Signature Gardens Retirement Resort

Flood Risk Assessment

Prepared for Maitland City Council

July 2024

Signature Gardens Retirement Resort

Flood Risk Assessment

Maitland City Council

RP1

July 2024

Version	Date	Prepared by	Reviewed by	Comments
V1	5/7/2024	Luke Norman	Nick Bartho	Final Submission

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3 July 2024

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1 Project background

1.1 Purpose of this report

Maitland City Council (MCC) currently own Lot 2 DP 1243663, New England Highway, Rutherford in New South Wales (NSW) (the site). This site is the proposed location of a seniors living housing development known as Signature Gardens Retirement Resort (Stages 12-20). The development approval and design are currently being performed by Northrop Consulting Engineers.

MCC is proposing a subdivision of the lot into two, with the proposed retirement resort to be constructed on the eastern lot (subject to separate development approval), and the western lot to remain undeveloped. This subdivision is shown in Figure 1-1.

Previous stages of the Signature Gardens Retirement Resort have been constructed and are located immediately south of the site.

EMM Consulting (EMM) has been engaged by MCC (in conjunction with Gyde Consulting) to perform an initial flood risk assessment to support the subdivision of Lot 2 DP 1243663 prior to any design inputs. This report assesses the flood risk based on existing flood information for both local and regional sources of flooding.

1.2 Site location

The site is located 400 m north of the New England Highway at Rutherford, and is bounded by residential housing on its northern and eastern boundaries, the existing Signature Gardens Retirement Resort development to the south, and a vacant lot to the east. The site is shown in Figure 1-1 below.

1.3 Description of flooding

The site is subject to flooding from two sources: local flooding, and regional flooding.

The local flood risk comes from overland flow via the adjacent catchment to the east of the site, which extends up to the ridge at Adam Avenue. Critical events posing local flood risk will result from localised rainfall events of relatively short duration (e.g. <1 hr). Further detail on this is provided in Section 2 of this report.

The site is located about 1 km south of the Hunter River, which is the source of regional flood risk. Long-duration storm events (e.g. >24 hours) pose the greatest risk due to the large size of the Hunter River upstream catchment. The site is far enough from the river such that inundation close to the site is backwater from the Hunter River with very low velocity. Further detail on this is provided in Section 3 of this report.

1.4 Site visit

A site visit was performed on 8th May, 2024, with the purpose of gaining site-specific information pertaining to the flood assessment. Some local drainage features were noted, including comparing observed infrastructure and natural features with the information provided (refer Section 1.5). This provided improved accuracy and context for the flood assessment.

1.5 Available information

MCC supplied EMM with two keys sets of data to support this assessment. For the local assessment, drawings of the exiting pit and pipe stormwater network for the surrounding areas was provided. For the regional assessment, the existing hydraulic model of the Hunter River was provided, including model and results files. Further detail on this model is discussed in Section 3.2 of this report.

Other information obtained by EMM to support this assessment includes:

- base spatial data (e.g. aerial imagery, cadastre, watercourses, etc)

- light detection and ranging (LiDAR) survey dated 2012 sourced from the ELVIS portal (https://elevation.fsdf.org.au/)

1.6 Relevant guidelines

This report and assessment are derived from the requirements set out in the *Flood Impact and Risk Assessment – Flood Risk Management Guideline LU01* (NSW Department of Planning and Environment, 2023) (Guideline LU01). It defines the detail required for a Flood Impact and Risk Assessment (FIRA). Section 2.8 of these guidelines, relevant where a 'Simple FIRA' is required, are as follows:

2.8 Simple flood impact and risk assessment

A FIRA based on a simple assessment should consider the requirements of the local council (see Section 2.7) or relevant consent authority. A simple assessment may be used:

- where no flood information or assessment requirements exist and the proposed development is relatively small-scale, such as single lot residential dwelling and associated works
- for a preliminary or initial stage assessment of impacts in larger developments to assist in scoping a more detailed assessment. This is particularly useful where the flood behaviour and the degree of potential impact on the development site is not known.

Simple assessments typically utilise simple techniques or modelling to establish an understanding of existing flood behaviour and assess the impacts of the proposed development on flooding and the existing community. They may include a check for key flood characteristics, including conveyance, hazard, flood storage and flood levels at a location based on a series of floods. One simple approach that may be suitable in some cases is to use cross-sectional analysis using representative pre- and post-development cross-sections, and existing flow information or flows determined using suitable techniques outlined in the current version of ARR. It should also consider the potential for changes in flow as part of the development.

The results of the analysis may:

- provide the information required to inform controls for the development proportionate with flood behaviour and the associated risks
- provide preliminary information on key flood characteristics at critical locations
- identify the potential for any significant adverse impacts to the existing community as a result of the proposed development. Where impacts are expected to be significant, a more detailed assessment would generally be warranted.

