Rapid Flood Risk Assessment - North Central CMA Region

Summary Report

Version 2

22/04/2020

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Rapid Flood Risk Assessment - North Central CMA Region

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Copyright and Limitation

The Rapid Flood Risk Assessments project is a joint initiative funded through the Victorian and Australian governments.

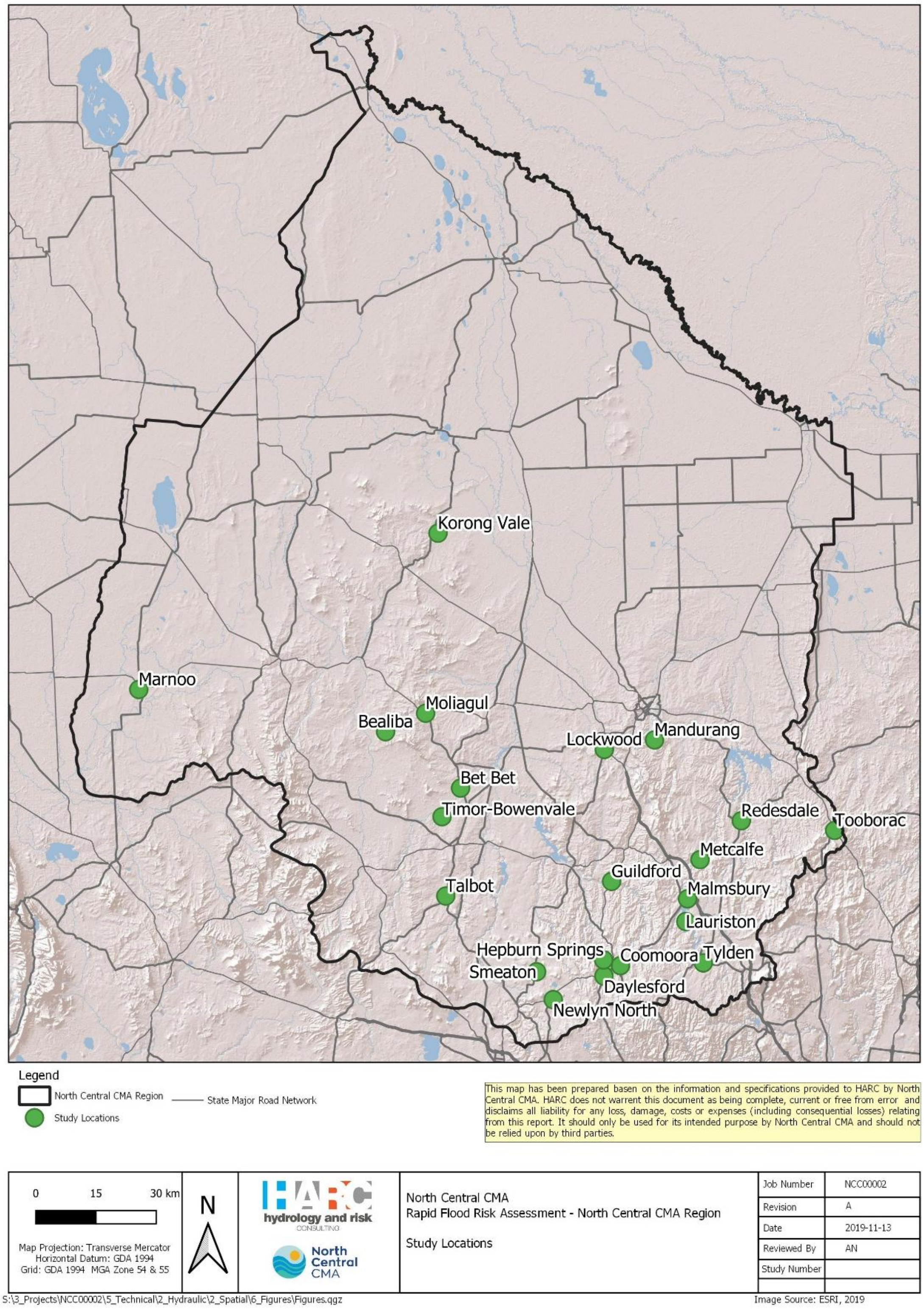
Acknowledgment of Country

We acknowledge Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

1. Introduction

The North Central Catchment Management Authority (CMA) commissioned HARC to undertake a rapid flood risk assessment for 21 townships in the North Central CMA region. The Rapid Flood Risk Assessments project is a joint initiative funded through the Victorian and Australian governments. The study focused on providing mapped flood extents for a range of AEPs using a range of existing and new hydrologic and hydraulic models. The rapid nature of the assessment precluded detailed, site specific studies, extensive model calibration or community engagement. The outcomes of the study were used to provide preliminary estimates of flood risk at the 21 locations, and to help identify and prioritise areas where more detailed, site specific flood studies were recommended. The study locations are shown in Figure 1-1 and the list of townships is shown in Table 1-1.

This report is a summary of the methodology, results and conclusion from the investigation. For details of each study location the reader is refer to each individual report.



n **Figure 1-1 Rapid Flood Risk Assessment Project Study Locations**

Table 1-1 List of Study Locations

No.	Name	No.	Name
1	Lockwood	12	Daylesford
2	Mandurang	13	Hepburn Springs
3	Redesdale	14	Korong Vale
4	Moliagul	15	Malmsbury
5	Bet Bet	16	Lauriston
6	Talbot	17	Tylden
7	Bealiba	18	Tooborac
8	Timor-Bowenvale	19	Guildford
9	Coomoora	20	Metcalfe
10	Newlyn North	21	Marnoo
11	Smeaton		

