From:	William Hodgkinson
To:	Andrew Cowan
Cc:	Sheelagh Laguna; Bianca Thornton; Travis Lythall; Stephen O"Connor; Paul Solomon
Subject:	SSD 9667 Kemps Creek Warehouse, Logistics and Industrial Facilities Hub
Date:	Friday, 23 August 2019 4:15:00 PM
Attachments:	Peer Review.pdf

Hi Andrew,

Please find attached the peer review of the Overland Flow Report, undertaken by an independent expert. It is requested that the RtS report includes a response to each of the matters raised within Section 5 – Conclusions and Recommendations.

Additionally, the Department provides the following comments, also to be responded to within the RtS Report.

General Comments

- The flood report prepared by Costin Roe does not appropriately consider the relationship the South Creek Catchment plays with the Hawkesbury-Nepean Floodplain and the significant risk to life that already exists.
- The report has not looked into the vulnerability of the proposed warehouses to failure in more extreme flood events (above that of the 1% AEP), nor has the report undertaken National best practice flood vulnerability mapping, which would demonstrate the impacts of the building types vulnerability to failure at all flood events.
- The report has not considered the nation best practice handbook 'Managing the floodplain: A guide to best practice in flood risk management in Australia' – Handbook 7 – Australian Institute for Disaster Resilience, 2017.
- The report does not take into consideration the impact of the already built neighbouring property and how the changes to the flood behaviour might impact on the assumptions made in this report.
- Infrastructure NSW is undertaking a cut/fill analysis of the South Creek catchment to determine the level of cut/fill that can occur before it impacts on the flood behaviour and Hawkesbury-Nepean floodplain for the full range of events. Without an in-depth analysis and study of the impacts of cut and fill on the floodplain, any cut and fill in south creek (both above or below the 1% AEP) may lead to increases in loss of life for those in the Hawkesbury-Nepean floodplain in severe to extreme flood events. Until the Infrastructure NSW cut/fill analysis is completed, the full impacts of the cumulative effects of cutting/filling the floodplain are unable to be quantified.

Detailed Comments

- Page iii of the Costin Roe Consulting document states that '*The modelling confirms the outcomes of the flood assessments completed and approved for the First Estate under SSD7173 are generally maintained. A minor difference of between 0.010-0.020m only is noted around the southern extent of the now constructed First Estate. It is important to point out that this increase is located within the high hazard flood classification zone and hence will not effect the development potential of this area.*'
    - The report states that there are increases to the flood levels as a result of the developments proposed cut/fill regime. Increases in the high hazard areas impact the overall flood behaviour of a floodplain and therefore there should be no increases as a result of any works proposed. The impact of these increases in flood levels in the high hazard area is not addressed in the report.

- Page iii of the Costin Roe Consulting document states that: '*In relation to the potential of cumulative impact as other sites within the catchment are developed to the same or similar degree to the proposal the following is noted. The development*

proposal does not provide for any incremental increase in peak flood levels off-site and relatively minor changes (less than 0.1m) on site. If other future developments provide for similar relative impacts and management measures (including flood storage compensation) as required of Penrith DCP, the overall cumulative impact within the South Creek corridor would be effectively managed. Accordingly, the development would be considered to not be contributing to a future cumulative impact'.

- Without actually modelling this assumption for the entire catchment and how it interacts with the backwater impacts of the Hawkesbury-Nepean this conclusion reached in the Costin Roe report cannot be substantiated.
- The report makes an assumption that there is no impact without modelling to determine that there is no cumulative impact.
- The report also focusses on only the 1% Annual Exceedance Probability event, it does not look at the impacts of filling above the 1% AEP on downstream environments, which may lead to further exacerbated flood evacuation issues in the Hawkesbury-Nepean – this is a risk to life issue if not fully modelled and addressed.

- Page iv of the Costin Roe Consulting document states that: '*Further to the above, there is also no effect on the Nepean River in relation to the development which is more than 20kM downstream of the development'*.
  - The boundary of the modelling undertaken did not encompass the whole catchment, nor go down to the confluence with the Hawkesbury River, and therefore this comment cannot be supported.

- Page 6 of the Costin Roe Consulting document states that: '*The NSW Floodplain Development Manual, 2005 recommends that the FPL generally be based on the 100-year ARI event. It suggests that, whilst this event can be varied, it should only be done in exceptional circumstances. It is considered appropriate to adopt the 100-year ARI event for the proposed industrial development'*.
  - The exceptional circumstances condition is only for residential development not commercial development. Further consideration is required regarding the intent of the manual and how it applies to non-residential development and the risks that need to be considered with this warehouse type development.

Yours sincerely,

William Hodgkinson
Senior Environmental Assessment Officer
Industry Assessments

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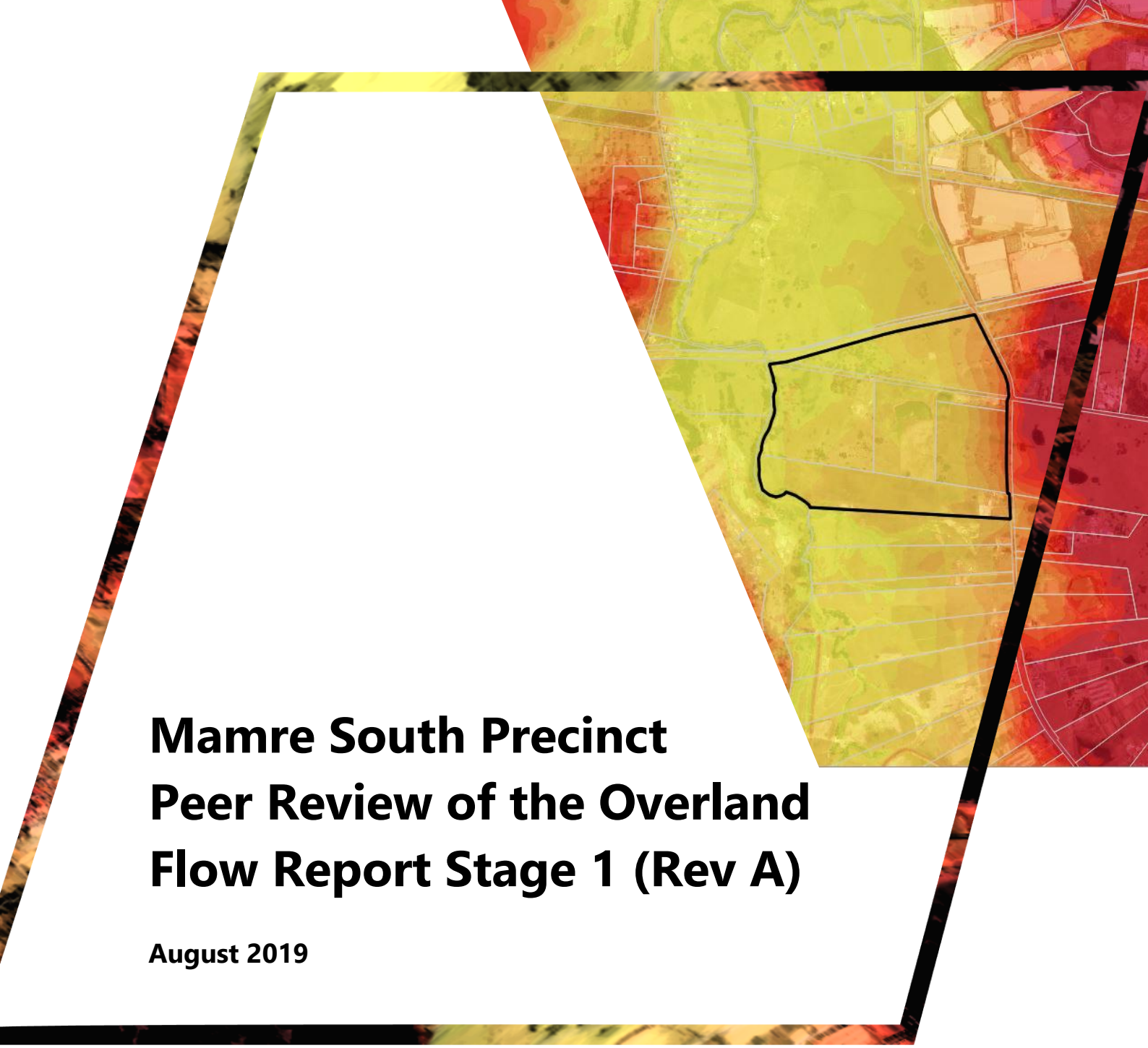