Where compatibility with relevant industry guidance or assessment criteria cannot be demonstrated, the development may need reconsideration, or a more detailed assessment may be required to examine impacts and management options.

This definition of a "Simple FIRA" defines the work detailed in this report, as the purpose is to better understand site flood risk in the context of the proposed subdivision. In future, a "Detailed FIRA" (Section 2.9 of Guideline LU01) may be required to support subsequent stages of the development.

Australian Rainfall and Runoff (Ball et al. 2019) (ARR 2019) is a national guideline used for the estimation of design flood characteristics in Australia. ARR 2019 and associated datasets including the ARR Data Hub (http://data.arr-software.org/) have also been used to support this assessment.

Maitland Development and Control Plan (MDCP) (Maitland City Council 2011) provides detailed provisions for development within the Maitland local government area. The MDPC stipulates the redisdential design requirements for flooding to which this flood assessment adheres.

KEY

- Site boundary
- Subdivision

Existing environment

- Train station
- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); DCSSS (2024); GA(2009); ESRI (2024)

0 1 2 km

GDA2020 MGA Zone 56

N

Site location

Signature Gardens Retirement Resort
Flood Risk Assessment
Figure 1.1

EMM
creating opportunities

2 Local Flood Risk

2.1 Site hydrology

The site is relatively flat, with a slight grade from east to west, and currently discharges to an existing channel running along the western boundary. Flow then continues along this channel before combining with flow from adjacent local catchments and crossing under the New England Highway via a large bank of culverts (3 x 1800 mm W x 1500 mm H).

Low points also exist along the northern site boundary, however the site does not currently drain to these locations. Flow that is generated here (i.e. at Dalby Lane and Aaron Cove) discharges either via pits and pipes or overland flow away from the site towards the north.

Local catchment delineation is defined in Figure 2-1.

The site has a local upstream catchment directly to the east (Catchment C), which extends to the local ridge line just beyond Adam Avenue. This catchment has an area of 9.5 ha. This catchment is urbanised medium density housing, with a pit and pipe network that diverts flows away from the project site, instead flowing to the south towards Catchment D.

It is this Catchment C that poses the greatest local flood risk to the site. This report quantifies the potential 1% annual exceedance probability (AEP) peak flow rate generated by this catchment assuming overland flow (Section 2.2 below). This is a conversative flow calculation, because a proportion of this flow will be drained away from the site via the pit and pipe network within Catchment C. This is shown in Figure 2-1 below, which shows the overland flow grades towards the site, while the pit and pipe network drains away from the site towards the south. 1D/2D hydraulic modelling of the local catchment (beyond the scope of this report) would provide a much more detailed understanding of this flow split.

Catchment F, north-east of the site, drains naturally to the channel north of the site and does not impact the site under local flooding conditions. Similarly, Catchments B, D and E are either disconnected or downstream from the site, and do not contribute to local inflows.

Catchment A is mostly made up of the site itself (both eastern and western segments of the proposed subdivision), with a small additional contributing area via the lot adjacent to the west.

Catchment B is immediately downstream of the site, and receives stormwater flows generated by the site under existing conditions. It mainly consists of the previously completed portions of Signature Gardens Retirement Resort. The outlet of Catchment B is the aforementioned large bank of culverts flowing under the New England Highway, and is the confluence of upstream catchments A, B, C and D. The total upstream catchment area at this catchment outlet at the New England Highway is 62.1 ha.

Catchment E does not interact with the site, draining under the New England Highway southeast of the Denton Park Drive / New England Highway roundabout.

Source: EMM (2024); DCSSS (2024); ESRI (2024)

Local catchment delineation

Signature Gardens Retirement Resort
Flood Risk Assessment
Figure 2.1

2.2 Local hydrologic modelling

2.2.1 Methodology

The local flood assessment for the project involved gaining an understanding of local sources of flooding and the design flow rates generated by the site and its surrounding catchments. To achieve this, a rainfall run-off model of the local catchment was developed using hydrologic modelling software package RORB. RORB processes design rainfall depths and catchment properties to generate run-off within each model sub-catchment. It then routes that run-off through the catchment, providing design flow rates at sub-catchment and catchment outlet locations.

Input data for the RORB model was sourced via the ARR Data Hub, and the RORB model was developed using ARR 2019 methodologies. Rainfall data was extracted via a single point at the centroid of the local catchment area. This includes loss values, ensemble temporal patterns and design rainfall data.

The rainfall intensity-frequency-duration (IFD) curves are provided in Figure 2-2.