This report summarises the outcomes of all 21 study locations.

2. Methodology

The following section provides a brief summary of the methodology adopted for each study area. The reader is referred to the individual study area report for detail on each study area.

2.1 Information Collation and Review

Information that was relevant to the study was collated for each study area. Information included:

- Previous hydrology models and associated reports
- Streamflow gauge information
- Details on hydraulic structures
- Previous flood studies
- Topographic (LIDAR) information

2.2 Hydrology

For each study area there is an existing RORB model available except for Korong Vale. Each of the RORB models was reviewed and an assessment made to determine if it is appropriate for use for each investigation. Table 2-1 summarises the outcomes of the review with the review placing the models into four categories:

- Model is appropriate with minor modifications
- New model
- Model is appropriate
- No model exists

The category labelled, “model is appropriate with minor modifications” means that, in general, the sub-division of the subareas was deemed appropriate for use in this investigation. However, some minor modifications were required, such as adjusting the model to finish at the boundary of the study area. The category labelled “new model” means that, in general, the sub-division of the subareas was deemed too coarse for this study. It is not to say the model was not appropriate for the use it was set up for originally. Finally the category labelled “model is appropriate” meant that the model was adopted as is. Noting that all models were set up to terminate at the study area outlet. For Korong Vale a new RORB model was established.

Table 2-1 Summary of RORB model

No.	Study Area	Previous Study	Comment
1	Lockwood	Marong Flood Study	Model is appropriate with minor modification
2	Mandurang	Bendigo Urban Flood Study	New model
3	Redesdale	Eppalock Dam Flood Hydrology Update	Model is appropriate with minor modification

