Forbesview
School Road, Forbes
Flooding and drainage report

ForbesView Pty Ltd

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The Power of Commitment

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Executive Summary

This Flooding, Water Cycle Management and Riparian Corridor Assessment has been prepared as part of the precinct planning for the Forbes View Subdivision, within the town of Forbes, NSW.

Allera, on behalf of ForbesView, are preparing a Planning Proposal to rezone a 92 hectare parcel of land within the Forbes Shire Council, referred to as School Road, Forbes ('the Site')

This report has been prepared to outline the findings of the engineering investigations of the flooding and water cycle management. The strategy outlined in this report has been developed using an integrated approach to flood risk management, water cycle management and urban design based on the principles of water sensitive urban design (WSUD). The Indicative Layout Plan, prepared by Hatch (drawing H371649_MasterPlan230922), incorporates urban design features with flood risk management measures, along with drainage, landscape, vegetation, and habitat values, while addressing water quality targets.

Flooding

Flooding resulting from overland flow within the precinct boundary has shaped the layout of the precinct, with a section of the land within the precinct located under the 1% Annual Exceedance Probability (AEP) flood level.

The planning constraints resulting from the outcomes of the flood modelling investigations have been incorporated in the development of the Indicative Layout Plan that guide this planning proposal. These will be incorporated into the design of the subdivision upon rezoning and at the later design stages of this project. These flood constraints include allowance for flow paths within landscaped areas, restriction of residential and commercial development to areas not inundated during the 1% AEP flood event, and layout of the road network to allow flood evacuation during extreme flood events. There are no upstream catchments that drain to the site and the are no areas of the site mapped by Council studies as being affected by mainstream flooding.

Water Cycle Management

The objective of the water cycle management measures for the Forbes View Subdivision are to achieve the treatment targets for the reducing pollutant export loads to the requirements of Forbes Shire Council. The overall water management strategy for the Forbes View Subdivision involves the implementation of water sensitive urban design features, along with traditional drainage infrastructure to achieve the objectives.

Integrated water cycle management measures have been incorporated into the master planning and development controls, with the development of the Forbes View Subdivision Indicative Layout Plan incorporating the measures outlined in this report.

These measures incorporate source control features and a traditional pit, pipe, and overland flow network, including vegetated swales located within road corridors. The plan is shaped by constraints located within the precinct. Treatment to meet water quality targets is to be provided by a water quality (bio-retention) basins incorporating gross pollutant traps, filter media and vegetation. There is provision to include open water bodies.

The water quality modelling of the measures outlined in the Forbes View Subdivision Indicative Layout Plan indicate that the water cycle management have been designed as suitable to meet pollutant removal targets.

The results of technical investigations developed as part of the precinct planning process, and the modelling of the measures outlined in this report demonstrate that the precinct plan is suitable for consideration and approval.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.2 and the assumptions and qualifications contained throughout the Report.

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1. Introduction

This report has been prepared as part of the precinct planning process for the Forbes View Subdivision, within the town of Forbes, NSW. This report summarises the investigations into the flooding and overland flow paths, outlines the findings and proposed measures for water management on site, including recommendations for the water management features to be included within the two mains overland flow paths within the precinct.

1.1 Purpose of this report

The objective of this report is to present the strategy for management of flooding, drainage, and water quality from the Forbes View Subdivision, along with management measures to incorporate water cycle management features into the overland flow paths within the precinct.

The strategy outlined in this report has been developed using an integrated approach to flood risk management, water cycle management and urban design based on the principles of water sensitive urban design (WSUD), incorporating urban design features with flood risk management measures, along with drainage, landscape, vegetation, and habitat values, while addressing water quality targets.

Integrated Water Management outcomes are most effectively managed through incorporation of management plans into planning and development controls of future development areas. Effective master planning works in combination with drainage, water quality and flood management measures to achieve satisfactory planning outcomes for all stakeholders.

1.2 Scope and limitations

This report: has been prepared by GHD for ForbesView Pty Ltd and may only be used and relied on by ForbesView Pty Ltd for the purpose agreed between GHD and ForbesView Pty Ltd as set out in Section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than ForbesView Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1.3 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared the TUFLOW and MUSICX ("Models") for, and for the benefit and sole use of, ForbesView Pty Ltd to support preliminary flooding and water quality investigations and must not be used for any other purpose or by any other person.

The Models are a representation only and does not reflect reality in every aspect. The Models contain simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Models. Accordingly, the outputs of the Models cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data, and assumptions ("Inputs") used as inputs into the Models are from publicly available sources or provided by or on behalf of the ForbesView Pty Ltd, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Models as further Inputs becomes available.

The Models are limited by the mathematical rules and assumptions that are set out in the Report or included in the Models and by the software environment in which the Model is developed.

The Models are customised and not intended to be amended in any form or extracted to other software for amending. Any change made to the Models, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Models including any outputs.

GHD has prepared this report on the basis of information provided by ForbesView Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.3 Assumptions

The following assumptions have been made in the preparation of this report:

– The road layout shown on the indicative layout plan will be appropriate for the development.

– Earthworks will be possible on the site to facilitate the drainage features required for the development.

– The areas assigned for drainage will be able to be utilised for drainage, water quality improvement and flood mitigation at later design stages.

2. Project background

2.1 School Road, Forbes masterplan

Allera, on behalf of ForbesView, are preparing a Planning Proposal to rezone a 92 hectare parcel of land within the Forbes Shire Council, referred to as the Forbes View Subdivision, School Road, Forbes ('the Site'). The Site is legally identified as Lots 375, 376, 386, 387, 388, 389, 830, 831, 1272, and 1273 in DP 750158.

The immediate surrounding context exhibits a rural and large lot residential zoning. Other land uses in the vicinity of the Site include Catholic Healthcare Jemalong Residential Village, Jenny Murphy Park, Forbes High School, and Goldridge Estate – being developed by Forbes Shire Council.

The Site has been identified by Forbes Shire Council for future residential development and is included within Council's Draft Local Housing Strategy (LHS) 2021 – 2024.

