very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.1	0.15
2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. bottom: gravels, cobbles, and few boulders	0.03	0.04	0.05
b. bottom: cobbles with large boulders	0.04	0.05	0.07
3. Floodplains			
a. Pasture, no brush			
1. short grass	0.025	0.03	0.035
2. high grass	0.03	0.035	0.05
b. Cultivated areas			
1. no crop	0.02	0.03	0.04
2. mature row crops	0.025	0.035	0.045
3. mature field crops	0.03	0.04	0.05
c. Brush			
1. scattered brush, heavy weeds	0.035	0.05	0.07
2. light brush and trees, in winter	0.035	0.05	0.06
3. light brush and trees, in summer	0.04	0.06	0.08
4. medium to dense brush, in winter	0.045	0.07	0.11
5. medium to dense brush, in summer	0.07	0.1	0.16
d. Trees			
1. dense willows, summer, straight	0.11	0.15	0.2
2. cleared land with tree stumps, no sprouts	0.03	0.04	0.05
3. same as above, but with heavy growth of sprouts	0.05	0.06	0.08
4. heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.08	0.1	0.12
5. same as 4. with flood stage reaching branches	0.1	0.12	0.16
4. Excavated or Dredged Channels			
a. Earth, straight, and uniform			

1. clean, recently completed	0.016	0.018	0.02
2. clean, after weathering	0.018	0.022	0.025
3. gravel, uniform section, clean	0.022	0.025	0.03
4. with short grass, few weeds	0.022	0.027	0.033
b. Earth winding and sluggish			
1. no vegetation	0.023	0.025	0.03
2. grass, some weeds	0.025	0.03	0.033
3. dense weeds or aquatic plants in deep channels	0.03	0.035	0.04
4. earth bottom and rubble sides	0.028	0.03	0.035
5. stony bottom and weedy banks	0.025	0.035	0.04
6. cobble bottom and clean sides	0.03	0.04	0.05
c. Dragline-excavated or dredged			
1. no vegetation	0.025	0.028	0.033
2. light brush on banks	0.035	0.05	0.06
d. Rock cuts			
1. smooth and uniform	0.025	0.035	0.04
2. jagged and irregular	0.035	0.04	0.05
e. Channels not maintained, weeds and brush uncut			
1. dense weeds, high as flow depth	0.05	0.08	0.12
2. clean bottom, brush on sides	0.04	0.05	0.08
3. same as above, highest stage of flow	0.045	0.07	0.11
4. dense brush, high stage	0.08	0.1	0.14
5. Lined or Constructed Channels			
a. Cement			
1. neat surface	0.01	0.011	0.013
2. mortar	0.011	0.013	0.015
b. Wood			
1. planed, untreated	0.01	0.012	0.014
2. planed, creosoted	0.011	0.012	0.015
3. unplanned	0.011	0.013	0.015
4. plank with battens	0.012	0.015	0.018
5. lined with roofing paper	0.01	0.014	0.017
c. Concrete			
1. trowel finish	0.011	0.013	0.015
2. float finish	0.013	0.015	0.016
3. finished, with gravel on bottom	0.015	0.017	0.02
4. unfinished	0.014	0.017	0.02
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.02	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.02
2. random stone in mortar	0.017	0.02	0.024
3. cement rubble masonry, plastered	0.016	0.02	0.024
4. cement rubble masonry	0.02	0.025	0.03

5. dry rubble or riprap	0.02	0.03	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.02	0.025
2. random stone mortar	0.02	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.03
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.03		0.5

Manning's n for Closed Conduits
Flowing Partly Full (Chow, 1959).

Type of Conduit and Description	Minimum	Normal	Maximum
1. Brass, smooth:	0.009	0.01	0.013
2. Steel:			
Lockbar and welded	0.01	0.012	0.014
Riveted and spiral	0.013	0.016	0.017
3. Cast Iron:			
Coated	0.01	0.013	0.014
Uncoated	0.011	0.014	0.016
4. Wrought Iron:			
Black	0.012	0.014	0.015
Galvanized	0.013	0.016	0.017
5. Corrugated Metal:			
Subdrain	0.017	0.019	0.021
Stormdrain	0.021	0.024	0.03
6. Cement:			
Neat Surface	0.01	0.011	0.013
Mortar	0.011	0.013	0.015
7. Concrete:			
Culvert, straight and free of debris	0.01	0.011	0.013
Culvert with bends, connections, and some debris	0.011	0.013	0.014
Finished	0.011	0.012	0.014
Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
Unfinished, steel form	0.012	0.013	0.014
Unfinished, smooth wood form	0.012	0.014	0.016
Unfinished, rough wood form	0.015	0.017	0.02
8. Wood:			

