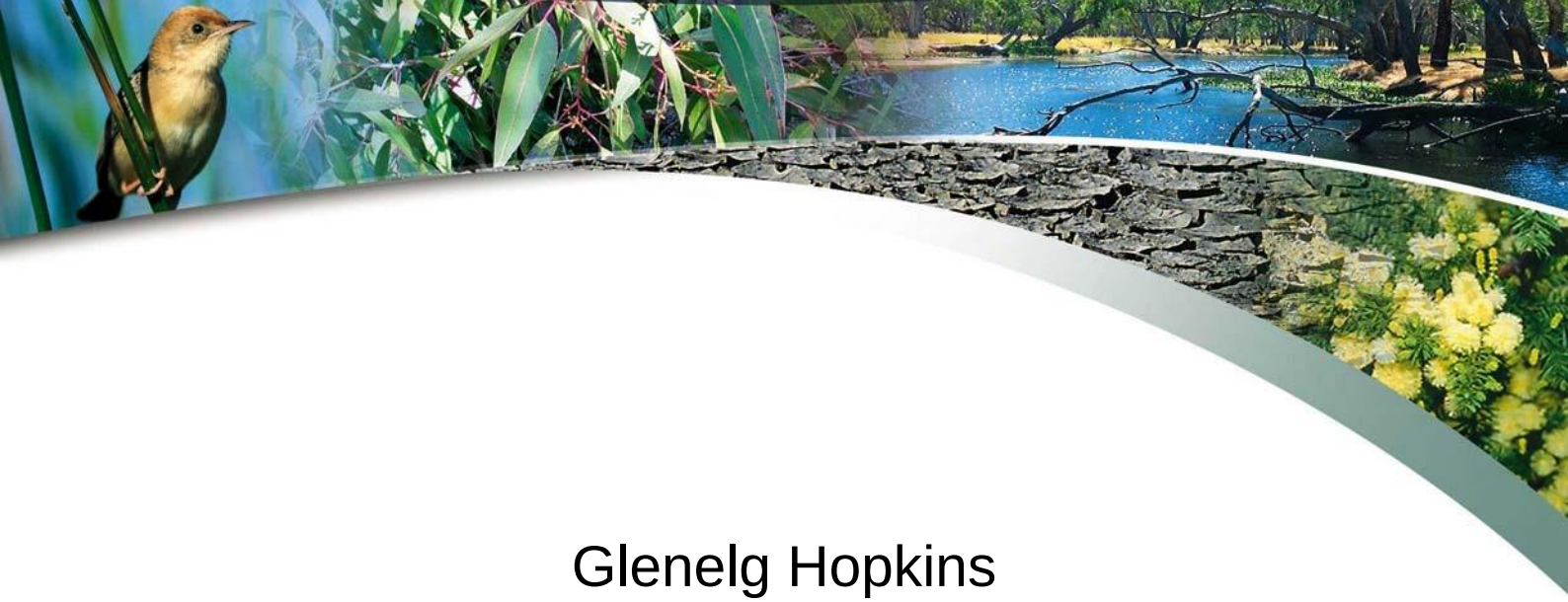

Glenelg Hopkins
Catchment Management Authority

Glenelg Hopkins

CMA

Flood Modelling
Guidelines and Specifications

August 2021

1. Introduction

Any changes to the way floodplain land is used and/or developed can lead to the health and wellbeing of people being put at risk and worsening of flood and stream flow behaviour to the detriment of neighbouring landholders and the environment. Floodplain modelling may therefore be required by the CMA for the purpose of assessing risk associated with floodplain development, new or replacement waterway crossings, waterway modification proposals, or to support planning scheme amendments.

Contemporary best practice flood modelling enables risks associated with alterations of topography (ground surfaces) and stream flow conveyance through flow controlling structures (eg. waterway crossings) to be assessed with a high degree of confidence. The information derived from flood modelling facilitates the determination of a development application, whether the application be associated with seeking approval for floodplain development or works affecting a waterway.

The Glenelg Hopkins CMAs support for developments within the floodplain is among other considerations (such as river health) contingent on demonstrating that there will be no adverse changes in flood behaviour as a consequence of the proposed development/works. These specifications must be read in conjunction with the CMAs cut and fill guidelines for any proposed development involving manipulation of existing floodplain topography (via earthworks) in order to gain favourable development outcomes.

These specifications provide the standard minimum requirements for flood modelling within the Glenelg Hopkins CMA region, however it must be noted that it is at the CMAs discretion to vary the scope of required modelling outputs outside that covered by this document prior to the CMA supporting any proposed flood modelling exercise.

2. Objectives to be achieved.

1. Flooding problems must not be transferred from one location to another

This means that the development or works must not result in any appreciable change (outside of modelling precision ie <0.01m) in flood extent, depth or velocity over neighbouring land or properties during flood events ranging in magnitude up to the 1% AEP design flood.