Mamre South Precinct Peer Review of the Overland Flow Report Stage 1 (Rev A)

August 2019

Level 17, 141 Walker St
North Sydney NSW 2060
Australia

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Revision B

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Project: Mamre South Precinct, Mamre Road, Kemps Creek
Peer Review of the Overland Flow Report Stage 1 (Rev A)

Rev	Description	Author	Review	Advisian Approval	Date
0	Draft Report (Issued for Internal Review)	RG / LC	CRT		6/08/2019
A	Final Draft Report (Issue for Client Review)	RG / LC	CRT	CRT	9/08/2019
B	Final Report	RG / LC	CRT	Chris Thomas	21/08/2019

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1 Introduction

Costin Roe Consulting has prepared an Overland Flow Report as part of a State Significant Development Application SSD 9522 for an industrial estate precinct that is located on the western side of Mamre Road at Kemps Creek, NSW. The site of the proposed development is known as the Mamre South Precinct.

Advisian was engaged by the NSW the Department of Planning, Industry and Environment (DPIE) to complete a peer review of the Overland Flow Report. The scope for the peer review includes:

- review of the adopted modelling approach to assess flood behaviour under post-development conditions;
- review of the predicted impacts of the development on peak flood levels and peak flow velocities with reference to the assessment criteria outlined in Penrith City Council DCP 2014, where applicable; and,
- review of the proposed emergency response measures for the Precinct.

This report documents the findings of Advisian's peer review. It also lists recommended actions for addressing concerns or perceived inadequacies in the modelling approach, the assessment of post-development flood behaviour, and the adopted methodology for assessing flood impacts and emergency response.

2 Review of Flood Modelling and Results

Modelling completed for the 'Overland Flow Report' by Costin Roe Consulting adopted a TUFLOW model that is "truncated" relative to the extent of the RMA-2 flood model that was developed and used to define design flood levels in the area as part of the South Creek Flood Study (*WorleyParsons 2015*). This truncated TUFLOW model and its results have been reviewed in accordance with the following scope, with details presented in the following section of this report:

- Review of the pre-development TUFLOW model set-up and predicted flood levels to confirm consistency with the *South Creek Flood Study* (*2015*).
- Review of the pre and post-development TUFLOW model set-up with a focus on the areas of proposed excavation and across the combined detention and bio-retention basin.
- Review of any changes to roughness parameters between pre and post-development scenarios.
- Review of the predicted modelling results and differences between pre and post-development conditions and the adequacy of the Overland Flow Report in documenting them.

2.1 Review of the Pre-Development TUFLOW Model for Consistency with the South Creek Flood Study (2015)

To confirm the consistency of the pre-development TUFLOW model with the RMA-2 model that was developed and applied as part of the *South Creek Flood Study* (*WorleyParsons, 2015*), 1% AEP flow hydrographs and peak flood levels have been compared as follows:

- Comparison of TUFLOW inflows to RMA-2 model flow hydrographs extracted at relevant locations using waterRIDE™ (*refer* **Figure 1**). Observations made from that comparison are as follows.
  - Hydrograph shapes, peak flows and total volume are similar
  - A slight offset in the start of the flood hydrographs is evident
  - The TUFLOW inflow hydrograph shapes are somewhat simplified (i.e. due to the 2 hour timestep used to define them) and have slightly higher peak flows than those extracted from the RMA model using waterRIDE
  - Overall it appears that appropriate data has been adopted to define inflows to the truncated TUFLOW model
- Comparison of peak 1% AEP flood levels simulated using the TUFLOW and RMA-2 models (*refer* **Figure 2**). Observations made from that comparison are as follows.
  - In the immediate vicinity of the proposed development site pre-development TUFLOW peak flood levels range from about 10 mm higher to 120 mm lower than the peak flood levels generated by the RMA-2 model, but are typically about 50 mm lower.
  - Some larger differences are observed further afield from the site including:
    - TUFLOW levels about 120 mm higher near the South Creek inflow boundary

- TUFLOW levels about 1.3 m lower within the South Creek Dam
- TUFLOW levels about 200 mm lower north of Mandalong Close
- TUFLOW levels about 140 mm higher north of Luddenhum Road
- TUFLOW levels about 220 mm higher on Cosgroves Creek upstream of Twin Creeks Drive

- While differences in 1% AEP peak flood levels simulated by the RMA model and truncated TUFLOW model are evident, this is not unexpected given the change in modelling software, associated differences in model setup and numerical solvers, the change in model extent and boundary conditions, and the adoption of more recently acquired LiDAR data defining the floodplain topography.
- The South Creek inflow boundary should arguably be moved further upstream to ensure flow behaviour is properly resolved in the vicinity of the South Creek Dam and Kemps Creek confluence, however relatively low differences in flood level upstream of the site indicate that this may not be necessary (**Finding A1**).
- Peak flood levels are generally within +/-100 mm over distances of about 850 m upstream of the site and 1350 m downstream and are mostly in the order of +/-50 mm within this area. Accordingly, the truncated pre-development TUFLOW model produces flood levels that are reasonably similar to those generated by the RMA model, and therefore is suitable for assessing the potential impacts of the development on flooding.