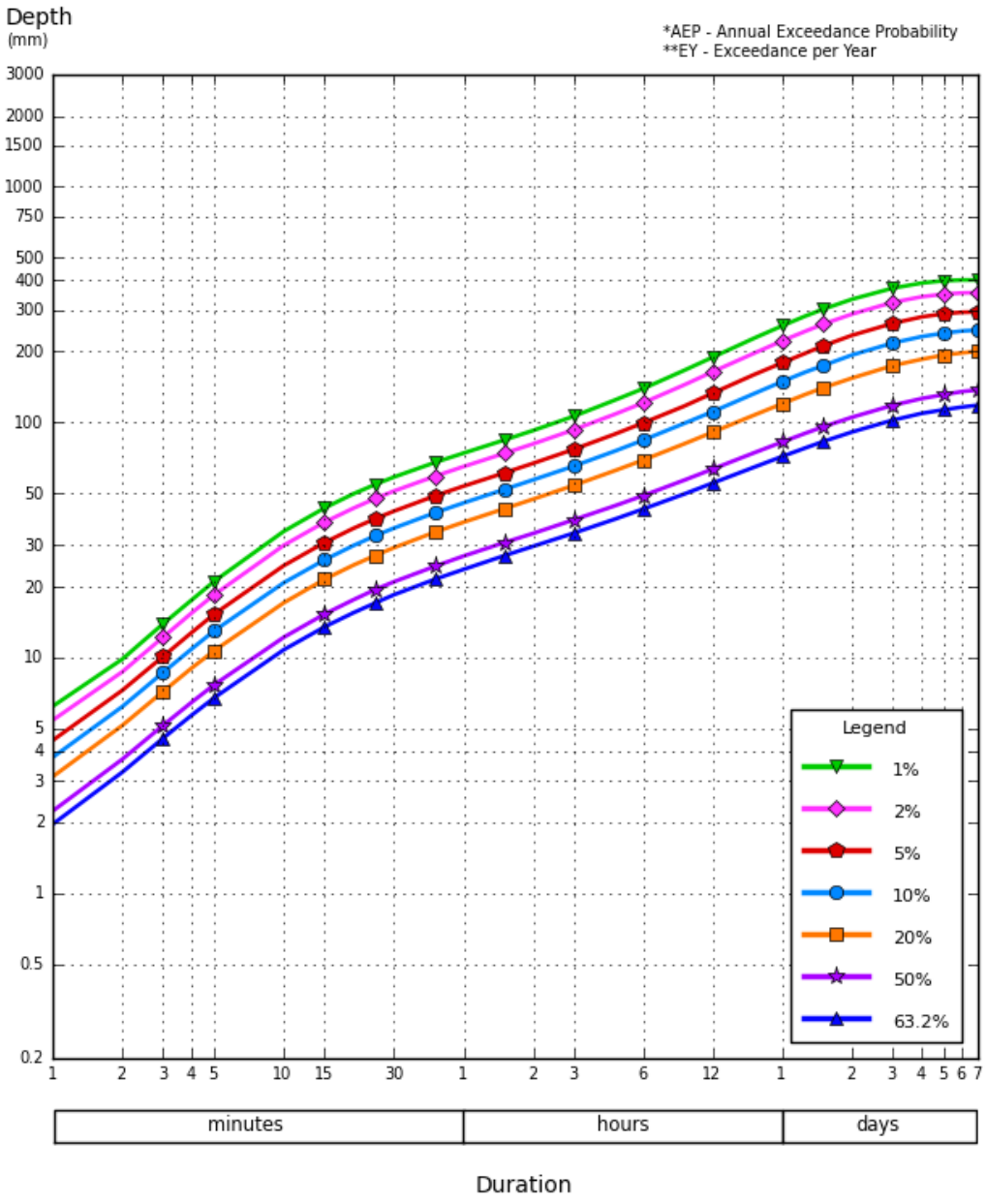


Figure 2-2: IFD Data for Local Catchment

Adopted rainfall loss values are shown in Table 2-1.

Table 2-1: Initial and continuing loss values

Loss Type	Adopted Value
Initial Loss	**8.0 mm**
Continuing Loss	2.8 mm/hr

Adopted RORB model parameters are shown in Table 2-2.

Table 2-2: RORB model parameters

Parameter	Adopted Value	Source
Kc	**0.95**	**ARR Book VII, Eqn 7.6.13**
m	0.8	ARR recommended value

Additionally, sub-catchment properties such as area, primary flow paths, and impervious proportions were calculated using geographical information software (GIS) and aerial imagery. LiDAR survey (collected 2012) was used to generate catchment topography and grading.

The local catchment delineation shown in Figure 2-1 was constructed in RORB, with the RORB conceptual model layout shown in Figure 2-3. The model was run for the 1% AEP event only, across a range of storm durations.