This objective must be met for all land surrounding the development that is owned by other parties including land in public ownership.

Potentially adverse effects on areas upstream, downstream and the other side of the floodplain must be identified and addressed.

2. New developments must provide safe access to all lots during floods ranging in magnitude up to the 1% AEP event

If a development proposal involves construction of roadways servicing new residential, commercial or industrial development then it must be demonstrated that safe roadway access will be available to all lots during the 1% AEP design flood.

The safe roadway requirement will be met if it can be demonstrated that a sufficient width of roadway pavement surface (generally equivalent to one trafficable lane of 3.0m width) is unlikely to be affected by flood water exceeding the following safety thresholds:

a. Depth of 0.3 metres; or

b. Velocity of 2 m/s; or
c. Velocity x Depth of 0.3 m^2/s

The above safety thresholds are consistent with the safety criteria for residential accessways provided by the Victorian *Guidelines for Development in Flood Affected Areas (DELWP, February 2019)*.

3. Development must maintain existing environmental values and where possible, result in net environmental benefit

Matters such as potential for erosion and potential impacts on instream fauna resulting from changes in velocity and barriers to movement must be considered and any potential negative impacts mitigated through appropriate design and implementation (eg use of box culverts instead of pipes, rock rip rap, baffled culverts to facilitate fish passage etc).

4. Climate change considerations must be factored into modelling where applicable

Climate change is altering the frequency and behaviour of floods. Increased rainfall intensity and rising sea level are clearly understood as changing climatic factors likely to exacerbate flood risk into the future. As a result, the CMA requires a minimum of one increased rainfall intensity scenario to be modelled as standard. This scenario should be in line with the worst-case scenario as per Australian Rainfall and Runoff 2019 (ARR) Book 1, Chapter 6. Provision of results from a range of modelled scenarios is preferable.

Higher sea level considerations *must* be considered for coastal locations. Coastal locations may be prone to storm tide (ocean) flooding only, or in the case of estuary floodplains they may be subject to both storm tide or riverine flood events happening at different times or a combination of both types of event happening at the same time. If you are unsure whether a location is considered coastal, please contact Glenelg Hopkins CMA for confirmation.

3. Modelling requirements

Hydrologic and two-dimensional hydraulic modelling is required for flood risk assessments and must meet the following minimum requirements:

a. **Existing/pre-development topography** must be accurately mapped for any proposals involving topography manipulation. Pre-development feature survey produced by a licensed surveyor should form the topography basis for the pre-development flood risk mapping for the development area – see Section 4. LiDAR derived ground level data may be available for some locations from external providers. The accuracy of any LiDAR derived ground level data must be verified.

b. **Hydrology** parameters must be determined using contemporary best practice according to the methodologies established by Australian Rainfall and Runoff (ARR) 2019 unless otherwise specified by the CMA. Hydrology modelling should be calibrated to stream flow gauging records where possible. In some instances, it will be preferable to adopt hydrology from previous studies, especially if it has been independently peer reviewed. Please contact the CMA prior to commencing hydrology elements to confirm the acceptability of the proposed hydrology method for the location of interest.

   RORB is the preferred hydrologic model software used by the CMA.

   Note: Teething issues exist with the ARR standard data hub outputs for Victoria. Work is currently underway to rectify these. The CMA may require validation and justification

of adopted hydrology parameters for locations where flood modelling has been completed using methodologies based on ARR1987. This is to ensure any mapping output differences stemming from the different hydrology estimation method are understood and fully justified.

c. **Hydraulic Model Boundaries** must be set a sufficient distance upstream and downstream of the subject property or development area to ensure unambiguous model outputs. The distance upstream and downstream of the subject property or development area should be established by professional judgement. If initial model runs reveal that model boundaries are likely to effect the model outputs within the area of interest then they must be moved further away from the subject site and further model runs must be completed and documented to demonstrate that the model outputs for the area of interest are free of boundary effects.

   Coastal Model Boundaries must consider existing mean sea level, 0.8m and 1.2m higher sea level scenarios and account for contemporary best estimates of present day and future ocean storm tide water levels for the South West Victorian Coastline consistent with the methodology applied by the University of NSW, Water Resource Laboratory to the 2013 Local Coastal Hazard Assessment for Port Fairy (downloadable from the CMAs website).

   The dynamic nature of coastal (ocean) boundaries must also be accounted for be consistent with the methodologies outlined in Bishop et al 2010 and WRL, 2013 (available on the CMAs website) and include consideration of wave runup.