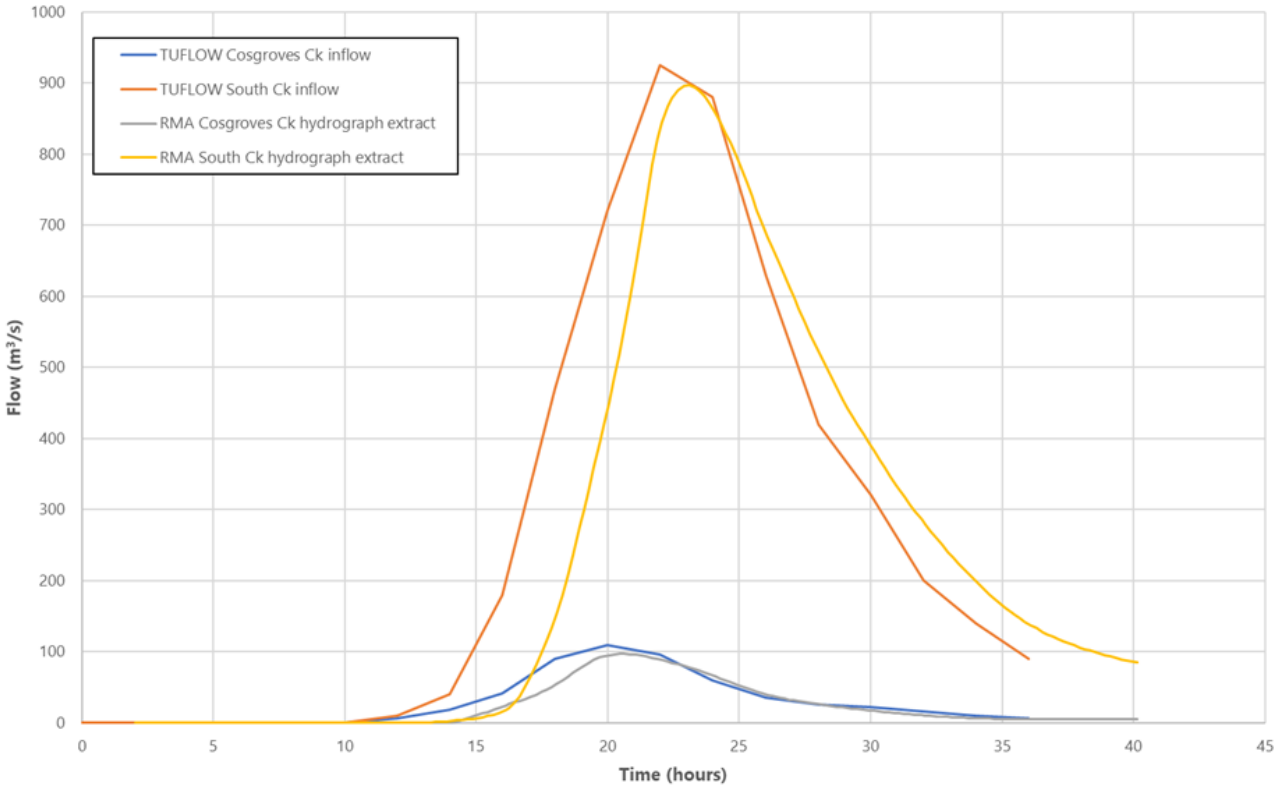

Figure 1 Comparison of RMA model 1% AEP flows with TUFLOW model inflows

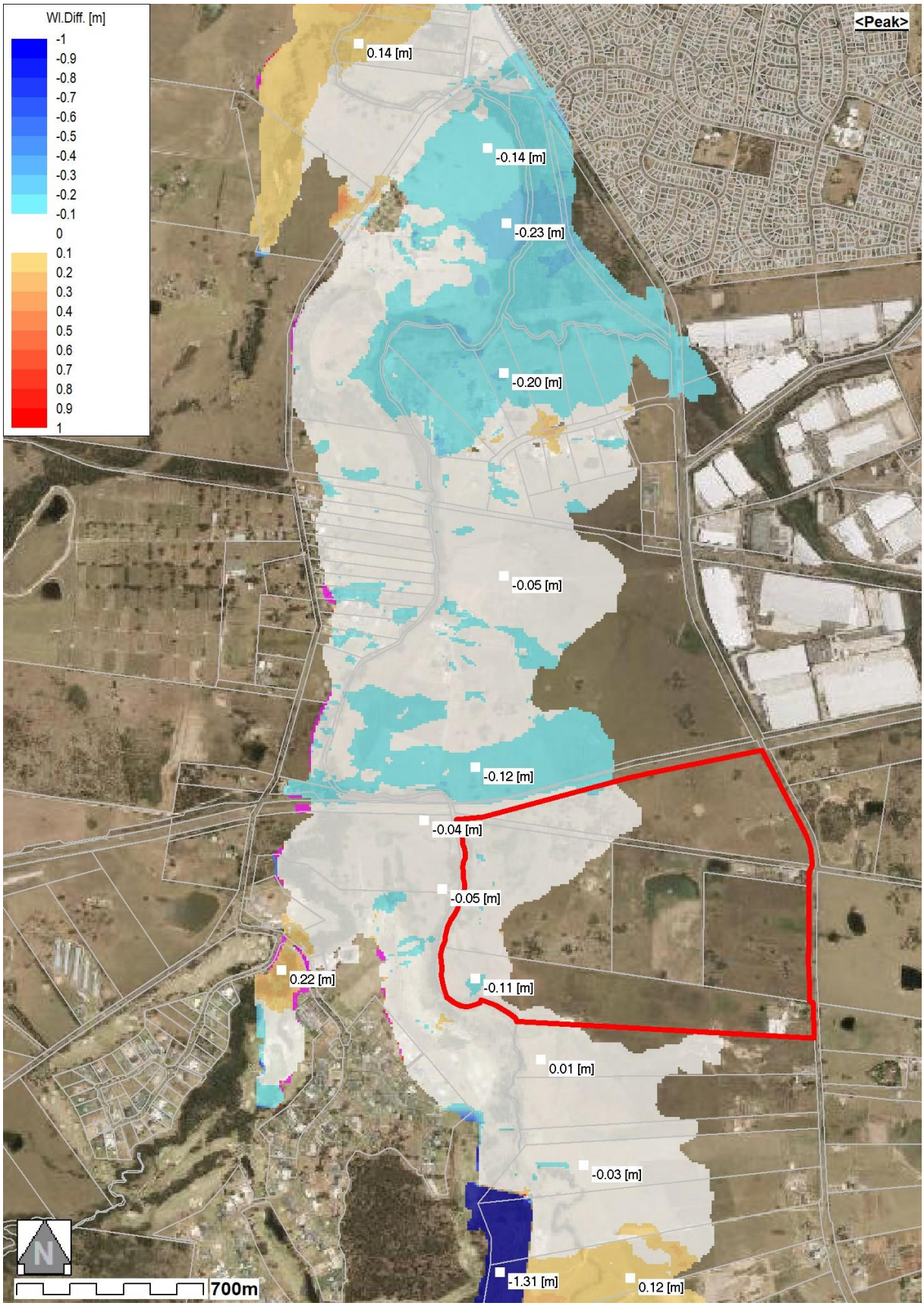

Figure 2 Difference in simulated 1% AEP peak flood levels (TUFLOW minus RMA)

2.2 Review of Model Boundary Conditions

A review of the TUFLOW model inflow boundary conditions found that the same 1% AEP flood hydrographs, as presented in **Figure 1**, were applied to both the pre-development and post-development simulations.

The South Creek inflow boundary lies within both the South Creek Dam and adjacent Kemps Creek channel. Comparison of RMA and TUFLOW 1% AEP peak flood levels (refer **Section 2.1**) shows that this results in significantly lower (1.3 m) TUFLOW peak flood levels within South Creek Dam and indicates that a greater proportion of flow is being directed into Kemps Creek than in the RMA model. The South Creek inflow boundary should arguably be moved further upstream to ensure flow behaviour is properly resolved in the vicinity of the South Creek Dam and Kemps Creek confluence. However, relatively low differences in flood level upstream of the site indicate that this may not result in significant changes (**Finding A1**).

The downstream boundary condition was also reviewed. This established that the same time-varying water level has been applied to both pre-development and post-development conditions. TUFLOW and RMA peak flood levels approaching the boundary are comparable suggesting that the downstream boundary has performed appropriately.

2.3 Review of Hydraulic Roughness and Manning's 'n'

The delineation of hydraulic roughness zones (also known as surface materials) in the pre-development and post-development TUFLOW models is shown in **Figure 3**, with corresponding Manning's 'n' values presented in **Table 1**.