Stave	0.01	0.012	0.014
Laminated, treated	0.015	0.017	0.02
9. Clay:			
Common drainage tile	0.011	0.013	0.017
Vitrified sewer	0.011	0.014	0.017
Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
Vitrified Subdrain with open joint	0.014	0.016	0.018
10. Brickwork:			
Glazed	0.011	0.013	0.015
Lined with cement mortar	0.012	0.015	0.017
Sanitary sewers coated with sewage slime with bends and connections	0.012	0.013	0.016
Paved invert, sewer, smooth bottom	0.016	0.019	0.02
Rubble masonry, cemented	0.018	0.025	0.03

Manning's n for Corrugated Metal Pipe
(AISI, 1980).

Type of Pipe, Diameter and Corrugation Dimension	n
1. Annular 2.67 x 1/2 inch (all diameters)	0.024
2. Helical 1.50 x 1/4 inch	
8" diameter	0.012
10" diameter	0.014
3. Helical 2.67 x 1/2 inch	
12" diameter	0.011
18" diameter	0.014
24" diameter	0.016
36" diameter	0.019
48" diameter	0.02
60" diameter	0.021
4. Annular 3x1 inch (all diameters)	0.027
5. Helical 3x1 inch	
48" diameter	0.023
54" diameter	0.023
60" diameter	0.024
66" diameter	0.025
72" diameter	0.026
78" diameter and larger	0.027
6. Corrugations 6x2 inches	
60" diameter	0.033
72" diameter	0.032
120" diameter	0.03
180" diameter	0.028

<i>Model</i>	<i>Review Type</i>	RAG	Coastal standard	Software
Coastal wave transformation only		Red	Strategic	ISIS/FMP
Coastal 1D inundation		Amber	Appraisal	FMP/TuFlow
Coastal 1D-2D inundation		Green	Design	Estry/TuFlow
Coastal 2D inundation		OK		TuFlow
Fluvial/tidal 1D model		N/A		MIKE11
Fluvial/tidal 1D-2D model				MIKE21 HD
Fluvial/tidal 2D model				MIKE21 SW
Surface water model				MIKEFLOOD
<i>Display all sheets</i>				SWAN
				SWAN/EuroTop/TuFlow
				Other

Model Type

1D only

2D only

1D/2D

Area Name

Cumbria and Lancashire

Devon and Cornwall - East

Devon and Cornwall - West

Cambridgeshire and Bedfordshire

Essex, Norfolk and Suffolk

East Midlands

Greater Manchester Merseyside and Cheshire

Hertfordshire and North London

Kent and South London

Lincolnshire and Northamptonshire

North East

Thames

West and East Sussex

Hampshire and Isle of Wight

Dorset and Wiltshire

Somerset and West of England

Shropshire Herefordshire Worcestershire and Glc

Staffordshire Warwickshire and West Midlands

North Yorkshire, East Ridings and Hull

South and West Yorkshire

Tab List

Model_Approach
1D_Model_Build
1D_Boundary_Conditions
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1D_Run_Parameters
2D_Model_Build
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Coastal_boundary
Wave_Transformation
Wave_Overtopping
Linked_1D_2D
Model_Stability
Model_Outputs_Calibration
Model_Sensitivity
Audit_Trail

QAR Sheet

FRA / Pre-App / ERR
PDU
CDF / CSF / MMF / MCF
Other

A - Design
B - Appraisal
C - Strategic
U - Unsatisfactory

Level 1

Level 2

Level 3

1 Very good
2 Good
3 Fair
4 Poor
5 Very poor
Not Previously assessed/known
Yes
No

Description

Baseline version

Add coastal template to baseline.

Add version control sheet and version number

Add roughness example sheet

Add sheet 'Lists' for maintenance

Update named ranges for RAG status

Add drop down box to select model type and VBA to hide/display relevant sheets

Explicitly reference Model_checks in cell comments

Switch off remove comments as code not yet resilient

Add the QAF Tab

Add the Additional Info. Tab

Change the VBA code to make them Hidden/Visible

Add the counting of colours in the QAR tab