No.	Study Area	Previous Study	Comment
4	Moliagul	Laanecoorie Dam Flood Hydrology	New model
5	Bet Bet	Laanecoorie Dam Flood Hydrology	Model is appropriate with minor modification
6	Talbot	Laanecoorie Dam Flood Hydrology	Model is appropriate with minor modification
7	Bealiba	Charlton Flood Study	New model
8	Timor-Bowenvale	Laanecoorie Dam Flood Hydrology	Model is appropriate with minor modification
9	Coomoora	Caairn Curran Dam Flood Hydrology	New model
10	Newlyn North	Newlyn Dam Flood Hydrology	Model is appropriate with minor modification
11	Smeaton	Newlyn Dam Flood Hydrology	Model is appropriate
12	Daylesford	Caairn Curran Dam Flood Hydrology	New model
13	Hepburn Springs	Caairn Curran Dam Flood Hydrology	New model
14	Korong Vale	-	No model exists
15	Malmsbury	Upper Coliban Storages Flood Hydrology	Model is appropriate
16	Lauriston	Upper Coliban Storages Flood Hydrology	Model is appropriate with minor modification
17	Tylden	Upper Coliban Storages Flood Hydrology	New model
18	Tooborac	Eppalock Dam Flood Hydrology Update	New model
19	Guildford	Caairn Curran Dam Flood Hydrology	New model
20	Metcalfe	Eppalock Dam Flood Hydrology Update	Model is appropriate with minor modification
21	Marnoo	Donald Flood Study	New model

For each of the models, except Korong Vale, the routing parameters (m and k_c), initial loss (IL) and continuing loss were taken from previous models. For the routing parameter, k_c, the ratio of k_c/d_{av} was used to ensure that the same routing is applied to the new model, as per the previous model. McMahon and Muller (1983) showed that k_c is directly proportional to d_{av}, where d_{av} is the weighted average flow distance to the catchment outlet (this is calculated automatically in the RORB model). Therefore, a way to measure the similarity of two different RORB models is to compare k_c/d_{av}.

Design inputs were produced for each RORB model in accordance with ARR2019. Inputs include:

- Rainfall depths (IFD - BOM),

- Areal reduction factors (Data hub),
- Spatial patterns (Rainfall depths over the catchment – based on IFD)
- Temporal patterns (Rainfall depths over time – Data hub)
- Losses (ARR guidance)
- Pre-burst (Data hub)
- Baseflow (ARR guidance)
- Starting reservoir water level (only applicable for Lauriston, Malmsbury, Newlyn North and Smeaton)

The joint probability framework that was adopted for the study was developed by Nathan et al (2002, 2003) and is summarised in Figure 2-1. In essence the approach involves undertaking numerous model simulations, where the model inputs are sampled from non-parametric distributions that are based either on readily available design information or on the results of recent research. For those study areas where reservoir starting water level is applicable, the level in the storage is also sampled.

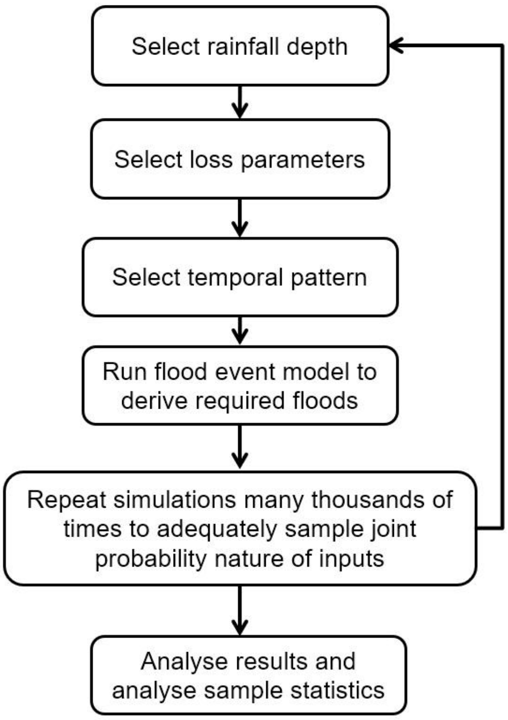


Figure 2-1 Overview of adopted joint probability framework

In developing the joint probability framework particular attention was given to ensuring that the model inputs and the manner in which they were incorporated was consistent with ARR (Ball et al., 2019). The following briefly describes the main inputs, and how they were related to establishing design information.

Select rainfall depth. Rainfall depths were stochastically sampled from the cumulative distribution of rainfall depths.