A review of the TUFLOW hydraulic roughness delineation and Manning's 'n' found the following:

- Review of Manning's 'n' roughness parameter values
  - Adopted values are within generally accepted ranges (e.g., ARR 2019) and align with those adopted the RMA model
  - Adopted values are common between pre-development and post-development scenarios.
- Review of TUFLOW hydraulic roughness delineation
  - Material delineation is quite simplistic but is none-the-less appropriate. For example, rural-residential areas are not differentiated from the default "grassed floodplain" material. Given the limited extent of development in these areas and the similarity in Manning's 'n', however, this is unlikely to have a consequential impact on simulated flood levels.
  - Differences between pre-development and post-development scenarios
    - Several "Ponds" are present in pre-development conditions but not post-development
    - The post-development scenario has not accounted for changes in landuse and Manning's 'n' associated with new and proposed commercial/industrial development. While the post-development terrain is predominantly above the 1% AEP peak flood level, the changes in land use may affect larger floods such as the 0.5% AEP and PMF (**Finding A2**).

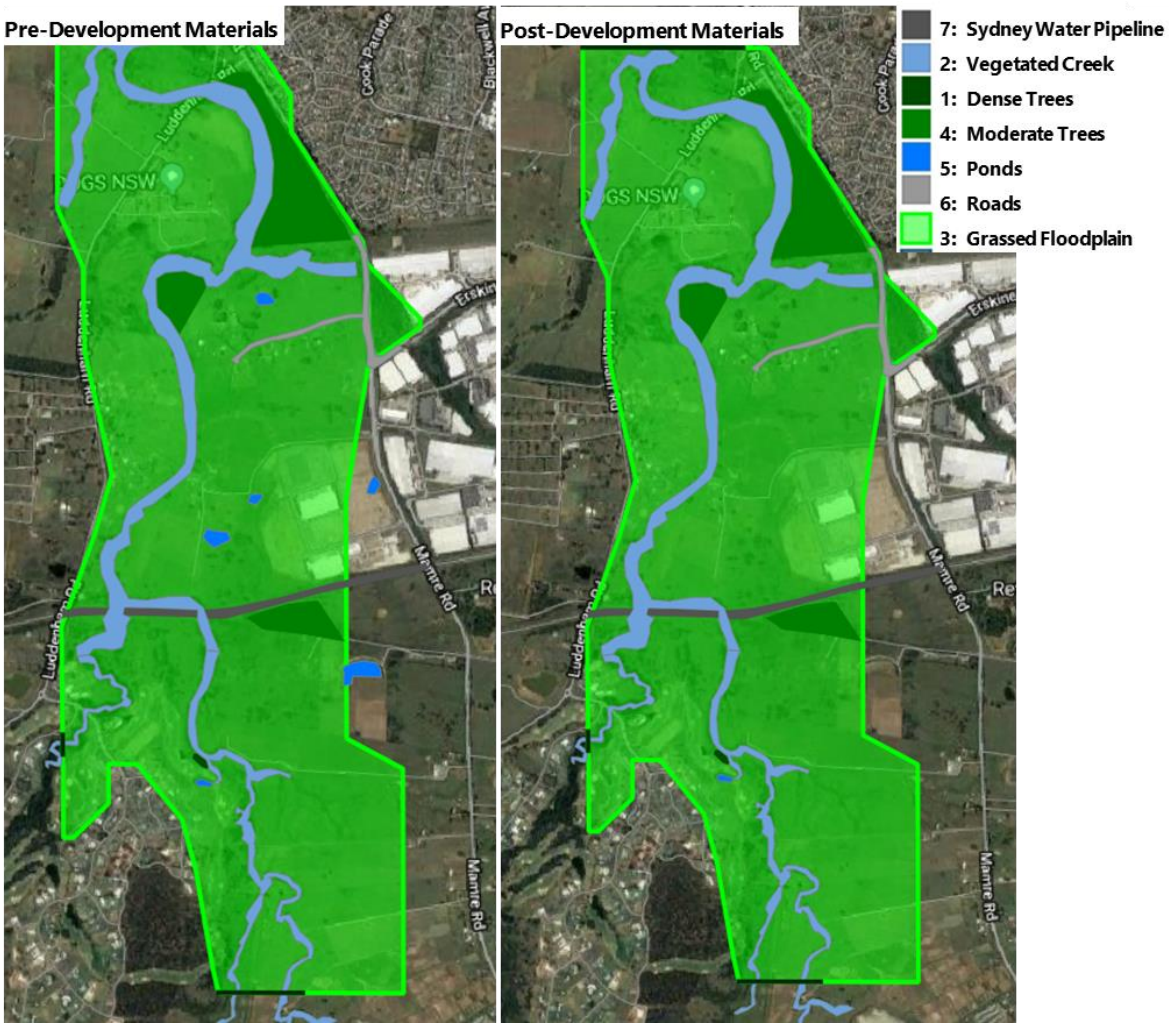

Figure 3 Comparison of pre-development and post-development TUFLOW material delineation

Table 1 Adopted TUFLOW Manning's 'n' values

Material ID	Description	Manning's n
7	Syd Water Pipeline	0.08
2	Vegetated Creek	0.1
1	Dense Trees	0.12
4	Moderate Trees	0.08
5	Ponds	0.025
6	Roads	0.015
3	Grassed Floodplain	0.04

2.4 Review of Model Grid Size

Section 6.1 of the Overland Flow Report states that TUFLOW modelling adopted a 7 m grid size. However, review of the provided TUFLOW geometry control file reveals that a model grid size of 8.5 m was adopted (**Finding A3**).

This 8.5 m model grid size is considered coarse, particularly for a relatively small model extent where model run times do not place any significant constraint on grid size. TUFLOW log files show that the model run time was just 16 minutes. Experience suggests that a more appropriate TUFLOW grid size for the study area would in the range of 3 m to 5 m. This would improve the topographic resolution of features critical to the flood impact assessment such as the geometry of the proposed on-site detention (OSD) basin which was found to be poor (*refer* **Section 2.5**).

Accordingly, it is recommended that future modelling adopt a grid size of not more than 5 m (**Finding A4**). Additionally, "2d_zsh" lines should be used to enforce elevations of hydraulically important features (e.g. the OSD basin overflow weir and embankment crest) that may not otherwise be explicitly captured by the TUFLOW grid (relates to **Finding A5**).

2.5 Review of Model Terrain

The TUFLOW model terrain for pre-development and post-development conditions is shown in **Figure 4**. Changes in model terrain under the post-development scenario are shown in **Figure 5** with decreases in ground level indicated by blue colours (*i.e. cut*) and increases indicated by red (*i.e. fill*) colours. A detailed comparison of the post-development model terrain and the design plan for the proposed development is presented in **Figure 6**.

A review of the post-development TUFLOW model terrain found the following:

- Terrain changes incorporated in the post-development model (*refer* **Figure 5**) include:
  - Medinah Avenue, Twin Creeks development (constructed):
    - Generally, increases in ground level of up to about 2.5 m
  - First Estate Stage 1 (constructed):
    - Generally, decreases in ground level associated with drainage
  - First Estate Stage 2 (proposed):
    - Both increases and decreases in ground level associated with regrading, differences are up to about 1.0 m
  - Mamre South Precinct (proposed):
    - Increases in ground level across most of the site associated with filling, differences are generally 1.0 m or more and are up to about 5.0 m
    - Decreases in ground level along the western edge of the site associated with cut, re-grading and the on-site detention basin. Differences are generally in the order of 1.0 m or more are up to about 1.8 m.
- Comparison of post-development terrain and design plans (*refer* **Figure 6**):

- Model ground elevations across the proposed lots generally match those indicated on the Stage 2 Erosion and Sediment Control Plan submitted for the Development Application (*Drawing No. C013362.00-DA210*)
- The only exceptions to the above were Lot 2 (*model elevation 40.0 mAHD rather than 39.8 mAHD*) and Lot 3 (*model elevation 39.5 mAHD rather than 39.8 mAHD*). These lots are outside of the simulated PMF extent.
- Model ground elevations associated with other recently constructed and proposed developments have not been assessed under this peer review.