   TUFLOW is the preferred hydraulic model software used by the CMA. Other modelling software packages may be acceptable, but it is advised to confirm the acceptability of other modelling software with the CMA prior to commencement of modelling.

d. **Model grid cell size must not exceed 2 x 2 metres**. This level of detail is required to assess any changes in flood behaviour at a scale appropriate to most site-specific development scenarios. The CMA may agree to larger grid cell sizes for large scale models, flexible mesh models or other situations where a fine grid cell size is not appropriate.

e. **Retention basins or artificial wetlands** within the 1% AEP flood extent must be included in the hydraulic model at full capacity. It is not to be assumed that retention basins or artificial wetlands will include flood storage unless they have specifically been designed to store floodwaters.

f. **Significant waterway structures** must be modelled in a 1D/2D linkage or layered flow constriction unless it can be otherwise demonstrated that this is not appropriate. This includes bridges, culverts and stormwater systems where applicable.

g. **Minor waterway channels or open drains** are to be constructed as a 1D channel where the grid cell size is insufficient to demonstrate the influence of the channel.

h. **Sensitivity analysis** must be completed in both hydrologic and hydraulic models to determine the sensitivity of input parameters such as boundary conditions, roughness coefficients, loss coefficients, timesteps, rainfall intensities etc. Sensitivity analysis of

timing of coincident peaks of main waterway and significant tributaries (or river and ocean storm tide events) may also be required.

i. **Post development/as constructed topography** must be verified as matching the approved design/modelled topography. "As constructed" feature survey as per section 4 below is generally required. Feature survey of the post development/as constructed topography shown on plans produced by a licensed surveyor generally provides sufficient means for verification of compliance of post development/as constructed surfaces with the approved plans.

   In the case of subdivisions, the CMA will not consent to the issue of Statement of Compliance in the absence of proof that the post development (as constructed) surfaces of the development match the approved design (potentially as modelled) surfaces of the development. For developments that require a planning permit only, the CMA will require verification that the post development (as constructed) surfaces matches the design (potentially as modelled) surfaces as a condition of the planning permit.

   In the event that the feature survey of the post development (as constructed) surface topography does not match the approved design/as modelled plans, then one of the following options will apply:

   - Rectification works shall be required to bring the post development surfaces into compliance with the approved plans; or
   - Further modelling shall be required to determine the impact of any changes in flood behaviour and if required, how the impact can be mitigated.

j. **Model output runs** must be done for the 1% AEP and 10% AEP flood events (or other events as agreed to by the CMA) for both the existing/predevelopment and design topography. Mapping outputs are to be produced in their native file type (eg .flt or .tiff) and MapInfo compatible grid file (.ers) format or MapInfo .tab file format covering the following parameters:

   i. Flood level (m AHD);

   ii. Depth (m);

   iii. Velocity (m/s); and

   iv. Hazard (m^2/s).

   Note: Modelling of additional design events may be required if the 10% or 1% AEP model outputs indicate significant changes in flood behaviour as a result of proposed works.

   Coastal model runs must also include sea level rise scenarios outlined in Section 3.c above and must include the additional storm tide scenarios in addition to the 1% AEP and 10% AEP riverine modelling:

   v. 1% AEP riverine flood coincident with 5% AEP ocean storm tide;

   vi. 1% AEP ocean storm tide only (no riverine); and

   vii. 1% AEP ocean storm tide coincident with a 5% AEP riverine flood.

k. **Model files and outputs** are to be provided to GHCMA for review in their native format.

   In some instances, the CMA may request that all modelling is subject to peer review by an independent consultant. If this is required, the CMA will request that all model files are delivered to the CMA for review by an external party. Please note that if this request is refused the CMA may not support the flood modelling, even if it meets the specifications contained herein.

4. Feature Survey Requirements

Feature survey for both predevelopment/existing conditions (where applicable) and post development/as constructed topography must meet the following requirements:

a. Completed by a licensed surveyor

b. Minimum point density of 2m x 2m

c. Levels expressed in Australian Height Datum (AHD)

d. All point coordinate data to be collected in MGA 94 OR MGA2020 Zone 54 Eastings and Northings. Please clarify preferred projection with CMA prior to collection.

e. Data to be provided to the CMA in dxf and preferably in GIS (MapInfo .tab or esri shapefile) format, including generation of detailed contours or a digital terrain model (dtm) using the surveyed topographic point data.

5. Flood Modelling Report Requirements

A standalone flood modelling report must be produced providing sufficient detail on the applied flood modelling methodology and assumptions to enable the modelling exercise to be replicated by another party if required.

The flood modelling report must include the following elements as a minimum:

1. Site description
2. A detailed description of the proposed development including any topography manipulations and/or new or replacement structure(s) to be built including design plans
3. Clear description of the hydrologic and hydraulic modelling methodology
4. Clear listing of the data used to build the model including (but not limited to):
   i. Feature survey plan(s) of predevelopment (existing) topography (ensure plan ID, version and number/date information is provided as relevant)
   ii. Design plan(s) of post development (modified) topography (ensure plan ID, version and number/date information is provided as relevant)
   iii. Ground level LiDAR data ensuring filename and date flown is supplied, and information on where LiDAR was sourced.
5. Clear listing and justification of all input parameters including boundary conditions, roughness coefficients, loss coefficients, timesteps and other relevant input parameters. Coastal models will require listing and justification of applicable ocean boundary water

levels including wave runup. Insufficient listing of parameters may result in delays in the CMA making a determination.

