



# Protocols for minimum standards in modelling (fluvial flood forecasting)

## Checklist proforma v1.01 (Word 97 compatible)

April 2005

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### Model details:

*Please complete as appropriate*

Project reference	
Project name	
Name of model	
Description of model	
Modeller(s)	
Project manager(s)	
Revision	
Date	

## 1. INCEPTION

<b>Protocol 1.1 The flood forecasting requirements are fully understood and agreed by both client and modeller.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q1.1.1 Are both parties clear regarding the operating platform/environment in which the model is to be run?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.1.2 Are both parties agreed on the level of sophistication of model required?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.1.3 Have the forecast points, lead times and other performance criteria been agreed?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.1.4 Have target values for model resolution/accuracy been agreed, and what are the allowable tolerances?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.1.5 Has the use of real time updating / error correction procedures been agreed?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.1.6 Are both parties agreed about the data sources to be used for real time modelling?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 1.2 Consideration has been given to previous work / models and their implications.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q1.2.1 Have existing hydrologic/hydraulic models relevant to the study area been identified?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.2.2 Have the quality of existing models and the data on which they are based been examined, documented and any potential problems highlighted?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.2.3 Have any weaknesses of existing models and/or modelling approaches been identified and documented?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.2.4 If parts of existing models are being reused, have they been thoroughly checked (e.g. are cross section data up to date)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 1.3 Consideration has been given to which particular catchment features are significant.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q1.3.1 Backwater effects?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.2 Floodplain storage?</i>	

<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.3 Confluences?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.4 Tidal influences?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.5 Typical speed of response in the catchment?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.6 Typical bed slope?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.7 Snowmelt?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.8 Groundwater and surface water interactions?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<i>Q1.3.9 Abstractions and discharges?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.10 Intakes and flood relief channels?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.11 Reservoirs and lakes?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.12 Sluices, gates - operational rules?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.13 Bridges and culverts causing significant constriction or afflux?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.3.14 Urbanisation?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 1.4 The proposed modelling approach is justified.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q1.4.1 Is the proposed modelling approach broadly applicable, given the flood forecasting requirements?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.4.2 Is the proposed approach suitable given the hydrologic and hydraulic characteristics of the river / catchment?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.4.3 If a hybrid approach is used, has thought been given to the consistency of the different elements?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.4.4 Can the data requirements of the proposed modelling approach be met?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.4.5 Are appropriate tools available to build and calibrate the proposed type of model?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.4.6 Are the assumptions and uncertainties of the approach recognised and documented?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 1.5 Consideration has been given to data requirements and availability.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q1.5.1 Have key data requirements (to cover hydrologic, hydraulic and geographical parameters) been identified?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.5.2 Have the required data been sourced? (By consultation with relevant Agency staff and/or external organisations and agencies where necessary)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q1.5.3 Have all available telemetry inputs been identified?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 1.6 A fully documented preliminary model schematisation has been submitted, including a schematic of the main elements.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q1.6.1 Has a preliminary model schematic been produced and accepted by the client?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

## 2. CONCEPTUALISATION & CONFIGURATION (BUILD)

<b>Protocol 2.1 Appropriate software tools have been selected for model build.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q2.1.1 Is the software package and version)to be used appropriate given the model requirements?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.1.2 Is the software package(and version)compatible with NFFS and approved for use?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.1.3 Is the modeller aware of the weaknesses and drawbacks of the software?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.1.4 If a bespoke model is required, is this cost effective and justifiable?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 2.2 Quality assurance procedures have been applied to input data.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q2.2.1 Have obtained data been documented in a project data register?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.2.2 Has an audit of the quality/reliability of each input data set been carried out and documented?</i>	



<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.2.3 Are methods used to manipulate data (if required) appropriate and acceptable?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 2.3 The raw model meets the requirements of the brief.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q2.3.1 Does the model reflect the key features of the system, as identified in Protocol 1.3?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 2.4 The raw model meets a minimum quality standard.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q2.4.1 If the model has been discretised into separate sub-catchments / reaches, have these been joined adequately?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.4.2 Is the model extent reasonable (i.e. how does the length of the modelled reach compare to the real river length)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.4.3 Are the method(s) of defining model boundaries appropriate and have they been adequately documented?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<i>Q2.4.4 Are the method(s) used to define fixed/geometric model parameters appropriate and have they been adequately documented?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.4.5 Are rules for gate and barrage operation adequately documented and checked?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.4.6 Has the modeller followed model/software specific guidelines where available (e.g. Isis Acceptance Criteria)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 2.5 The resolution of the model is acceptable.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q2.5.1 Is there justification of the selected time step (is it small enough)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q2.5.2 Is the spatial resolution sufficient to represent key controls?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

### 3. REVIEW

<b>Protocol 3.1 The model is parsimonious.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q3.1.1 Are time and spatial resolutions no more detailed than strictly necessary?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q3.1.2 Has a check been made for structures, junctions and controls that do not affect the forecast and can be removed from the model?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q3.1.3 Has a check been made for any hydrodynamic reaches that can be simplified to routing reaches?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q3.1.4 Has a check been made for any sub-catchments or reaches that can be combined?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q3.1.5 Has a check been made for 'surplus' cross sections?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<b>Protocol 3.2 The model is robust when simplified.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q3.2.1 Does decreasing the cross-section spacing reduce stability / accuracy?</i>	