Select storm losses. Storm initial losses were stochastically sampled from a nonparametric distribution that was determined from the analysis of a large number of catchments across Australia (Hill et al., 2014). The limited number of investigations that have explored the correlation between initial and continuing loss values have concluded that there is little systematic dependence between the two. There is little information regarding the correlation between initial and continuing loss rates, and since antecedent conditions have most influence on initial loss rates, in this study the continuing loss rates will be held constant. Current practice is for initial losses to be sampled from a distribution, while the continuing loss is held constant; this approach was used for the design flood modelling.

Select temporal pattern. Temporal patterns were randomly selected from a sample of temporal patterns relevant to the catchment area and duration of the storm. The temporal patterns in the data hub were derived from large historic storms that have been observed in the region.

Monte-Carlo simulation. Simulations were undertaken using a stratified sampling approach in which the sampling procedure focuses selectively on the probabilistic range of interest. Thus, rather than undertake many millions of simulations in order to estimate an event with, say, a 1 in 100 probability of exceedance, a reduced number of simulations were undertaken over a specified number of probability intervals. In this study, the rainfall frequency curve was divided into 100 intervals uniformly spaced over the standardised normal probability domain, and 250 simulations were taken within each division. Thus, a total of 25,000 simulations were undertaken to derive the frequency curve corresponding to each storm duration considered. This approach accounts for the natural variability inherent in floods. Monte Carlo techniques are grounded in, and consistent with, the principle that “no two floods are ever the same”.

The key advantage of the Monte Carlo approach is that it reduces uncertainty by accounting for variability. The results of a Monte Carlo analysis are presented as median peak flow estimates rather than single hydrographs, however it must be remembered that the natural variability of the key inputs is built into these median estimates. The median peak flows are not biased one way or the other by selection of a single arbitrary rainfall temporal or spatial pattern. Using the technique described above hydrographs will be produced for the 20%, 10%, 5%, 2%, 1% and 0.5% AEP events. A separate method will be used to determine an estimate of the PMF (described below).

Each of the previous RORB models were calibrated and/or verified to local gauged at-site flood frequency estimates, which gives some confidence that the parameters adopted for this investigation are representative of the catchment characteristics. However, to gain additional confidence in the parameters the model results were compared to the Regional Flood Frequency

Estimation Model (RFFE) developed as part of ARR2019[1]. The RFFE was only used as a guide with more confidence given to the calibration/verification process undertaken for each individual catchment. For Malmsbury, Redesdale, Bet Bet and Smeaton the RORB results were compared to the flood frequency curve based on the streamflow gauge within the study area.

In the context of a rapid flood risk assessment the estimation of the magnitude of the PMF was based on regional prediction equations. The method proposed is described in Nathan et al. (1994). Nathan et al. (1994) estimates of the PMF magnitude are based on the catchment area.

2.2.1 Climate change

The ARR2019 approach to climate change has a number of limitations, including the fact that it does not provide a means to account for potential increases in rainfall losses under a drying climate. Therefore, for this rapid assessment it was decided that full consideration of climate change impacts be held over until detailed flood studies are undertaken on each of the study areas. For this investigation in the peak flood flows were increased for the 10% and 1% AEP at each site based on the appropriate increases to rainfall intensity to account for climate change obtained from the ARR data hub.

The flood hazard was defined in terms of a change in AEP (which can be interpreted in relation to the extents from the hydraulic model – refer to Section 2.3). As it was assumed that the increase in peak flow rate for a given AEP is the same percentage increase in rainfall depth derived from ARR2019 this enabled the likely shift in both peak flood level and AEP associated with climate change to be assessed.

2.3 Hydraulics

A TUFLOW model was created for each of the 21 study areas. The key inputs to the hydraulic models were:

- Topographical information
- Cell size
- Roughness values
- Hydraulic structures
- Inflows
- Downstream boundary

The topographical information was based on the LIDAR data supplied by the NCCMA.

The Manning's roughness for each of the study areas utilised the Victorian Land Use Information System (VLUIS) dataset. This provided a consistent and efficient means of assigning Manning's n.

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[1] The results were not compared to the RFFE for Lauriston, Malmsbury, Newlyn North and Smeaton as these results are impacted on by the reservoirs upstream.