Pit and pipe networks were considered in the model in terms of sub-catchment connectivity and delineation. Detailed hydraulic modelling of local catchment pit and pipe networks was beyond the scope of this assessment, therefore the hydrologic modelling was performed without detailed pit and pipe data. This is a conservative assumption because the upstream catchment to the east, Catchment C, has a pit and pipe network that drains to the south towards Catchment D rather than towards the site, while overland flow from this catchment drains west towards the site eastern boundary. Reported peak flow generated by this catchment represent the total run-off from Catchment C (Table 2-3 below).

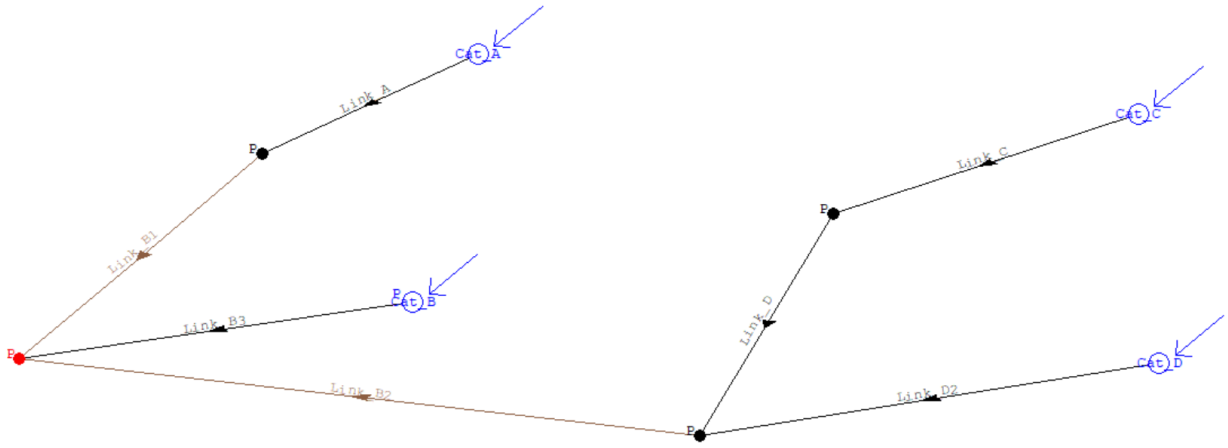


Figure 2-3: RORB conceptual model layout

2.2.2 Results

Results of the local catchment assessment are shown in Table 2-3, which summarises the catchment area and estimated 1% AEP peak flow rate at three key locations. Figure 2-4 shows ensemble results for the total catchment area draining to the New England Highway.

The flow rates provided give an indication of hydrologic conditions at the site under existing conditions. The local catchment assessment also provides consideration of the local catchment delineation and features as detailed above.

All calculated peak flow rates are for the 1% AEP event based on ARR 2019 data and methodologies. These flows were verified using the Regional Flood Frequency Estimate (RFFE) tool, which resulted in the modelled flow rate at the catchment outlet lying within the 5% and 95% RFFE confidence interval.

The proposed subdivision of the lot will have no impact on these results as no physical works will occur. Details such as local flood inundation extents, mitigation requirements and stormwater design are beyond the scope of this assessment. Further investigation will be required when the proposed development plans are being assessed for development approval.

Table 2-3: 1% AEP peak flow rates

Location	Catchment Area (ha)	1%AEP Peak Flow (m^3/s)	Description
Catchment C	9.5	5.4	Catchment upstream (east) of site
Catchment A	11.1	5.2	Flow generated by site
Catchment Outlet (A + B + C + D)	62.1	22.5	Flow crossing New England Highway