The Draft LHS indicates that the Site could facilitate the development of upwards of 600 dwellings (including R5 Large Lot Residential portion). The Site is identified as Stage 4 and Stage 4a of Precinct 5 within the Draft LHS and identified for release in 2036. However, Council have indicated that they would support bringing this forward given the need for housing in the Forbes LGA.

2.1.1 Site description and constraints

The Site, shown on Figure 1, is located approximately three kilometres north of the town centre of Forbes, in NSW. The Site has an approximate area of 92 hectare and is bound on the west by Farnell Street, to the north by an electricity easement and School road, to the west by Edward Street and to the south by Morton Street.

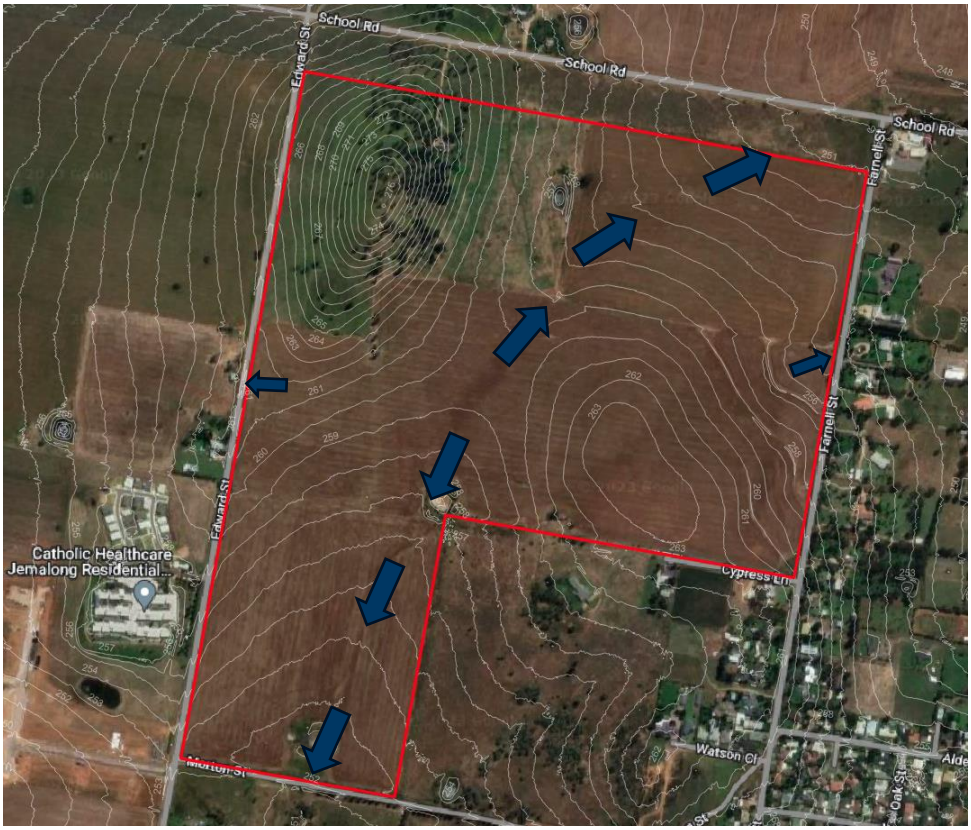

Figure 1 Existing features of the Site

The site is currently mostly used for agriculture and contains two hills. The hill located in the eastern area of the site has an elevation of approximately 263 metres AHD and gradient of approximately 1-2% and is used for cropping. The northwestern hill is relatively steeper, with grades up to 10% and an elevation of approximately 277 metres AHD. This hill is vegetated and not used for agricultural purposes.

The site is crossed centrally by ridgeline, a saddle between the two hills that roughly runs in a north-west to southeast direction. The site generally grades away from this ridgeline, the north-eastern area drains to the northeast, with the southwestern section draining to the south. There are no defined watercourses on the site and no upstream catchment draining onto the site. There are four overland flow paths and four discharge locations, with the main two are north and south, with two minor flow paths to the east on Farnell Street, and to the west on Edward Street.

There are several small farm dams on the site, one located off-line of the main flow path in the northern area of the site, with two located generally on the flow path to the south.

2.1.2 Indicative layout plan

The Indicative Layout Plan prepared by Hatch (on drawing H371649_MasterPlan230922) as part of the precinct planning process has been prepared to accommodate the input from planning and specialist studies, including this flooding and drainage assessment. The Indicative Layout Plan is provided in Figure 2.

Figure 2 Indicate Layout Plan prepared by Hatch

Key issues to note on the Indicative Layout Plan, as they relate to this flooding and water cycle management are:

– The location of the open water ponds and riparian corridor on the southern flow path (discussed in Section 4.3).
– The location of the central median swales and stormwater treatment basin for the northern flow path (discussed in Section 4.3.3).
– The road layout, incorporating roads to allow flood evacuation (discussed in Section 3.4.2).

2.2 Legislative and planning context

This section introduces the legislation and planning documents applicable to the project, providing explanations of how each relates to the development, including the relevant approvals required.

2.2.1 NSW Environmental Planning and Assessment Act 1979

This Act is the primary piece of land use and planning legislation in New South Wales. It allows for the creation, at various levels of government, of environmental planning instruments to control land use and planning. State environmental planning policies (SEPPs), regional environmental plans, Local Environment Plans (LEPs), development control plans (DCPs), and council codes and policies can all be established under Part 3 the Act. The rezoning of land as part of precinct planning is under Part 3 of the Act.

2.2.2 Water Act 1912 / Water Management Act 2000

The objects of the Acts aim to provide for the sustainable and integrated management of the water sources and to apply the principles of ecologically sustainable development. The Acts set guides for the preparation of water management plans and direct the NSW Office of Water in decision making. The NSW Office of Water is a separate office within the NSW Department of Primary Industries. It is responsible for the management of the State's surface water and groundwater resources. The Office reports to the NSW Government for water policy and the administration of key water management legislation, including the Water Act 1912 and Water Management Act 2000.