For each study area a basic check, compared to aerial imagery, was undertaken to check for consistency between the VLUIS and aerial photography. The basic check was only intended to pick up any large errors in assigned land use rather than lot scale errors. Table 2-2 shows the Manning's n values adopted.

Table 2-2 Manning's n values for different land use types

Land Use Type	Manning's n adopted
Residential areas – urban high density (building and parcel combined)	0.35
Residential areas – rural high density (building and parcel combined)	0.15
Industrial/commercial or large buildings	0.30
Residential areas – rural low density (parcel only or large blocks with house)	0.05
Open space or waterway – minimal vegetation	0.04
Open space or waterway – moderate vegetation	0.06
Open space or waterway – heavy vegetation	0.095
Paved roads/car park/driveways	0.025
Railway line	0.05
Grass reserves/floodway (regularly mowed)	0.035
Rural floodplains in clear paddocks	0.05
Forested (heavy stand of timber)	0.12
Dam/Reservoir body of water	0.035

Bridges were represented using a layered flow constriction and culverts in 1D based on the best available data sources.

The inflows to the hydraulic models were taken from the RORB models, as discussed in Section 2.2. The downstream boundary conditions was conceptualised as a normal depth relationship with a slope based on the LIDAR data.

All the hydraulic models were run for the 20%, 10%, 5%, 2%, 1% and 0.5% AEP and PMF events. A single set of hydrographs was modelled for each AEP, based on the critical duration and median temporal pattern identified from the hydrology results. Hydraulic grids of flood level, depth, velocity, hazard and flood level contours were extracted for each event.

2.4 Flood Risk Assessments

Flood risk to properties and buildings was produced in both tabular and mapped format illustrating the comparison of flood level and floor level for the 20%, 10%, 5%, 2%, 1% and 0.5% AEP and PMF events.

2.5 Flood Intelligence Information

From the modelling results and other project deliverables the relevant MFEPs were updated.

2.6 Developing Indicative Quick Look Flood / No-Flood Tools

Using the results of the hydrologic and hydraulic modelling work, indicative quick look flood / no-flood assessment tools was developed for the 21 study areas.

These tools are aimed at providing a rapid indication of whether flooding is likely with some lead time and the approximate scale of that flooding. They are intended to be indicative only and will not provide a forecast of expected flood depth. They will however link to the mapping and intelligence produced by this project and in that way provide an indication of likely consequences.

2.7 Limitations

The methodology adopted was intended to make best use of the available data whilst remaining consistent with the intentions of a rapid assessment. However the following limitations of the analysis should be noted.

Any information provided by the Bureau of Meteorology, Geoscience Australia as well as published methodologies (e.g. Australian Rainfall and Runoff) cannot be guaranteed to be free of errors.

The hydrological parameters rely on the previous calibration and verification undertaken for each of the RORB models. Therefore, the accuracy of these will vary depending on the information available to calibrate the models. However, any calibration and verification of the models to streamflow information will most likely be better than just relying on regional parameter estimates.

The adopted methodology for the PMF estimate is preliminary in nature. Other, more detailed techniques are available in which to estimate the PMF. However, for this investigation a preliminary assessment was considered to be appropriate.

The analysis relied heavily on the supplied LIDAR terrain data. For this investigation no survey was undertaken to independently check the terrain data.

For the hydraulic model the cell size that was generally chosen with 4-5 cells to represent the main waterway with a lower limit of 2 metres. Where a waterway is less eight metres wide it was represented by less than the 4-5 cells which could mean that the waterway is not fully represented.

To assign the Manning's roughness for each of the study areas the VLUIS dataset was used. As the VLUIS is a state wide dataset there may be some areas that have either been developed since the VLUIS was established or not captured accuracy. Basic checks were undertaken to pick up any large errors in assigned land use but there may still be some lot scale differences in land use which may not have been picked up.

As the hydraulic models are not calibrated to surveyed flood levels the Manning's n values listed in Table 2-2 may not necessarily represent the roughness values accurately.