- On-site detention (OSD) basin representation (*refer* **Figure 4**):
  - Review of basin embankment crest elevation
    - A definitive RL for the crest of the basin embankment could not be confirmed from review of the Overland Flow Report, Water Cycle Management Strategy or associated drawings.
    - Based on model terrain elevations it appears that the TUFLOW modelling intended to adopt a crest RL of 33.3 mAHD, just 0.3 m higher than the proposed overflow weir RL of 33.0 mAHD and 0.2 m higher than the maximum detention level quoted on drawings.
    - Review of the post-development TUFLOW model terrain using waterRIDE indicates that the crest RL ranges from 32.5 to 33.3 mAHD, with RLs of less than 33 mAHD along much of its length (>50%). Such a topographic representation would result in the obstruction to flood flows caused by the basin being under-represented (**Finding A5**). A profile across the OSD basin in the direction of flow is shown in **Figure 4**.
    - It is noted that the TUFLOW terrain reviewed comprises of a raster created by triangulation of the actual terrain elevations (at grid cell centre, corner and mid-side nodes) used in hydraulic calculations. Thin 'breakline' features in the model terrain used to set elevations along only the sides of model grid cells can be excluded or smoothed out from this raster interpretation of the TUFLOW terrain. However, without any indication within the Overland Flow Report or the provided TUFLOW files that 'breaklines' have been used, it appears that the modelling does not adequately define the basin and the obstruction it could cause to floodwaters.
    - Additionally, the parts of the OSD basin embankments fall within areas classified as floodway (refer **Section 3.1** of this report)
  - Review of basin bed elevation / initial water level
    - The Overland Flow Report (refer Table 9.1, Criteria 5) states that the OSD basin was modelled as 80% full under the assertion that the peak of local flows into the basin would be unlikely to align with the peak of flooding in South Creek.
    - The post-development model terrain indicates that a level of 32.5 mAHD was adopted within the basin (as a fixed terrain level rather than initial water level) to represent this 80% full condition.

- From the available information on the proposed basin design presented in Drawing No. C013362.00-DA414 (Drawing DA414) it could not be confirmed how the level of 32.5 mAHD was determined. Drawing DA414 suggests the basin has an 'empty' level of 31.6 mAHD and a 'full' level of at least 33.0 mAHD (i.e. the overflow weir RL). These details suggest that an 80% full condition would equate to an RL of 32.72 mAHD (**Finding A6**).

- Review of proposed extent of compensatory cut:
  - The post-development model terrain indicates that excavation is proposed within close proximity to South Creek and within the riparian corridor as defined by the Penrith City Council DCP (2014) and the Water Management Act (2000) (refer **Section 3.3 of this report**). This excavation is considered to be extreme and potentially detrimental to maintaining the local ecology and environment of the natural waterbody. As the report does not directly address this excavation it is unclear if the extent of earthworks modelled is a true reflection of the proposed works.

    Given the sensitive nature and potential environmental impacts of such excavation, and the influence the excavation has on the results of the post-development modelling, it is recommended that it be clearly addressed within the report.