2.2.3 Water Management Amendment (Controlled Activities) Regulation 2008

This Regulation of the *Water Management Act* 2000 replaces the *Rivers and Foreshores Improvement Act* 1948 from 4 Feb 2008. Under this Regulation a *Controlled Activity Approval* (CAA) is required from the NSW Office of Water for works within 40 metres of top of bank of a defined watercourse.

A controlled activity permit is not required under this regulation, as there are no defined watercourses on the Site.

2.2.4 Local Government Act 1993

This Act creates local governments and grants them the power necessary to perform their functions, among which are the management, development, protection, restoration, enhancement, and conservation of the environment of the area the local government is responsible for, in a manner that is consistent with and promotes the principles of ecologically sustainable development. The *Local Government (Ecologically Sustainable Development) Act* 1997 amended the *Local Government Act* so that ecologically sustainable development, including the sustainable use of resources, is now a guiding operational principle.

The *NSW Flood Risk Management Manual: the management of flood liable land* 2022 relates to the management of flood liable land in accordance with Section 733 of the *Local Government Act*.

Approval for the Forbes View Subdivision is required from Forbes Shire Council under the Local Government Act 1993.

2.2.5 Forbes Shire Council Local Environment Plan 2013

LEPs are prepared in accordance with the requirements of the *Environmental Planning and Assessment Act* 1979. The LEPs set out zoning for land within the local government area and identifies planning objectives and development controls for each zone.

This Surface Water Assessment (and the EA) will make reference to the relevant components of the LEP where appropriate. Part 5.21 of the LEP outlines objectives, planning regulations and considerations with respect to flooding.

Under the Forbes Local Environmental Plan 2013, the land is currently zoned RU1 - Primary Production, R5 - Large Lot Residential, and RE1 - Public Recreation. A Planning Proposal is required to rezone the Site to facilitate future residential development.

2.2.6 Forbes Shire Council Development Control Plan 2013 (V2)

The *Forbes Development Control Plan 2013* (V2) applies to all land within the Forbes local government area where Council is the consent authority. This document was adopted by Forbes Shire Council on 21 June 2012 and became effective on 9 August 2013.

This document aims to preserve and protect the amenity and property of existing residents, landowners, and the community and to protect the physical environment and receiving waters of catchments. The DCP contains a separate chapter (Chapter 4) on Flooding and Flood Affected Land. Section 9 of this Flooding chapter outlines guidelines for flood risk management, including development controls for various types of development within flood risk zones as defined by Council. Map 2 of this section indicates that the site is not subject to flooding by the Lachlan River.

This plan also identifies potential flood affectation of immediately surrounding lands which are the subject of prescriptive development controls prescribed in Schedule 3 of the DCP.

These controls for Subdivisions include:

– The development is to be consistent with any relevant flood evacuation strategy.
– Engineers report required to certify that the development will not increase flood affection elsewhere.
– Provided existing drainage is maintained.
– Development shall not block the conveyance of flood waters across the floodplain.
– Filling of land up to 0.5 metres above Adopted Flood level permitted provided this does not result in any significant effect on the conveyance of flood waters.
– Filling of a maximum of a 1/3 of allotment up to 0.5 metres above the Adopted Rood level permitted provided this does not result in any significant effect on the conveyance of flood waters or flood levels.
– Applicant to demonstrate the at potential development as a consequence of a subdivision proposal can be undertaken in accordance with this Plan (DCP.

For houses within these subdivisions:

– Habitable floor levels to be equal to or greater than the Adopted Flood level plus 0.5m freeboard.

The adopted flood level for the DCP is the 1952 flood in Forbes under current land use and topography conditions. Detailed rainfall data for this event is not available.

2.2.7 New South Wales Flood Prone Land Policy

The primary objective of the flood prone land policy is to reduce the impact of flooding and flood liability of owners and occupiers of flood prone land. The policy adopts a merit-based approach for development decisions in the floodplain with consideration of social, economic, and ecological factors, as well as flooding considerations.

2.2.8 Flood Risk Management Manual 2022

The Flood Risk Management Manual (2022) updates and replaces the Floodplain Development Manual (2005) as the NSW Government's manual to support the NSW Government's Flood Prone Land Policy. The manual provides sustainable strategies for managing occupation and use of the floodplain, conserving risk management principles. The manual provides for evaluation of strategies and formulation of plans that achieve effective flood risk management outcomes accounting for social, economic, ecological, and cultural factors, together with community aspirations for the use of flood prone land. These are based on a hierarchy of risk avoidance, minimisation (using planning controls) and mitigation works. The manual applies to floodplains across NSW in both rural and urban areas and is used to manage major drainage issues in overland flooding areas.

2.2.9 Floodplain Risk Management Guidelines

These series of guidelines and other resources complement the Floodplain Development Manual and provide extra support to councils when they are creating and carrying out floodplain risk management plans. These guidelines include Flood Impact and Risk Assessment Flood Risk Management Guide LU01, discussed in Section 3.

2.2.10 Other relevant specifications and design guides

The documents outlined above are to be read in conjunction with the following:

– AS/NZ3500.3 Plumbing and Drainage – Stormwater Drainage
– Australian Rainfall and Runoff 2019
– Australian Runoff Quality (Engineers Australia)
– Building Code of Australia Housing Provisions (current edition)
– Managing Urban Stormwater – Soils and Construction (current edition)
– State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004

3. Flood investigation

To support this precinct plan, this report includes a ‘simple assessment” in accordance with Section 2.7 of the Department of Planning and Environment Flood Impact and Risk Assessment Flood Risk Management Guide LU01. This assessment is defined as:

> *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.*

Recommendations for additional investigations to be undertaken at later development stages are included in Section 3.5 of this report.

3.1 Data sources

This section of the document outlines the sources of data used in the flooding, water cycle management and riparian corridor investigations. Data used in the hydrologic and hydraulic modelling is presented in the Model Summary Sheet, provided in Appendix A.

3.1.1 Previous flood studies

The Forbes Flood Study Review was prepared by Lyall and Associates in May 2020 to review and update the findings of previous flooding investigations that have been carried out for Forbes.

The mapping in the Lyall and Assoc report on Figure 6.8 indicates that the Site is not inundated during the Probable Maximum Flood by flows from the Lachlan River or Lake Forbes.