The ARR2019 approach to climate change has a number of limitations, including the fact that it does not provide a means to account for potential increases in rainfall losses under a drying climate.

The quick look flood / no flood tools may be replaced where more detailed investigations are undertaken in the future.

3. Flood Risk Assessment

3.1 Flood Mapping

Flood maps showing flood level, depth, velocity and hazard (depth x velocity) have been produced for the 1 in 5, 10, 20, 50, 100 and 200 AEP events along with the PMF. A complete set of flood maps is found in each individual report.

3.2 Flood behaviour and impact of flooding

The following section summarises the impact of flooding for each study location. Table 3-1 is a summary of the number of properties that are inundated for each AEP event. Table 3-2 is a summary of the number of properties that are inundated above floor for each AEP event. Table 3-2 was based on floor level survey provided by the North Central CMA.

Table 3-1 Summary of property inundation

Study Location	AEP (1 in Y)					
	1in5	1in10	1in20	1in50	1in100	1in200
Lockwood	0	0	3	5	8	10
Mandurang	6	6	8	8	8	10
Redesdale	0	0	0	0	0	0
Moliagul	0	0	5	7	7	7
Bet Bet	0	0	1	4	5	17
Talbot	0	3	3	3	8	8
Bealiba	0	0	0	3	3	3
Timor-Bowenvale	1	3	3	5	9	12
Coomoora	0	0	0	0	0	0
Newlyn North	1	1	1	1	1	2
Smeaton	0	0	2	2	2	2
Daylesford	4	4	6	8	10	26
Hepburn Springs	3	3	3	3	3	3
Korong Vale	20	24	29	35	36	42
Malmsbury	0	2	2	2	2	6
Lauriston	0	0	0	4	4	4
Tylden	6	6	6	6	6	6
Tooborac	0	0	0	0	0	0
Guildford	6	7	8	8	9	12
Metcalfe	0	1	1	1	2	2
Marnoo	19	20	23	26	27	28

Table 3-2 Summary of over floor flooding*

Study Location	AEP (1 in Y)					
	1in5	1in10	1in20	1in50	1in100	1in200
Lockwood	0	0	0	1	3	4
Mandurang	2	2	3	3	3	3
Redesdale	0	0	0	0	0	0
Moliagul	0	0	0	3	4	4
Bet Bet	0	0	0	2	2	4
Talbot	0	0	2	2	4	7
Bealiba	0	0	0	0	0	0
Timor-Bowenvale	0	1	1	2	2	3
Coomoora	0	0	0	0	0	0
Newlyn North	0	1	1	1	1	1
Smeaton	0	0	1	2	2	2
Daylesford	0	1	1	3	5	12
Hepburn Springs	2	2	2	2	2	2
Korong Vale	7	9	15	22	22	26
Malmsbury	0	2	2	2	2	3
Lauriston	0	0	0	2	3	3
Tylden	2	2	2	2	2	2
Tooborac	0	0	0	0	0	0
Guildford	1	1	1	1	2	5
Metcalfe	0	0	1	1	1	1
Marnoo	8	9	9	11	13	14

* Note the floor levels have assumed to be 300 mm above the natural surface level for those buildings without surveyed floor levels

4. Summary of rating of key areas

The following section provides a summary rating of each of the key areas of the project for each study location. The rating is subjective but has been rated against current standards and industry best practice for undertaking detailed flood studies.

The intention is that this will enable the North Central CMA to easily identify the areas where additional caution may need to be applied when using the information from this investigation for making decisions on flooding issues. In addition it will identify the areas of additional investigation, should a more detailed study be undertaken in the future.