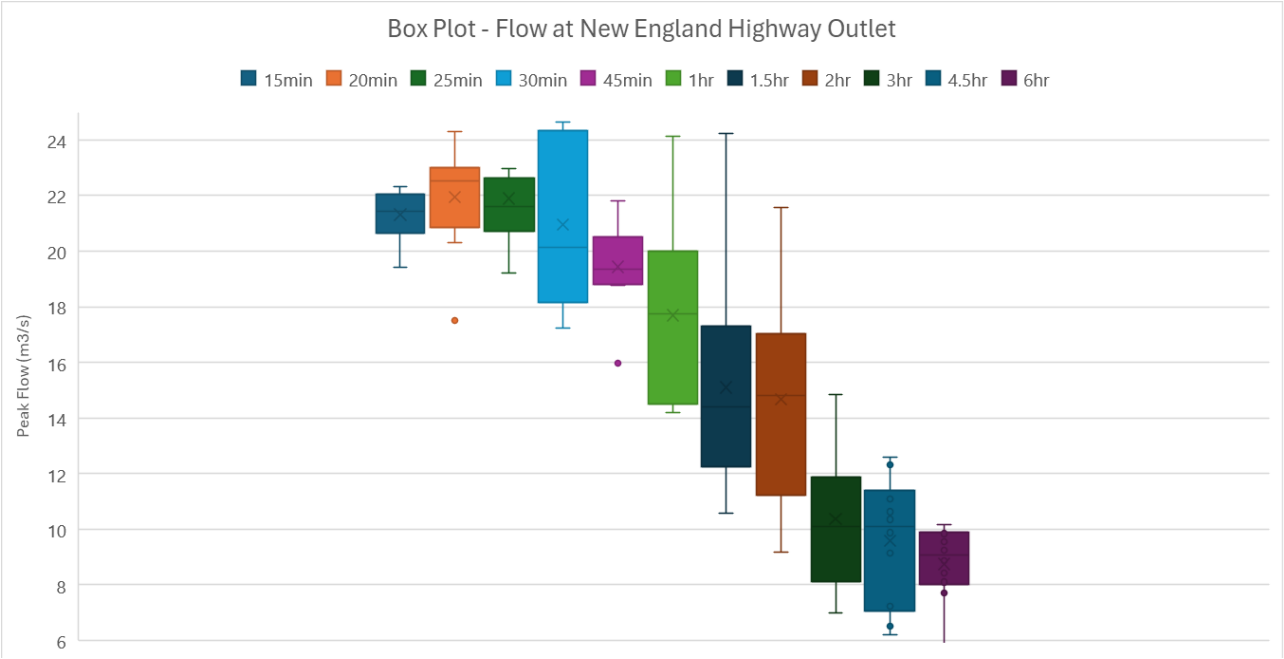


Figure 2-4: Box Plot - New England Highway catchment outlet - 1% AEP

3 Regional flood risk

3.1 Assessment approach

The regional assessment is based on existing flooding information pertaining to the Hunter River, applied to the site. Specifically, the *Hunter River– Branxton to Green Rocks – Flood Study* (WMAwater, 2010) is the regional flood report that includes the site within its study area.

WMAwater (2010 was produced based on flood modelling of the Hunter River using 1D/2D hydraulic modelling software TUFLOW. MCC provided EMM with a copy of this TUFLOW model, including all model and results files.

The scope of the regional assessment was to assess and interrogate the Hunter River Flood Study TUFLOW model data, and the extract hydraulic outputs relevant to the site and its proposed development. This information would then be used to interpret the results with respect to the potential for any significant adverse impacts to occur. The design event for this assessment was the 1% AEP, with no consideration of more frequent or more extreme events.

Interrogation and extraction of relevant model data provided information on flood extents, peak flood depths, design water levels, peak velocities and flood hazard. Details of these results are provided in Section 3.3 below.

3.2 Limitations and assumptions

3.2.1 Model veracity

MCC provided EMM with the existing Hunter River – Branxton to Green Rocks TUFLOW hydraulic model. While a basic check was performed by EMM to ensure overall model veracity, a detailed model review was beyond the scope of this study and was not performed. It was assumed that this model is of adequate quality to provide a basis for the site risk assessment covered in this report.

3.2.2 Model age and approach

It is understood the supplied TUFLOW model was developed in 2010. It is assumed that this modelling information remains applicable at time of writing in 2024. However, there have been many changes to flood modelling methods and datasets in that period, for example, the transition to ARR 2019 from previous editions, and improvements to software including TUFLOW. The supplied TUFLOW model is assumed to be the most up-to-date source of regional flooding information relevant to the site, therefore these changes have not been considered.

3.2.3 Catchment development status

Similar to the above, it was assumed that the hydrologic information that provides inflows to the TUFLOW hydraulic model is up to date. Therefore, any changes to developed areas throughout the Hunter River catchment since 2010 that may impact on impervious proportions were not considered.

3.2.4 Site topography

Site levels were derived from LiDAR survey collected in 2012. No additional and/or updated site survey data was provided. Therefore, this assessment was based on the LiDAR data, with visual inspection only occurring to confirm general site topography in 2024 compared with the 2012 LiDAR data.

3.3 Results

Results from the Hunter River TUFLOW model 1% AEP event as they apply to the site and the proposed subdivision are detailed below.

3.3.1 Inundation and design flood levels

Figure 3-1 below shows the peak flood depths and water levels from the regional flood event. It also shows the extents of the flood planning area (FPA), which is defined as the area of land below the flood planning level (FPL). The Maitland Development Control Plan 2011 defines the FPL as the 1% AEP flood level + 500 mm freeboard.

These results demonstrate that the site is not subjected to inundation from the 1% AEP regional event. Floodwaters extend to the natural channel just north of the site. At this location, approximately 750 m from the southern bank of the Hunter River, floodwaters are backwater with very low velocity. The 1% AEP flood level at this location is 19.5 m relative to Australian Height Datum (AHD), which is the same water level as the adjacent location in the Hunter River to the north.