The Cypress Lane to Lachlan River Flood Study was commissioned by Forbes Shire Council in 2001. This investigation identified perspective flood affected land which Council has identified for future acquisition purposes in the Forbes Local Environmental Plan 2012. This includes the Site, which is identified as flood liable land, shown on Figure 3, taken from Section 5.0 of the DCP (Site boundary shown in red).

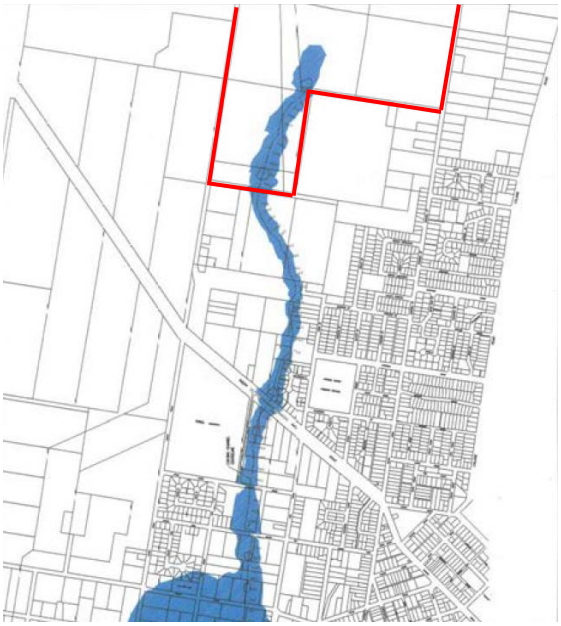

Figure 3 Flood mapping from Forbes DCP showing site boundary

3.1.2 Site investigations

A site inspection was carried out on 15 June 2023 by Nigel Bosworth of GHD. Observations include:

- The site does not have any defined flow paths or water courses.
- The agricultural area of the site is uniform in terms of roughness and gradient.
- The vegetated area has a slightly steeper gradient with rocks present at the surface, along with trees.
- The roadside swales are relatively uniform.
- Farnell Street is paved with a thin (~15-20 millimetre) layer of asphalt.
- School Road and Edward Street are unpaved.
- Morton Street is unformed.
- Piped culverts are located on Farnell Street, School Road and Edward Street are 450 millimetres in diameter, generally blocked and non-functional (noting that the culvert on Edward Street is not located at the low point in the road).

Culvert on Farnell Street (twin 450 mm diameter pipes)

Culvert on School Road (twin 450 mm diameter pipes)

Trapped low point on Edward Street (no culvert)

Culvert on Edward Street (450 mm diameter pipe)

Figure 4 Site photographs

The observations made during the site investigation have been used in the preparation of the hydraulic modelling.

3.1.3 Topographic data

Initial topographic data for the base model was obtained from the NSW Department of Land and Property Information, Spatial Data Services. Land and Property Information (LPI) have medium and high resolution orthorectified digital imagery from their Digital Image Acquisition System (ADS40) and Leica ALS50 (Airborne Laser Scanner) as well Digital Elevation Data across NSW using the latest Light Detection and Ranging Systems Technology (LiDAR), ADS40 Imagery, Radar, and or Satellite Technologies.

The airborne digital imagery used in this investigation were sourced from the LPI and have an 800 millimetre horizontal and 300 millimetre vertical resolution. The imagery used in this study is on tile BoganGate202104-LID1-AHD_5926308_55_0002_0002_1m. The data obtained from LPI was converted into a TIN using the *12d* software package and sampled into the *TUFLOW* model by the model engine at a one metre grid spacing for the entire Site.

Survey for the site was obtained by Zenith Construction Surveying, from field survey taken on 04-06-23. This survey data, shown on Drawing 8082_001 Rev 00, dated 11-06-23 has been incorporated into the TUFLOW modelling.

A grid size of 1.0 metre has been used in this investigation, with the grid aligned north-south/east-west.

3.1.4 Rainfall data

The Australian Rainfall and Runoff 2016 Intensity-Frequency-Duration (IFD) parameters have been downloaded from the Bureau of Meteorology website and used in the develop of the TUFLOW model for this assessment. Rainfall durations from 20 minutes up to 12 hours were assessed for the 1 in 100 (1% AEP) events within the hydrologic model boundary.

Coordinates entered into the IFD system were latitude -33.3565, Longitude 148.000.

As stated in Section 2.2.6, detailed rainfall data is not available for the “Adopted flood” which occurred in 1952. In lieu of this data, the 1% AEP rainfall event has been selected as the adopted flood level for the preparation of this report.

3.1.5 Buildings and structures

Buildings and other obstructions were modelled by mapping using aerial photography. A map showing the buildings identified within the model (yellow) is shown in Figure 5.

Figure 5 Building obstructions

Australian Rainfall and Runoff 2019 recommends completely removing building from models where rainfall volumes within building footprints are not significant. The approach to remove buildings has been used in this modelling investigation.

The culverts under roads surrounding the site (discussed in Section 3.1.2) have not been included in the hydraulic modelling due to their size relative to the flow rate and their blockage. The flow characteristics have been modelled with all flow travelling overland.

3.1.6 Land use/roughness

A uniform Manning's roughness (n) was used in the hydraulic model of 0.05 based on site observations. This roughness values are adopted from the Table 6.2.2. Valid Manning 'n' Ranges for Different Land Use Types in Book 6 of *Australian Rainfall and Runoff* 2019.

3.1.7 Losses

Probability neutral loss Initial losses for different storm events and duration as well as continuing losses of 1.52 mm/hr have been obtained from the ARR Data Hub (http://data.arr-software.org/). A multiplication factor of 0.4 was adopted for continuing loss as recommended by ARR Data hub-NSW Specific Data info.

3.1.8 Boundary conditions

The downstream extents of the hydraulic model have been located at a distance of between 200 to 600 metres downstream of the Site boundary in north, east, south, and west directions. The downstream boundary conditions were configured as a water level vs. flow (HQ) boundary, representing a free-discharge boundary condition with no tailwater.

This approach was used in the modelling as the location of the downstream boundary is approximately 5-10 metres lower than the property boundary. This would not impact the flood hydraulics at the boundary.