Table 4-1 shows a summary of the rating for each study location where green is considered to be good, orange is OK and red is poor. Below is a summary of the main considerations given to each aspect of the study:

- *RORB model set up*. Adequacy of sub-area division, reach types, impervious fractions
- *RORB model parameters*. Has the RORB model been calibrated and/or verified to streamflow gauge information
- *Currency of hydrology*. Rated based on whether the hydrology used in the study is consistent with current practice and data sets.
- *Topographic data*. Typically will be rated orange or red if LiDAR data is not available and if the state wide DEM is required for use.
- *Manning's n*. Has land use been represented with appropriate values
- *Modelling of key structures*. Reflects whether the model was attempted to incorporate key hydraulic structures within the inundation zone and to what degree.
- *TUFLOW model set up.* Considers such aspects as does the cell size capture key features and the boundary conditions.
- *TUFLOW parameters*. Has the TUFLOW model been calibrated and/or verified to recorded flood levels.

Refer to the individual study reports for additional commentary on selection of red/orange/green ratings for each criteria.

Table 4-1 Summary of review

Category	Rating										
	Lockwood	Mandurang	Redesdale	Moliagul	Bet Bet	Talbot	Bealiba	Timor-Bowenvale	Coomoora	Newlyn	Smeaton
RORB model set up											
RORB model parameters											
Currency of hydrology											
Topographic data											
Manning's n											
Modelling of key structures											
TUFLOW model set up											
TUFLOW parameters											

Table 4-1 Summary of review (continued)

Category	Rating									
	Daylesford	Hepburn Springs	Korong Vale	Malmsbury	Lauriston	Tylden	Tooborac	Guildford	Metcalfe	Marnoo
RORB model set up										
RORB model parameters										
Currency of hydrology										
Topographic data										
Manning's n										
Modelling of key structures										
TUFLOW model set up										
TUFLOW parameters										

5. Conclusions and Recommendations

This project forms part of the Rapid Flood Risk Assessment for the North Central CMA region. Outputs from the assessment will assist the North Central CMA to meet a range of business requirements. Outputs can be used to assist in flood related controls, develop flood intelligence products, inform emergency response planning and assist in the preparation of community flood awareness and education products.

Based on the investigation the following sites are recommended for additional investigation:

- Mandurang
- Daylesford
- Hepburn Springs
- Korong Vale
- Tylden
- Guildford
- Marnoo

All of these sites were chosen as they have buildings that are inundated during a frequent event (1 in 5 AEP).

For Mandurang, Daylesford, Hepburn Springs, Guildford, Newlyn North and Marnoo if additional investigation is to take place it is recommended that the focus is on the hydrological parameters in RORB. For these sites, calibration and verification to surrounding streamflow gauges is recommended and should be used to inform the parameters of the study site catchment. Also for Newlyn North as the two buildings impacted are from a local catchment, additional local catchment sub-division is recommended, if more detailed local flows are required. For Mandurang, Daylesford and Marnoo there are a number of hydraulic structures which could be surveyed to improve the information in the hydraulic model.

For Korong Vale there is no streamflow gauge within close proximity to help with the confirmation of the RORB parameters. A regional approach to the flood frequency estimation could be undertaken and then the RORB model re-verified to the regional flood frequency estimate. However, the regional flood frequency analysis in ARR does this. So, whilst a localised study could improve the confidence in the results it would still be uncertain. Therefore, for Korong Vale, it is recommended that the best approach would be refinement of the hydraulic model. This would include obtaining additional survey along the channels then check the survey against the LIDAR and then refine the channels to suit. Following refinement of the hydraulic model it would then need to be re-run.

For Tylden as a number of buildings impacted are from a local catchment, therefore additional local catchment sub-division is recommended, if more detailed local flows are required. In addition there are a number of hydraulic structures which could be surveyed to improve the information in the hydraulic model.

6. References

Agriculture Victoria (2016) Victorian Land Use Information System (VLUIS)

Austroads (1994) Waterway Design: A Guide to the Hydraulic Design of Bridges, Culverts and Floodways

Ball J, Babister M, Nathan R, Week W, Weinmann E, Retallick M, Testoni I, (Editors) (2019) Australian Rainfall and Runoff: A guide to flood estimation, Commonwealth of Australia (Geoscience Australia).