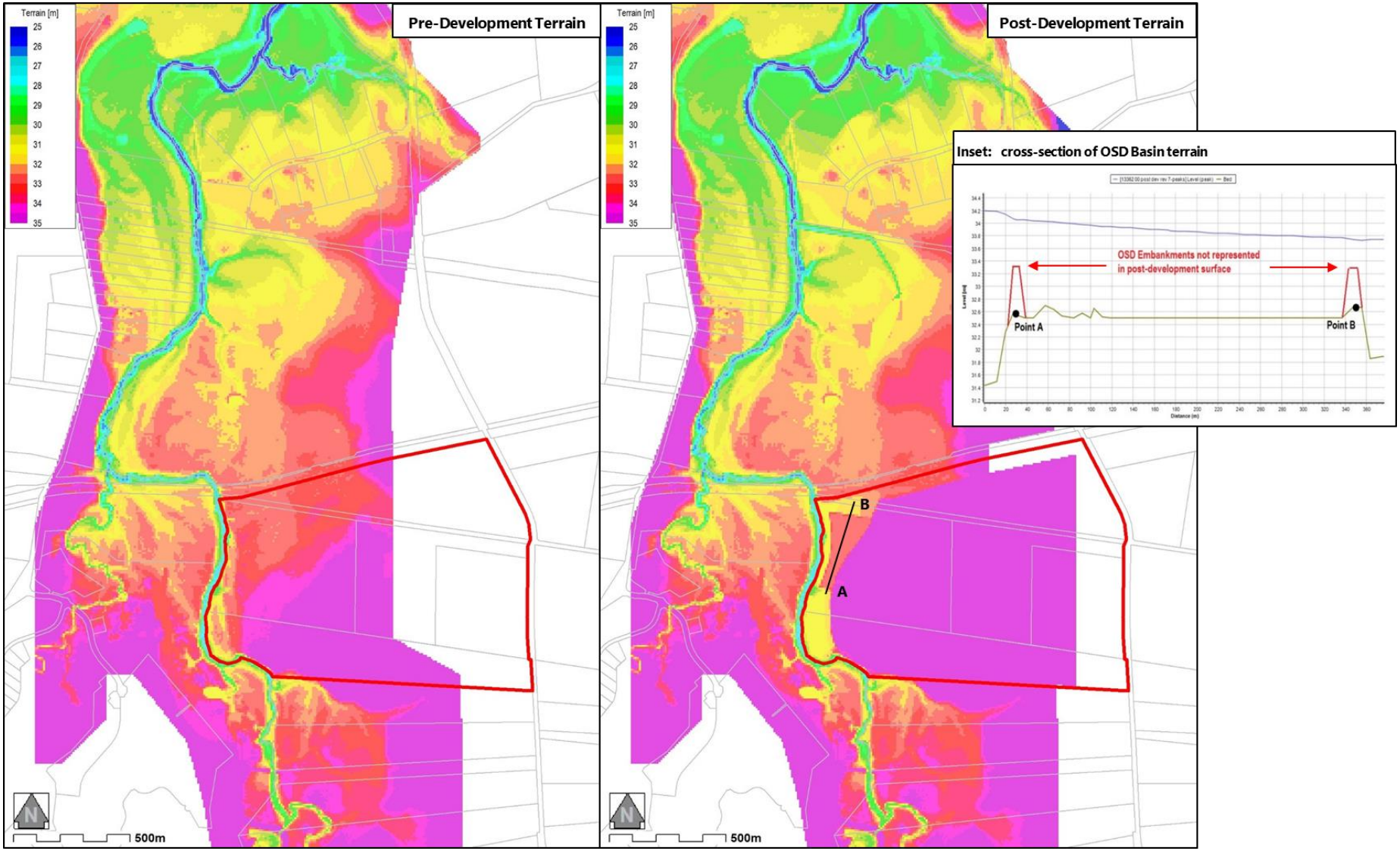

Figure 4 Comparison of pre-development and post-development TUFLOW model terrain

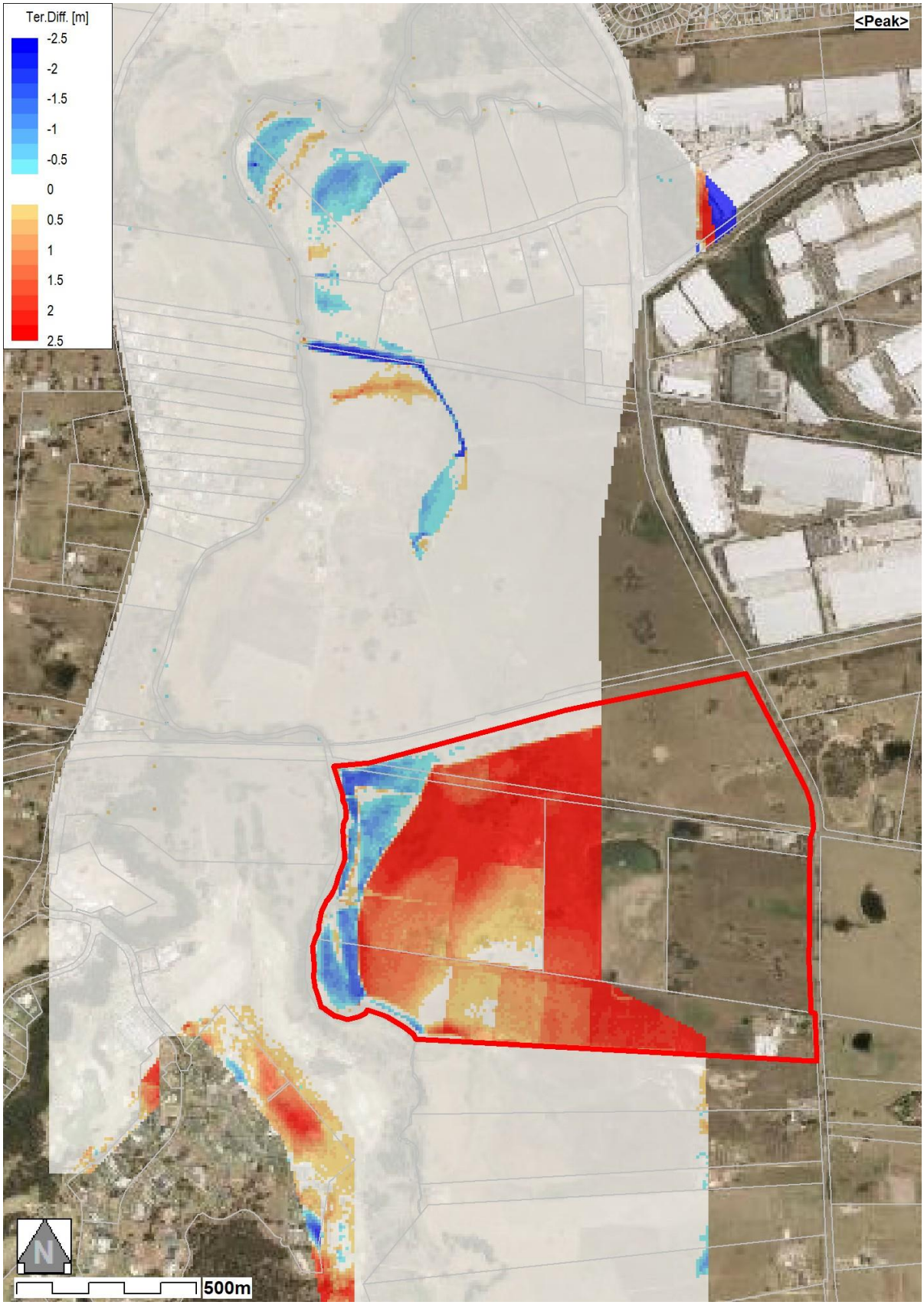

Figure 5 Difference in TUFLOW model terrain (post-development minus pre-development)

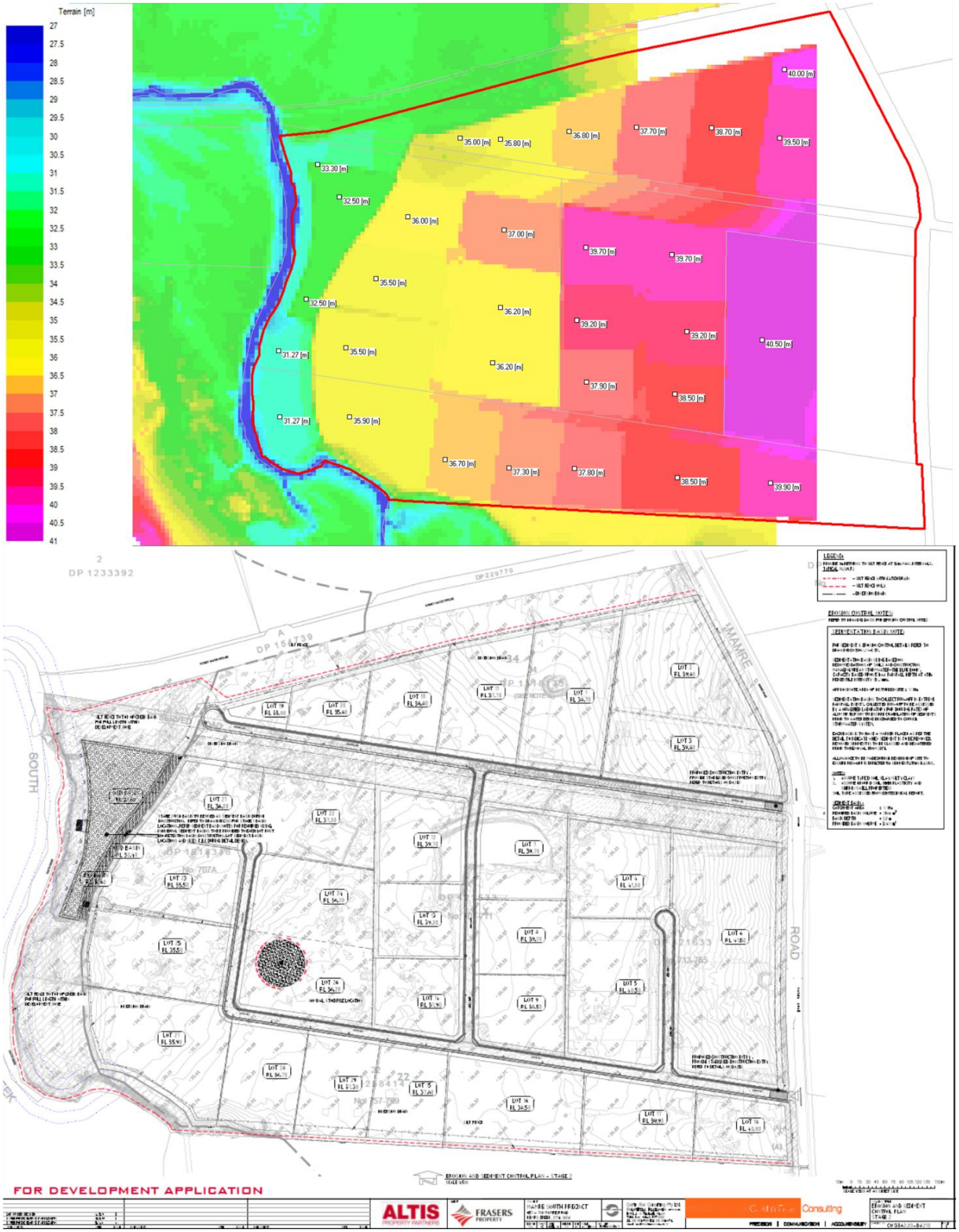

Figure 6 Comparison of post-development TUFLOW terrain and DA design RLs

2.6 Review of Flood Impacts

To assist in review of flood impacts expected to be caused by the proposed development, differences in peak flood levels and velocities were independently calculated from provided TUFLOW model results using waterRIDE™. Changes in simulated 1% AEP peak flood levels are presented in **Figure 8** and changes in peak velocity in **Figure 9**. Review of peak flood level and velocity differences is summarised as follows:

- Changes in peak flood level and velocity calculated independently with waterRIDE appear to correlate with those presented in the Overland Flow Report
- The maximum peak flood level increase within the site is 0.08 m, occurring about 15 m inside the northern boundary of the site immediately downstream of the OSD basin
- The maximum peak flood level increase outside of the site is 0.07 m, occurring immediately outside the northern site boundary. This excludes a localised increase of 0.14 m adjacent to the proposed Fist Estate Stage 2 which Costin Roe attributes to that development.
- Peak flood level decreases occur over a significant area near the south-western corner of the site in a narrower section of the South Creek floodplain. This is associated with the proposed area of cut to the south of the OSD basin which results in an increase in the cross-sectional flow area.
- The above-mentioned area of cut, along with fill at Medinah Avenue, causes some redistribution of flow and associated increases in peak 1% AEP velocities adjacent to the south-west corner of the site. Velocity increases immediately outside of the site amount to a maximum increase of 14%, while immediately inside the site boundary velocity increases of about 23% occur locally.
- Peak velocities across a section of South Creek where the 14% increase occurs are presented in **Figure 7**. The velocity profile suggests that velocity increases may be predominantly caused by filling of the floodplain at Medinah Avenue in the Twin Creeks development and the associated redistribution of flows. There was no increase in the maximum peak velocity across the section.
- Points 3 and 6 above are indicative of the difficulty in determining which flood impacts are directly attributable to the proposed Mamre South Precinct development. While it is useful to know cumulative flood impacts associated with the development and other proposed and recently constructed developments, it may be preferable to have separate scenarios to simulate the expected impacts of the development currently being assessed and the cumulative impacts including other pending development applications (**Finding A7**).

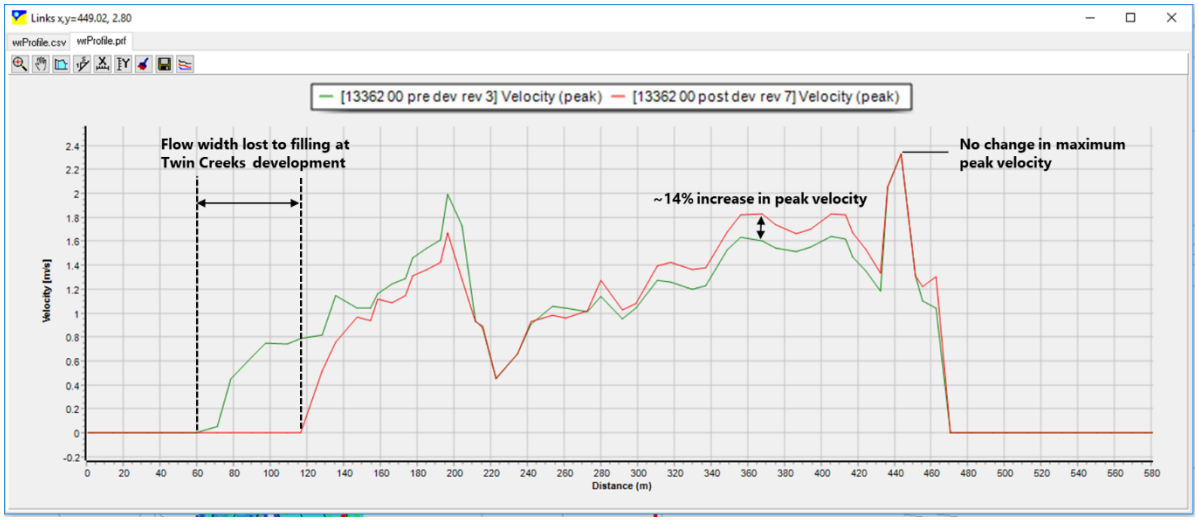

Figure 7 1% AEP peak flood velocities across South Creek near upstream site boundary