3.2 Modelling methodology

This investigation used the application of rainfall directly onto the grid of the two–dimensional hydraulic model within the *TUFLOW* flood modelling software (Build 2020-10-AF). This methodology is known as the direct rainfall approach or 'rainfall on the grid.' This approach removes the need for a separate hydrological modelling package.

In traditional flood modelling, separate hydrological and hydraulic models are constructed. The hydrological model has inputs of rainfall, area losses and roughness within a lumped or partially distributed sub–catchment, calculating runoff hydrographs for modelled storm events. This hydrograph is then applied to the hydraulic model, which performs flow calculations based on hydraulic features to develop estimations of flood behaviour across the study area.

In the direct rainfall approach, the hydrological model is either partially or completely removed from the process. The hydrological routing is undertaken in the distributed two–dimensional model, rather than in a lumped hydrological package.

3.3 Flood modelling results and mapping

The flood extent map for existing conditions calculated in the hydraulic modelling of the 1% AEP flood event, is presented on Figure 6.

The results of the flood mapping presented on Figure 6 indicate that the flooding within the Site boundary is generally isolated to within the two main flow paths (north-east and south).

Peak discharge at the site boundaries are presented in Table 1

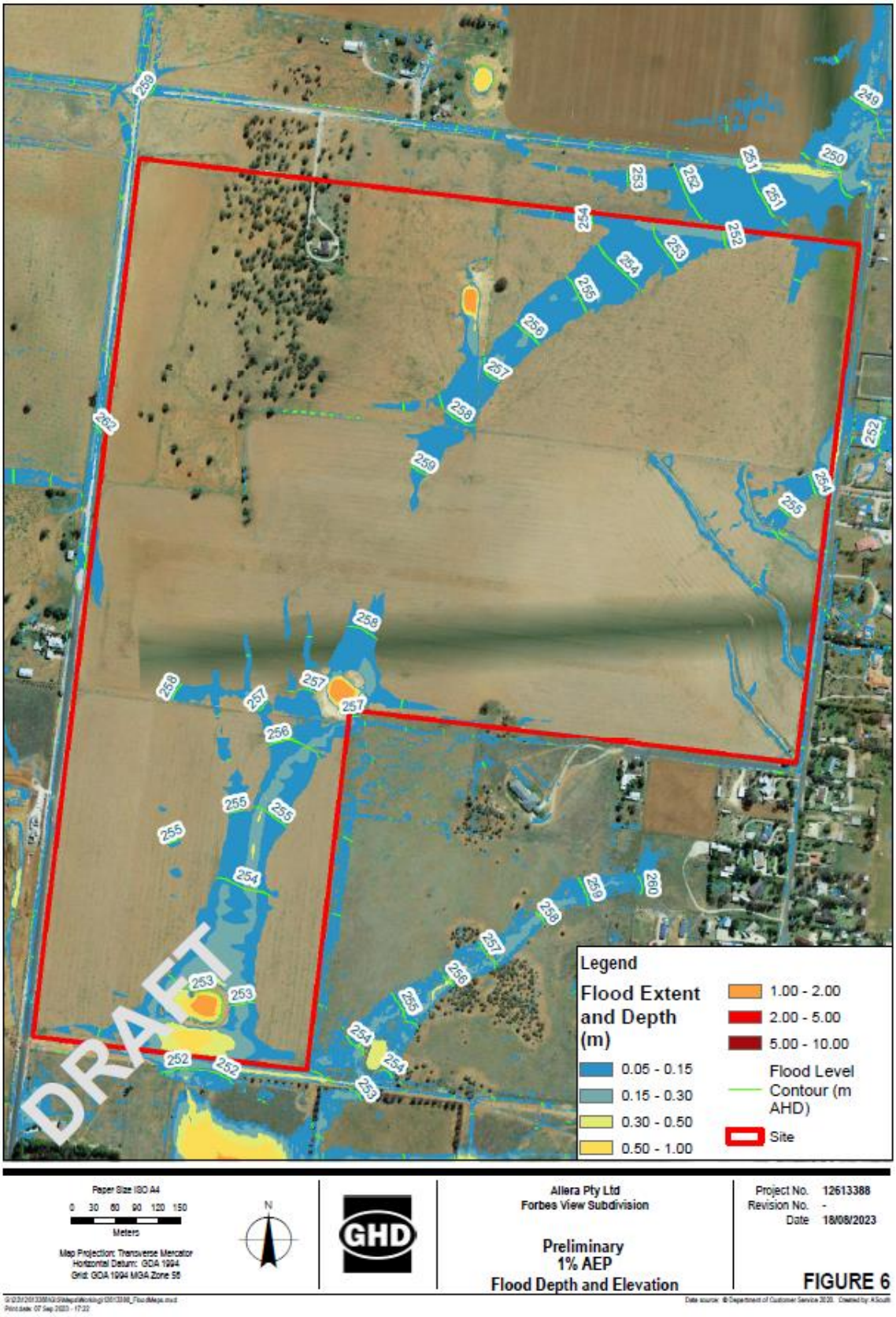

Figure 6 *Preliminary 1% AEP flood map (existing conditions)*

Table 1 Peak flow rates at Site boundaries

Location	Peak flow rate (m^3/s)
Northern boundary (School Road)	4.98
Eastern Boundary (Farnell Street)	1.67
Southern Boundary (Morton Street)	6.92
Western Boundary (Edward Street)	0.7

Maximum depths in the northern flow path are generally around 0.15 metres, which is generally classified as shallow flow. Maximum depths in the southern flow path are up to 0.3 metres in the northern, upstream area and up to 0.5 metres in the southern area downstream of the southern on-line dam. Ponding within the on-line dams is up to 1.5 metres.

Some contour grading on the eastern side of the Site results in minor ponding and redirection of flows in the 1% AEP event. No flow from upstream enters the Site in the 1% AEP event.

The discharge location on the eastern side of the site results in flooding within properties on Farnell Street. Minor ponding and flooding occur to the west of the site on Edward Street, with the overland flow continuing to the west along a property boundary.