Babister, M, Trim, A, Testoni, I, Retallick, M. (2016) The Australian Rainfall & Runoff Datahub, 37th Hydrology and Water Resources Symposium Queenstown NZ.

BMT (2018), TUFLOW Classic/HPC User Manual. Build 2018-03-AD

BMT WBM (2013), Charlton Flood and Drainage Management Plan

Bureau of Meteorology (2016) 2016 Rainfall IFD Data System. http://www.bom.gov.au/water/designRainfalls/revised-ifd/.

GHD (2014) Donald Flood Study

Hydrology and Risk Consulting (2016) ArcRORB, A tool for creating RORB catchment files in ArcMap, User Manual, version 1.6.

Hydrology and Risk Consulting (2017) GMW Dam PRA Hydrology Review – Lake Eppalock

Hill PI, Graszkiewicz Z, Taylor M and Nathan RJ (2014) Australian Rainfall and Runoff revision project 6: Loss models for catchment simulation. Stage 4: Analysis of rural catchments.

Hill P and Thomson R (2015) Chapter 3 in Book 5: Losses. In Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I, (eds) Australian Rainfall and Runoff: A guide to flood estimation. Commonwealth of Australia, Canberra.

Jordan P, Nathan R, Podger S, Babister M, Stensmyr P and Green J (2016) Chapter 4 in Book 2: Areal reduction factors. In Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I, (eds) Australian Rainfall and Runoff: A guide to flood estimation. Commonwealth of Australia, Canberra.

Laurenson EM, Mein RG and Nathan RJ (2010) RORB version 6 runoff routing program - User manual. Monash University Department of Civil Engineering in conjunction with Hydrology and Risk Consulting Pty. Ltd. and the support of Melbourne Water Corporation, Melbourne.

Minty, L.J and Meighen, J (1999), Development of temporal distributions of rainfall antecedent to large and extreme design bursts over southeast Australia, Hydrology Report Series HRS Report No.6, Hydrometeorological Advisory Service, Bureau of Meteorology.

Nathan RJ, Weinmann PE and Hill PI (2002) Use of a Monte Carlo framework to characterise hydrologic risk. Proceedings of the 2002 ANCOLD Conference, Adelaide. Australian National Committee on Large Dams.

Nathan RJ, Weinmann PE and Hill PI (2003) Use of Monte Carlo simulation to estimate the expected probability of large to extreme floods. Proceedings of 28th Hydrology and Water Resources Symposium, Wollongong. Institution of Engineers, Australia.

Nathan RJ, Weinmann PE and Gato SE (1994) A quick method for estimating the probable maximum flood in South Eastern Australia, Water Down Under 94. Hydrology and Water Resources Symposium I.E. Aust. Nat. Conf. Publ. 94/10, pp.229-234

North Central Catchment Management Authority (2018) Marong Flood Study Draft

Pearse M, Jordan P and Collins Y (2002) A simple method for estimating RORB model parameters for ungauged rural catchments. Proceedings of 27th Hydrology and Water Resources Symposium, Melbourne. Institution of Engineers, Australia.

Phillips, B, Goyen, A, Thomson, R, Pathiraja, S and Pomeroy, L. (2014), Australian Rainfall and Runoff Revision Project 6: Loss models for catchment simulation - Urban Losses Stage 2 Report, February.

Scorah M, Hill P, Lang S and Nathan R (2016), Addressing embedded bursts in design storms for flood hydrology. Water, Infrastructure and the Environment: Proceedings of the 56th New Zealand Hydrological Society Conference and the 37th Hydrology and Water Resources Symposium, Queenstown, New Zealand. New Zealand Hydrological Society and Engineers Australia.

SKM (2012) Laanecoorie Dam: Flood Hydrology Update and Construction Flood Risk

SKM (2012) Cairn Curran Dam: Flood Hydrology Update

SKM (2005), Review of Flood Hydrology for Newlyn Dam

SKM. (2010) Review of the Upper Coliban Storages Flood Hydrology. Final. July 2010

Water Technology (2013) Bendigo Urban Flood Study