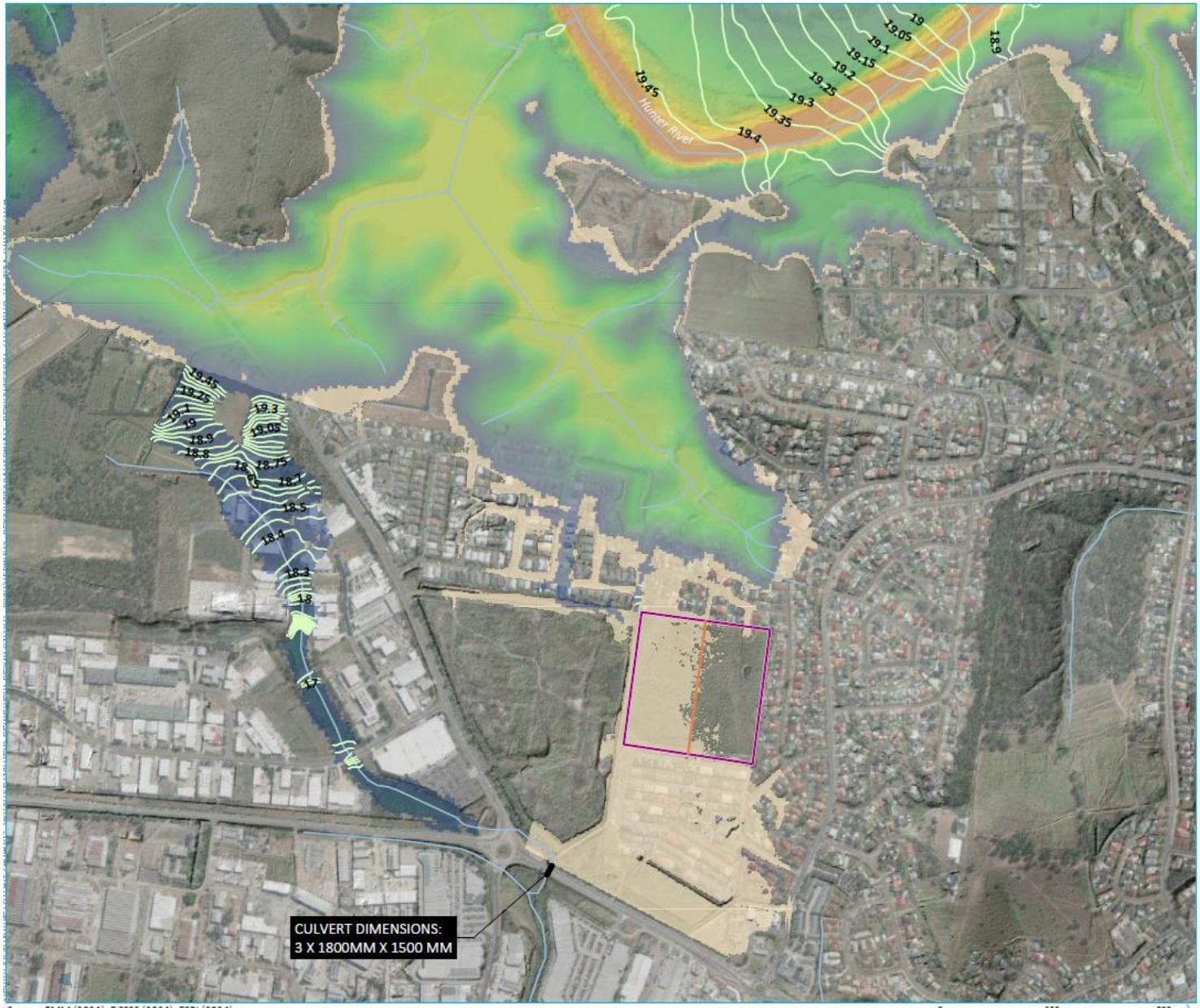
This water level defines the design 1% AEP regional flood level for the site. The FPL is defined as 500 mm above the 1% AEP flood level, therefore the defined FPL for any future proposed development on the site will be 20.0 m AHD.

The extents of the FPL are shown in Figure 3-1 below. This demonstrates that the eastern portion of the site is almost entirely unaffected by these extents, with a small section of the eastern subdivision (along the boundary in the north and south) falling just below RL 20.0m AHD.

The western segment of the subdivision is not inundated under 1% AEP flooding conditions, however the addition of the 500 mm freeboard then covers almost the entire western portion of the subdivision.

This is also shown in Figure 3-2 below, which provides a cross-section of the site topography in relation to the 1% AEP flood level and the FPL.

These results demonstrate that any future development of the eastern segment of the site will have no adverse flooding impact on surrounding properties for regional events up to and including the 1% AEP. All planned development will be required to be constructed at a level at or above RL 20.0 m AHD.