6. Mapping demonstrating location of boundary conditions, model extent, the application of roughness coefficients across the model, and any other parameters that can be represented visually.

7. Flood mapping meeting the following requirements for both the pre and post development topography for each of the model output runs specified under Modelling Requirement (j) above.

    (a) Flood maps are to be overlaid onto aerial imagery

    (b) Any road reserves must be shown in all mapping scenarios as a minimum representation of potential inundation of the roadway(s). In order to be clear as to the likely extent of flooding over the roadway pavement, it is preferable for the maps to also show the width of the pavement surface within the road reserve to clearly show the nature of risk (if any) posed by flooding of the roadway(s) in the design modelling

    (c) The flood risk characteristics (specified under Section 3.i above) must be thematically mapped according to the range requirements specified in Table 1 below and the maps included in the report. Colours must be block colours (no graded shading) and enable clear delineation between ranges

Table 1 - Thematic mapping ranges

Flood characteristic	Mapping range requirements
Flood level (m AHD)	0.5m increments
Depth (m)	0 to 0.15 0.15 to 0.3 0.3 to 0.5 0.5 to 1 1 to 2 2+
Velocity (m/s)	0 to 0.5 0.5 to 1 1 to 1.5 1.5 to 2 2+
Hazard VxD (m^2/s)	0 to 0.3 0.3 to 0.4 0.4+

    Mapping of **coastal** flooding must include a coincidence envelope demonstrating the worst flooding of all scenarios listed under Modelling Requirement (j) above. For example, storm tide flooding may be the dominant form of flooding for the downstream reaches of a waterway, with riverine flooding dominant upstream – a coincident envelope must combine both scenarios to show both these cases within a single map.

    (d) Flood characteristic <u>difference</u> maps are to be included where there are proposed changes to topography or structures. These must show the likely differences (as

determined by the hydraulic model) in the characteristics of flood events due to altering the floodplain topography or flood conveyance through a structure.

The difference maps must enable judgment as to the significance of likely changes in flood characteristics stemming from development and differ from the flood characteristic mapping listed under 7c above. Sufficient positive and negative change ranges between the two datasets should therefore be shown in mapping format to discern differences in the nature of flooding between the existing/predevelopment and post-development/as constructed cases.

Suggested ranges for both increases and reductions (±) are provided for each parameter below.

The following difference maps are required:

(i) Change in peak flood level (m AHD) showing increased and decreases changes within the following ranges (both positive and negative – ie. ± change)

0m, 0.02m, 0.05m, 0.1m, 0.2m, 0.3m, 0.5m, 1m and 2m+

(ii) Change in depth (m) showing increased and decreased changes within the following ranges (both positive and negative – ie ± change)

0m, 0.02m, 0.05m, 0.1m, 0.2m, 0.3m, 0.5m, 1m and 2m+

Note: ranges such as 'was dry, now wet', 'newly flooded' or 'no longer flooded' should be displayed as hatching over the relevant change in depth.

(iii) Change in peak velocity – sufficient ranges to show difference as detected by the model output.

Note: Should significant changes in velocity be observed to the extent of the model boundaries, the CMA may request that model boundaries are extended further upstream or downstream and the models rerun.

(e) Where a planning scheme amendment may be required to change zoning or overlays, the CMA requires that the 'floodway' and 'flood fringe' are delineated to determine the most appropriate controls.

Urban Floodway Zone and Floodway Overlay are typically characterised by the 'floodway' portion of the 1% AEP floodplain which is determined by the following characteristics:

(i) Depths of, or exceeding, 0.5 metres; or

(ii) Hazard of, or exceeding, 0.4 m^2/s

Land Subject to Inundation Overlay is typically applicable to the 'flood fringe' component of the 1% AEP floodplain that is the flood extent outside of the 'floodway' as described above.

In locations where there is existing Urban Floodway Zone or Floodway Overlay, the CMA may encourage retaining these controls within the flood fringe portion of the 1% AEP floodplain.

In coastal locations where sea level and storm tide modelling has been undertaken the CMA will require that the floodway and flood fringe are

determined based on the coincidence envelope as described under 7c of the Flood Modelling Report Requirements.

Glenelg Hopkins CMA are happy to liaise directly with the relevant personnel on appropriate range changes if any questions arise as a consequence of modelling outputs.

Contact the Waterway Planning Team on (03) 5571 2526 or at planning@ghcma.vic.gov.au for further information.