<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q3.2.2 Does the representation of floodplain storage affect the model stability or accuracy?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q3.2.3 Does simplification of structures lead to a loss of stability or accuracy?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 3.3 The model appears to run fast enough for real time use.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q3.3.1 Has the run time of the model been checked in relation to the required lead time?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

## 4. CALIBRATION & VALIDATION

<b>Protocol 4.1 Calibration criteria are clear.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.1.1 Have locations used for calibration (e.g. forecast points / downstream boundary / gauged data) been documented and agreed with the client?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.1.2 Have the criteria for calibration been documented and agreed (e.g. R2, visual fit, RMSE)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.1.3 What 'sensitivity tests' are to be applied (e.g. channel capacity is sensible relative to median annual maximum flood)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 4.2 Calibration and validation data are representative of operational conditions.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.2.1 Have you checked that the calibration data are of the same type and resolution as real-time data?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.2.2 Is the calibration data of sufficient resolution to be able to resolve the features of the hydrograph that are of most relevance?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.2.3 Are the flow conditions represented in the calibration data of sufficient range, given the scope of the model (including the effects of any artificial influences)?</i>	

<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.2.4 Does the calibration data include at least one significant flood event (where flows are larger than QMED or out of bank)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.2.5 Has the quality of event data used in calibration been reviewed and accepted?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.2.6 Where there are periods of missing data within calibration events, have appropriate decisions been taken and documented as to whether these should be infilled or whether the event should be rejected from the calibration?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.2.7 Are calibration events representative of current catchment conditions. (Have there been any recent works or events in the catchment that may have modified the hydrologic / hydraulic regime)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 4.3 Performance of calibrated model is acceptable.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.3.1 Does the model fit the hydrograph peaks (magnitude and timing) and rising limb according to the agreed criteria?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.3.2 Does the model also simulate the full flow range to an agreed standard of performance?</i>	

<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.3.3 Do the model output look reasonable at flows higher than the calibration event data?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.3.4 Are flood storage areas modelled adequately during a large or multi-peak event?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.3.3 Are there any unexplained headlosses (e.g. at structures) in the model results?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.3.6 Have the outputs been reviewed by Area or Regional staff with local knowledge?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 4.4 Model parameters are plausible and acceptable.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.4.1 Has the sensitivity of the model output to parameter values been evaluated?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.2 For Transfer function models: are the time delay and gain parameters plausible?</i>	

<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.3 For Rainfall-runoff models: are the values of store depths and time constants physically realistic?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.4 For Kinematic wave models: are wave speed and attenuation parameters realistic?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.5 For Hydrodynamic models: are channel roughness values realistic?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.6 For Hydrodynamic models: does model attenuation match with actual?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.7 For Hydrodynamic models: are weir coefficients and bridge losses physically realistic?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.4.8 For Hydrodynamic models: are spill coefficients applied at washland and overland flow paths realistic?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>



<b>Protocol 4.5 Model performs well with validation data.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.5.1 Does the model perform to agreed and documented criteria for the validation event(s)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 4.6 Limitations of validated model are understood and acceptable.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.6.1 Does the model perform sensibly when extrapolated to more extreme conditions?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.6.2 Has the EA project manager been advised of the limitations of the validated model?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 4.7 Calibration and validation procedures are well documented.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q4.7.1 Has a project report or record been delivered?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q4.7.2 Have documented model and data files been delivered?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

## 5. TESTING

<b>Protocol 5.1 A plan for testing the model has been specified and agreed.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q5.1.1 Has a set of test runs has been agreed &amp; documented?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 5.2 Model runs correctly in emulated real time forecasting network.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q5.2.1 Will the model run for calibration events in the test-control environment?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.2.2 Are the results in the test-control environment the same as for off-line calibration or validation?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.2.3 Has the link between the model and other components of the network been checked?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.2.4 Can differences between model runs using actual and forecast data be explained?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 5.3 Model performance is stable in emulated real time use.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q5.3.1 Is the model robust to reasonably foreseeable drop-outs or errors in the input data (e.g. forecast rainfall, telemetry)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.3.2 Do time-varying parameters change smoothly?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.3.3 Is the model stable for both cold and hot starts (i.e. for varying run-in times)?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.3.4 Will the model run over a sufficiently wide range of flow conditions for real-time use?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.3.5 Is the river model stable for reasonably foreseeable start-up conditions?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.3.6 Is the river model stable for reasonably foreseeable downstream boundary conditions?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.3.7 Are the lowest stable flows documented?</i>	

<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
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<b>Protocol 5.4 The model runs fast enough to achieve the required lead time.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q5.4.1 Can the model provide the required lead time over a range of initial and input conditions?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 5.5 An updating or error-predicting scheme is used if applicable.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q5.5.1 Is state-updating used?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.5.2 Is error prediction used?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.5.3 Are updating or error prediction stable over a range of different events?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.5.4 If there is significant variation between consecutive forecast runs can this be explained by the error correction or updating procedures?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>

<b>Protocol 5.6 Operating uncertainties and issues are documented.</b>	<b>ACCEPTABLE / UNACCEPTABLE</b>
<i>Q5.6.1 Has the change in uncertainty with increasing lead time been checked?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.6.2 Are there features of the catchment that may introduce uncertainty because they cannot be modelled, such as control structures not operating to prescribed rules or reservoir spills?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>
<i>Q5.6.3 Have the operating uncertainties been documented in the project report?</i>	
<i>Modeller's response here</i>	<i>Agency PM's comment here</i>