Source: EMM (2024); DCSSS (2024); ESRI (2024)

Peak depths and water levels, regional flood, 1%AEP

Signature Gardens Retirement Resort
Flood Risk Assessment
Figure 3.1

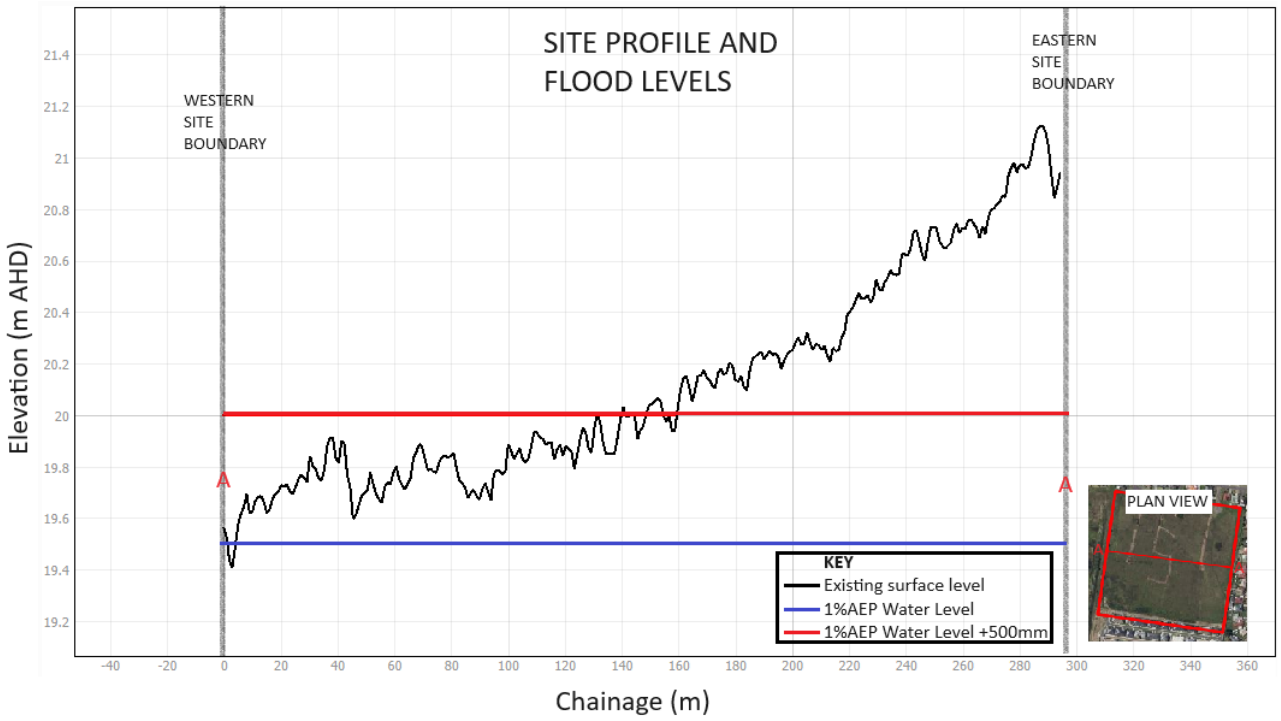


Figure 3-2: Long Section - Site Topography (west to east)

3.3.2 Velocities and flood hazard

The site is not inundated under 1% AEP flooding conditions, therefore velocities and flood hazard are non-existent and do not require consideration for the regional sources of flooding for events up to and including the 1% AEP.

3.3.3 Flood storage

Guideline LU01 references the requirement for flood storage offset in instances where a proposed development lies within an existing floodplain. The above results demonstrate that the site in its current state lies above the 1% AEP flood level of 19.5m AHD, and almost the entire eastern segment of the proposed subdivision lies above the FPL level of 20.0m AHD.

As a result, if future development is restricted to the eastern segment of the site (as is proposed), there will be no loss to floodplain storage volume for the 1%AEP event, or any smaller event. Additionally, if the flood storage requirements include the 500 mm freeboard to a design level of 20.0 m AHD, and the entire eastern segment is raised to 20.0 m AHD or above, only a small volume of storage offset will be required to offset the areas in the north-west and south-west corners of the eastern segment. This could feasibly be offset by providing the equivalent additional storage volume in the undeveloped western segment of the split lot.

This is applicable for the simple FIRA (Flood risk management guideline LU01, Section 2.7), which pertains to a subdivision.

It is a key assumption of this report that the western segment of the subdivided lot will remain undeveloped due to the larger flood risk of this segment compared to the eastern (proposed development) segment. Communications between EMM and MCC have confirmed that this will remain the case for the foreseeable future, with an understanding of the challenges that prevent future development of the western segment of the subdivided lot. However, if this assumption changes in the future, and development of the western segment is proposed, further investigation into potential flood risks and mitigation options is recommended.