3.4 Flood planning masterplan outcomes

The planning constraints resulting from the outcomes of the flood modelling investigations carried out as part of the precinct planning process have been incorporated in the development of the Indicative Layout Plan. These flood constraints include:

– Earthworks and drainage infrastructure to direct and manage flows within the site for the range of storm events.
– Incorporation of detention basins and flow mitigation measures to ensure peak flow rates for design developed conditions do not exceed those modelled for existing conditions.
– Restriction of residential and commercial development to areas not inundated during the 1% AEP flood event for design conditions.
– Layout of the road network, including central median swales located within the roads, to allow passage of flood flows during extreme flood events.
– Layout of the road network to allow flood evacuation during extreme flood events.

The developed scenario flood modelling will be undertaken to ensure that the precinct layout (shown on the Indicative Layout Plan but subject to change as part of the ongoing design process) does not result in inundation of areas that proposed to be developed.

3.4.1 Flood planning levels

Flood planning levels within the Forbes View Subdivision will be developed in accordance with Chapter 4 – Flooding and Flood Affected Land of the *Forbes Development Control Plan 2013* (V2). Flood planning levels will be set above the adopted flood level, the 1% AEP rainfall event:

– Habitable floor level 100 year flood elevation + 0.5 metres
– Garage floor level 100 year flood elevation + 0.1 metres

The flood planning level requirements will be applicable to both Residential and Industrial/Commercial Areas within the precinct.

3.4.2 Flood evacuation plannings

The road layout shown on the Indicative Layout Plan has been designed to allow movement of people and vehicles from lower lying areas centrally with the precinct to higher ground located on the western and eastern edges of the development area. The higher ground within the precinct is located above the 1% AEP Flood level (shown on Figure 6), allowing safe refuge. This study has not been prepared for submission to the SES but has been prepared as a preliminary study to guide further investigations.

3.5 Further investigations

This preliminary flood investigation has mapped existing flood characteristics for the site and identified the site as suitable for rezoning to residential development, as presented on the Indicative Layout Plan prepared by Hatch. The drainage and flood management measures will be updated as the design of the Forbes View Subdivision progresses, with additional investigations to occur at later design stages. The flood modelling and drainage design additional investigations will include:

– The civil design including earthworks for building pads and roads.
– The pit and piped drainage network to be designed and included within the flood model.
– Design of drainage along eastern side of site to re-direct flows to northern basin and avoid increase in flood flow rates during large events.
– Layout to allow drainage along swales within streets and other water sensitive urban design features.
– Riparian corridors and overland flow paths to allow safe passage of flood waters within the Site.
– Central median swales sized to safely accommodate flood flows.
– Detention basins to be sized to limit flows to pre-developed levels given in Table 1.

Incorporation of the measures outlined in this report into the design of Forbes View Subdivision, will allow the development to proceed in accordance with the relevant State and local flood management requirements.

4. Water cycle management plan

This section outlines the strategy and measures that are proposed as part of the Forbes View Subdivision that will meet the water management and pollution removal targets set by Forbes Shire Council.

Consultation with Forbes Shire Council as part of the precinct planning process, involving a meeting held on 4 August 2023 have indicated that standard pollutant removal targets used throughout NSW and Australia will be appropriate for Forbes View Subdivision.

Rainwater tanks, vegetated swales located within the central median of roads, and bio-retention basins have been modelled based on providing treatment for all development areas, including commercial and residential areas. This strategy has been developed in order to maximise the developable land above flood planning levels by utilising land flooded by local flooding for water quality measures and recreation.

4.1 Objectives

The objective of the water cycle management measures for the Forbes View Subdivision are to achieve the treatment targets for the reducing export loads to the requirements of Forbes Shire Council.

The per cent reduction in pollutant load targets for the project are from the *Sydney Metropolitan Catchment Management Authority, Draft NSW MUSIC Modelling Guidelines:*

– Gross pollutant (>5 mm) 90%
– Total suspended solids 85%
– Total phosphorus 65%
– Total nitrogen 45%

These targets are consistent with other stormwater documentation in NSW and were selected at the meeting held on 4 August 2023 with Forbes Shire Council as appropriate for the development of Forbes View Subdivision.

4.2 Strategy

The overall water management strategy for the Forbes View Subdivision involves the implementation of water sensitive urban design features, along with traditional drainage infrastructure to achieve the objectives for water quality. Stormwater and drainage measures within the precinct will include the following components:

– Source control features including rainwater tanks, street trees and permeable landscape features.
– Transfer of flows through a traditional pit, pipe, and overland flow network.
– The use of central median swales within the road network for conveyance of high flows and treatment of stormwater.
– Water quality (bio-retention) basins incorporating gross pollutant traps, filter media and vegetation, including provision for open water bodies where space is available.
– Discharge from the system to existing flow paths, including from the southern flow path to the receiving environment of Lake Forbes.

Preliminary designs for the infrastructure required to all the water cycle management system to meet the objectives have been prepared as part of this study in order to determine the impacts on development patterns within the precinct. These preliminary designs are discussed in detail in Section 4.3.

4.3 Water management infrastructure

This section outlines the preliminary design of water management infrastructure undertaken as part of this study.

The potential for water management infrastructure to place constraints on the pattern of development has been assessed at this precinct planning stage, in order to facilitate more detailed design of drainage infrastructure at later precinct design stages.

The preliminary design and layout of the water management infrastructure has been part of the preparation of the Indicative Layout Plan, with the development of the drainage and layout plans occurring in consultation with Hatch. The catchments have been mapped based on the existing and assumed design topography and the road layout in the Indicative Layout Plan shown on drawing H371649_MasterPlan230922, annotated with the water management features identified on Figure 7.

The water cycle management measures proposed for Forbes View Subdivision are discussed in Sections 4.3.1–4.3.6.

4.3.1 Rainwater tanks

Water quality treatment to manage runoff will be incorporated at source by the use of rainwater tanks on dwellings, Forbes Shire Council require that all residential, industrial, and commercial developments install rainwater tanks. Rainwater tank or tanks will be included in the design of residential, commercial areas within the Forbes View Subdivision to harvest roof runoff to be reused for toilet flushing and external irrigation.

The roof runoff will be collected in standard roof guttering and collected in rainwater tanks draining to a *Building and Sustainability IndeX* (BASIX) compliant reuse system. In addition to this BASIX requirement, the Forbes Subdivision will require the same requirement as Council specified for Goldridge Estate, i.e. that an additional 3000 litre storage is incorporated over and above BAISX requirements. For the purposes of this design, and the lot sizes being smaller than 1000 m^2, this is assumed to require a 5500 litre tank on each property.

Overflow from the roof drainage capture system will drain to the pit and pipe drainage network where it will be discharged into the precinct bio-retention basins.

4.3.2 Pit pipe and overland flow path drainage system

Stormwater runoff from lots and roads in excess of the capacity of source control measures will be directed to a trunk drainage system for minor storm events in a conventional pit and pipe system. Preliminary pipe sizes calculated based on the Indicative Layout Plan road and catchment layout will be prepared at later design stages, as discussed in Section 3.5.

Pipe diameters will be designed in accordance with Forbes Shire Council guidelines, including gradient and cover requirements. The overland flow network has been incorporated into the road layout of the Indicative Layout Plan. This road layout has been designed to allow free drainage of all roads. The road layout shown on the Indicative Layout Plan prepared by Hatch (shown on drawing H371649_MasterPlan230922, on Figure 7) avoids trapped low points, which can result in localised flooding.

4.3.3 Central median swales and street trees

A vegetated, central-median swale incorporating street trees will be included into the road design where required, with details included on the road design and landscape drawings. The vegetated swale, including the street trees will be irrigated passively by allowing for breaks in kerbs, with the paved road surface graded to drain to landscaped central median, which will incorporate and scour protection at the edge of the landscaped bed. This swale has been modelled within the *MUSICX* models discussed in Section 4.4 and will be incorporated in later designs of the subdivision, potentially reducing the area of bio-retention basin required.

Due to site grade and area constraints on the northwestern side of the Site resulting in basins not being a feasible option for water quality improvement, central median swale have been designed to provide all treatment prior to discharge at the western boundary.

Figure 7 *Water management features identified on Indicate Layout Plan prepared by Hatch*

4.3.4 Riparian corridor/open space in south of the Site

The drainage corridor for the southern flow path incorporates water management features along with habitat, recreation, and community amenity facilities. These features include the two water quality basins, along with vegetated channels and open water in ponds.

4.3.5 Redirection of flow to east

Constraints on the eastern side of the site require the development area that would under existing topographic conditions, drain to the eastern boundary on Farnell Street, be redirected to northern basin. This northern basin will provide quality and quantity treatment to the flows, limiting export of pollutants to target rates and flow rates to pre-development rates.

The redirection of flows will be designed to not increase flooding in 1% event in properties to the east of the site, on Farnell Street.

4.3.6 Water quality basin strategy

Water quality basins proposed for the Forbes View Subdivision are bio-retention systems, to be designed in accordance with the requirements of Forbes Shire Council. Bio-retention basins (also known as bio-retention systems, bio-filters, and rain gardens), are a form of natural water treatment that use natural processes to achieve water quality improvements from stormwater flows.

Bio-filtration systems use vegetated soil-based filters to attenuate flows, reduce runoff volumes, and improve water quality through sedimentation, filtration, sorption, and biological uptake by reed and sedge types of vegetation. Bio-retention basins have advantages over open water treatment systems such as wetlands or ponds due to decreased risk to human health via contact with untreated water. This lack of open water also provides mosquito control, odour control and minimises wildlife interactions with polluted water.

The design of bio-retention basins for the Forbes View Subdivision will be prepared in detail in later development stages and will incorporate typical design features including:

– Gross pollutant trap.
– Flow distribution/inlet structure.
– Bio-retention filter comprising of:
  - Filter media (coarse sand and organic material).
  - Planting (grass and sedge species to remove pollutants).
  - Sub-soil drainage and flow collection.
– Outlet and discharge location to creek.
– Maintenance access path for vehicles.

The design of basins within the Forbes View Subdivision will receive flows from the developed sub-catchments, directed to a splitter pit, or high flow weir. This weir directs high flows away from the bio-retention basin to prevent damage to the vegetation and filter media during high flow, high energy events. Flows lower than the design recurrence interval (to be set at four exceedances-per-year or the three month peak event) will be directed to a gross pollutant trap (GPT). The purpose of the gross pollutant trap is to remove litter, debris, and sediment to prevent blockage of the basin. Flow from the gross pollutant trap will be directed through a pipe network into a bio-retention treatment area. Flow in excess of the design event pass bypass the basin.

The bio-retention areas located downstream of the gross pollutant trap will be designed to incorporate several treatment cells. Flow from the gross pollutant trap will be distributed evenly within the cell or cells through a combination of pipe network, weirs, scour protection or flow spreaders. Water levels within the cells will be managed through hydraulic connections set at bio-retention cell operating level.

The bio-retention cell consists of a filter media, an enriched coarse sand, planted with nutrient removing vegetation. Nutrient removal occurs through sorption to soil particles, decomposition by subsoil biota, and removal by plants. An extended detention depth (ponding above the filtration media) will be provided to increase treatment volumes within a basin.

Potential open water areas have been incorporated in the layout. The development urban design features include open water to be incorporated into stormwater basins within the Forbes View Subdivision for aesthetic reasons and for possible stormwater re-use.

Northern basin

The northern basin, presented on Figure 7 is located in the northeastern area of the Forbes View Subdivision and takes drainage from the catchment to the north of the ridge line, discharging at the northeast corner of the site. The basin has been sized with a total filter area of 1500 m^2. This filter area has been modelled (in Section 4.4) to reduce pollutant export from the catchment to meet the pollutant removal targets presented in Section 4.1.

The northern basin is located within the landscaped area at the northeastern corner of the Forbes View Subdivision and could potentially be incorporated into an area of open space for recreation purposes.