4 Conclusion and recommendations

4.1 Subdivision flood risk

This report has provided an assessment of the local and regional flood risk to the project site, pertaining to the proposed subdivision. The proposed future use of this site (i.e. the Signature Gardens Retirement Resort Stages 12-20 development) has been considered, however this report refers specifically to the subdivision of the site, and does not consider conceptual or detailed designs for the proposed retirement resort.

For this site, the regional flood risk to the eastern segment of the proposed subdivision is minimal, as the entire site currently lies above the 1% AEP flood level of 19.5 m AHD, and only a small section of the eastern segment lies below the required flood planning level of 500 mm (i.e. 20.0 m AHD).

However, this is not true for the western segment of the subdivided site. This western segment is not the subject of this assessment, and it is assumed that this segment of the site will remain undeveloped indefinitely. As with the eastern segment of the site, it is not subject to inundation during the 1% AEP Hunter River design flood, but does almost entirely lie below the design level of 20.0 m AHD.

Therefore, flood risk of the proposed subdivision of Lot 2 DP 1243663, New England Highway, Rutherford in to two lots for the purpose of the future planned Signature Gardens Retirement Resort Stages 12-20 is considered low, with the following considerations:

a) Flood risk to the eastern lot is low, as detailed in this report

b) The western segment of the lot is assumed to remain undeveloped indefinitely

4.2 Future development

Beyond the considerations of the subdivision, the following should be adhered to in relation to the proposed Signature Gardens Retirement Resort:

a) Development should be restricted to the eastern subdivided lot only, as the western segment has greater flood risk

b) The flood planning level for the site is RL 20.0m AHD (i.e. 1%AEP water level + 500mm)

c) Any imposed flood storage requirements are met by offsetting flood storage volume (presumably by excavating additional flood storage volume on the western segment)

d) The proposed development is designed such that it can receive local flood flows (via the local catchment to the east of the site), and discharge these flows to the existing points of discharge

e) Other standard local run-off requirements are met for a stormwater management plan (e.g. flood storage to mitigate peak flows to match existing flow rates)

Additionally, the large culvert bank (3 x 1800 mm x 1500 mm) that runs under the New England Highway is the key hydraulic control for the local catchment. The culvert capacity is very large and may provide adequate drainage of downstream flows away from the site, noting however this has not been reviewed as part of the current assessment. However, if this culvert is blocked or damaged during either a large regional or local storm event, it will pose significant flood risk to the site. It is therefore recommended that the condition of this culvert be regularly checked by Council and the landowner to ensure functionality during a large storm event. Flood risk associated with culvert blockage will also need to be considered and potentially designed for as part of any future development proposal for the site.

4.3 Additional work

This assessment has provided insight into both local and regional sources of flood risk as they pertain to the subdivision of the site. It has not, however, considered designs for any proposed development of the Signature Gardens Retirement Village (neither detailed nor conceptual). Development approval of such plans may require additional hydraulic and hydrologic modelling to demonstrate compliance. These may include:

- Hydraulic modelling of upstream existing pit and pipe network
- Hydraulic modelling of design pit and pipe network
- Site-based stormwater management plan
- 1D / 2D hydraulic model of site to demonstrate compliant hydraulic impacts on neighbouring properties and to better understand inflows from the eastern upstream catchment
- Allowance for impacts of structure blockage and climate change
- Assessment of smaller and/or larger events other than the 1%AEP, including 5%, 0.2%, 0.5% AEP and PMF

This additional work will then draw from Section 2.9 of the Flood risk management guideline LU01, which references a detailed FIRA rather than the simple FIRA used for this report.

Work performed for this assessment can potentially be used as baseline / input data for any further hydraulic and hydrologic requirements. For example, the RORB rainfall run-off modelling can be used as upstream boundary conditions to a potential local 1D/2D hydraulic model, and the Hunter River regional hydraulic model could be used to apply downstream boundary conditions.

Additionally, the regional assessment detailed in this report is based on Hunter River hydraulic modelling from 2010. While this remains a the most current source of information, if this model is updated and/or superseded, this new regional flooding information should be used for the Signature Gardens site.

Any future assessments should also seek to include improved and/or updated topographical information. This could include updated LiDAR, detailed site survey, as constructed drawings / digital elevation models from surrounding areas, and digital elevations models of and proposed designs.

5 References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2019), *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia

Maitland City Control Plan (2011), Maitland City Council

NSW Department of Planning and Environment (2023), *Flood Impact and Risk Assessment – Flood Risk Management Guideline LU01*

WMA Water (2010), *Hunter River – Branxton to Green Rocks – Flood Study*, report prepared for NSW Department of Environment, Climate Change and Water, Maitland City Council, Cessnock City Council

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