Southern basin - upstream

The upstream southern basin, presented on Figure 7 is located in the central area of the Forbes View Subdivision and takes drainage from the catchment to the south of the ridge line to the main east west road, discharging into the open water body located in the northern area of the space/riparian corridor. The basin has been sized with a total filter area of 500 m^2 and an open water body of 1200 m^2. This filter area has been modelled (in Section 4.4) to reduce pollutant export from the catchment to meet the pollutant removal targets presented in Section 4.1.

The upstream southern basin is located within the northern area of the space/riparian corridor of the Forbes View Subdivision and could potentially be incorporated into an area of open space for recreation purposes.

Southern basin - downstream

The downstream southern basin, presented on Figure 7 is located on the southern boundary of the Forbes View Subdivision and takes drainage from the catchment to the south of the main east west road, discharging into the open water body located upstream of the southern boundary of the site. The basin has been sized with a total filter area of 500 m^2 and an open water body of 1000m^2. This filter area has been modelled (in Section 4.4) to reduce pollutant export from the catchment to meet the pollutant removal targets presented in Section 4.1.

The downstream southern basin is located within the southern area of the space/riparian corridor of the Forbes View Subdivision and could potentially be incorporated into an area of open space for recreation purposes.

4.4 Water quality modelling

Preliminary water quality modelling of the precinct water infrastructure presented on Figure 7 has been undertaken during the preparation of the Indicative Layout Plan. This modelling of the preliminary design, undertaken using the *MUSICX* water quality modelling software (Version 1.10.0.12491) has been prepared in accordance with the water quality targets selected for the Forbes View Subdivision and is used to determine the required bio-retention areas needed to meet the pollutant removal targets presented in Section 4.1. The results of the MUSICX modelling are presented in Table 2.

Table 2 Preliminary MUSICX modelling results

Discharge location	Pollutant removal target	Northern discharge	Western Discharge	Southern Discharge
Gross Pollutant	90%	99.5%	100	100
Total suspended solids	85%	89.8%	93.4	92.0
Total Phosphorus	65%	66.5%	70.2	73.25
Total Nitrogen	45%	51.7%	45.4	54.4

The results of the modelling in in Table 2 indicate that the water cycle management system incorporated in the Indicative Layout Plan prepared by Hatch (shown on drawing H371649_MasterPlan230922) shown on Figure 7 has been designed to address the pollutant removal targets presented in Section 4.1.

The layout of the basins and bio-retention areas will be updated for later design stages and may also include open water to use in water harvesting, along with open space for recreation. This may result in modifications to the filter area, dependent on the area of open water proposed, usage rates of the water, along with any additional treatment measures.

4.5 Water cycle management masterplan design outcomes

The planning outcomes resulting from the water cycle management study and design carried out as part of the precinct planning process have been incorporated in the development of the Indicative Layout Plan. These measures include:

– Incorporation of source control features including rainwater tanks. street trees and landscape features.

– Layout of roads to facilitate a traditional pit, pipe, and the central median swale overland flow network.
– A total of three water quality (bio-retention) basins incorporating gross pollutant traps, filter media and vegetation, including open water bodies for the potential re-use of harvested stormwater for irrigation.

The developed scenario water quality modelling indicates that the precinct layout shown on the Indicative Layout Plan will incorporate water cycle management features able to meet pollutant removal targets.

4.6 Further water quality investigations

This preliminary drainage investigation has developed water quality targets for the site and identified the site as suitable for rezoning to residential development, as presented on the Indicative Layout Plan prepared by Hatch. The drainage and water quality improvement measures will be updated as the design of the Forbes View Subdivision progresses, with additional investigations to occur at later design stages. The flood modelling and drainage design additional investigations will include:

– Design of central median swales, where required including sizing for conveyance and treatment.
– Design of channel in southern flow path and open water ponds.
– Design of bioretention basins for water quality including:
  - Gross pollutant trap.
  - Flow distribution/inlet structure.
  - Bio-retention filter comprising of filter media (coarse sand and organic material), planting (grass and sedge species to remove pollutants), sub-soil drainage and flow collection.
  - Outlet and discharge location to creek.
  - Maintenance access path for vehicles.

5. Conclusions and recommendations

The Forbes View Subdivision prepared by Hatch (shown on drawing H371649_MasterPlan230922) shown as part of the precinct planning process has been prepared to accommodate the input from planning and specialist studies, including this flooding and drainage assessment. The Indicative Layout Plan is provided on Figure 2.

Key issues to note on the Indicative Layout Plan, as they relate to this flooding and water cycle management are:

– The location of developed land, above the 1% AEP flood level (discussed in Section 3).
– The location of stormwater treatment basins and central median swales within roads (discussed in Section 4).
– The road layout, incorporating roads to allow flood evacuation (discussed in Section 3.4.2).

Flooding

The planning constraints resulting from the outcomes of the flood modelling investigations carried out as part of the precinct planning process have been incorporated in the development of the Indicative Layout Plan. These flood constraints include:

– Restriction of residential and commercial development to areas not inundated during the 1% AEP flood event.
– Layout of the road network to allow flood evacuation during extreme flood events.

The developed scenario flood modelling will be required at later design stages to ensure that the precinct layout does not result in inundation of areas that are not flooded in existing conditions.

Water Cycle Management

The planning outcomes resulting from the water cycle management study and design carried out as part of the precinct planning process have been incorporated in the development of the Indicative Layout Plan. These measures include:

– Incorporation of source control features including rainwater tanks. street trees and permeable landscape features.
– Layout of roads to facilitate a traditional pit, pipe, and the central median swale overland flow network.
– A total of three water quality (bio-retention) basins incorporating gross pollutant traps, filter media and vegetation, including open water bodies for the potential re-use of harvested stormwater for irrigation.

The developed scenario water quality modelling indicates that the precinct layout shown on the Indicative Layout Plan will incorporate water cycle management features able to meet pollutant removal targets.

Recommendation

The Indicative Layout Plan for Forbes View Subdivision prepared by Hatch incorporates measures to address the flooding, drainage, and water quality requirements for approval by the Forbes Shire Council and other stakeholders. The results of technical investigations developed as part of the precinct planning process, and the modelling of the measures outlined in this report demonstrate that the Forbes View Subdivision is suitable for consideration and approval by relevant determining authorities.

Appendix A

Model summary sheet

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