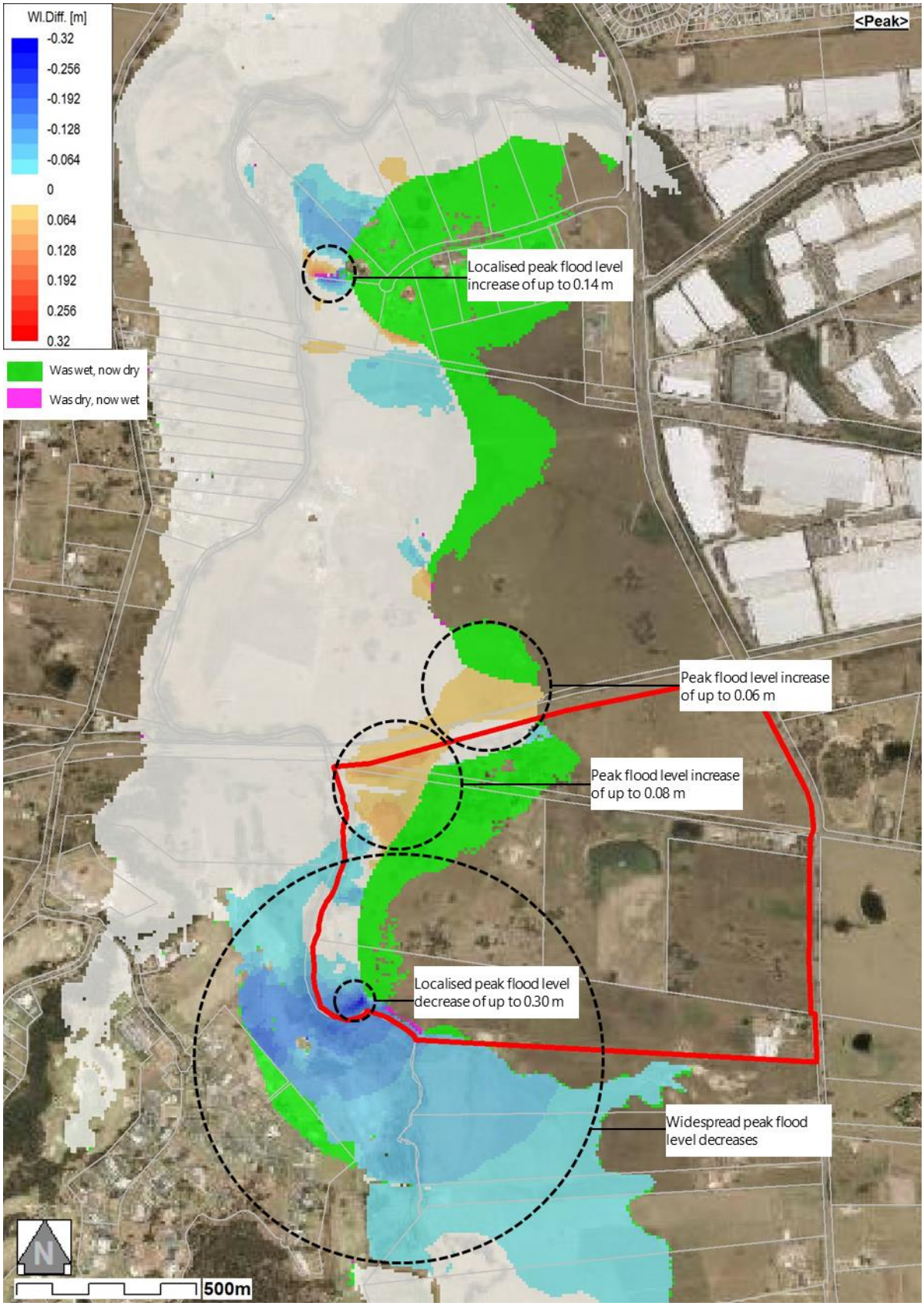

Figure 8 Difference in 1% AEP peak flood levels (post-development minus pre-development)

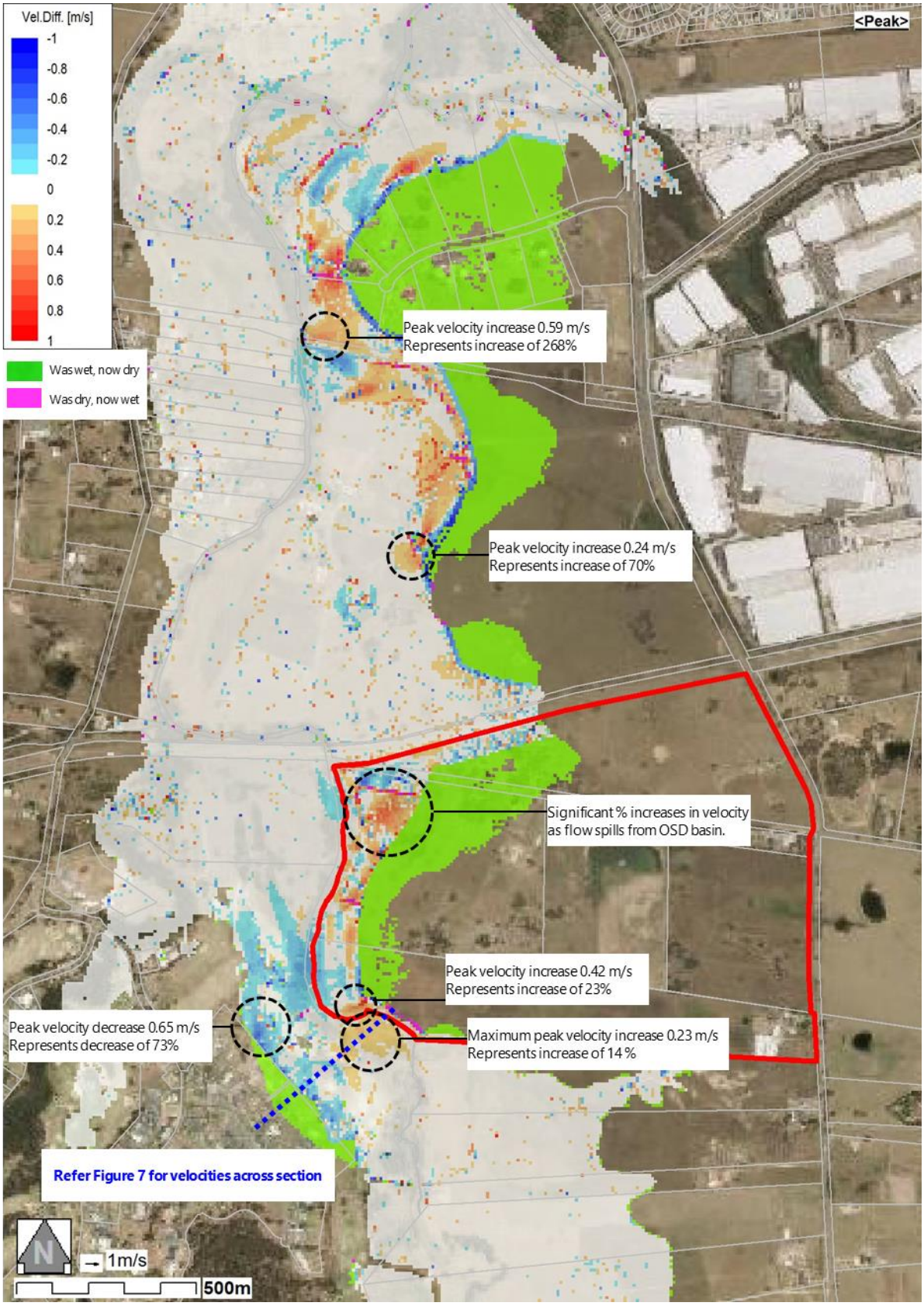

Figure 9 Difference in 1% AEP peak flood velocities (post-development minus pre-development)

3 Review of Relevant DCP Requirements

3.1 Penrith City Council DCP (2014), Chapter C3.5

Chapter 9 of the '*Overland Flow Report*' discusses the predicted impacts of the proposed development relative to the requirements of Penrith City Council's DCP (*2014*). In particular, the flood related requirements for filling of land at or below the flood planning level as outlined in Chapter C3 Section 3.5 of the DCP (*2014*) are addressed. These requirements are:

a) Council will not grant consent to filling of floodways or high hazard areas.

The filling of other land at or below the flood planning level will generally not be supported; however, Council will adopt a merits-based approach. Council may consider such an application when the following criteria are met:

i) Flood levels are not increased by more than 0.1 metres by the proposed filling

- *As part of discussions with Council and DPIE, Item i) above has been revised to ensure that no effect to upstream or downstream properties is to occur. The maximum off-site flood level change confirmed for the assessment was to be 0.010-0.020m or less. On-site changes would need to be within the 0.1 m as stipulated in the Council DCP.*

ii) Downstream velocities are not increased by more than 10% by the proposed filling

iii) Proposed filling does not redistribute flows by more than 15%

iv) The potential for cumulative effects of possible filling proposals in that area is minimal

v) There are alternative opportunities for flood storage

vi) The development potential of surrounding properties is not adversely affected by the filling proposal

vii) The flood liability of buildings on surrounding properties is not increased

viii) No local drainage flow/runoff are created by the filling

ix) The filling does not occur within the drip line of existing trees.

Comments on each of the above DCP requirements are provided in the following.

a) Council will not grant consent to filling of floodways or high hazard areas

Parts of the proposed OSD basin are located within areas that are designated as both "floodway" and "high hazard". This is clearly indicated in the Overland Flow Report, Appendix C, Drawing No. C013362.00-F02, as reproduced in **Figure 10**.

The embankments of the proposed basin would raise the topography above the existing level, obstruct flood flows and potentially reduce flood storage. Accordingly, this would be considered filling of a floodway area and would not be permitted under the DCP (**Finding A8**).

As this first criterion is not met, it is understood that the proposed development in its current form would not be permitted. Accordingly, the following merits-based criteria (*i to ix*) do not apply, but have been assessed nonetheless to assist in any subsequent refinements of the proposed development from a flooding perspective.

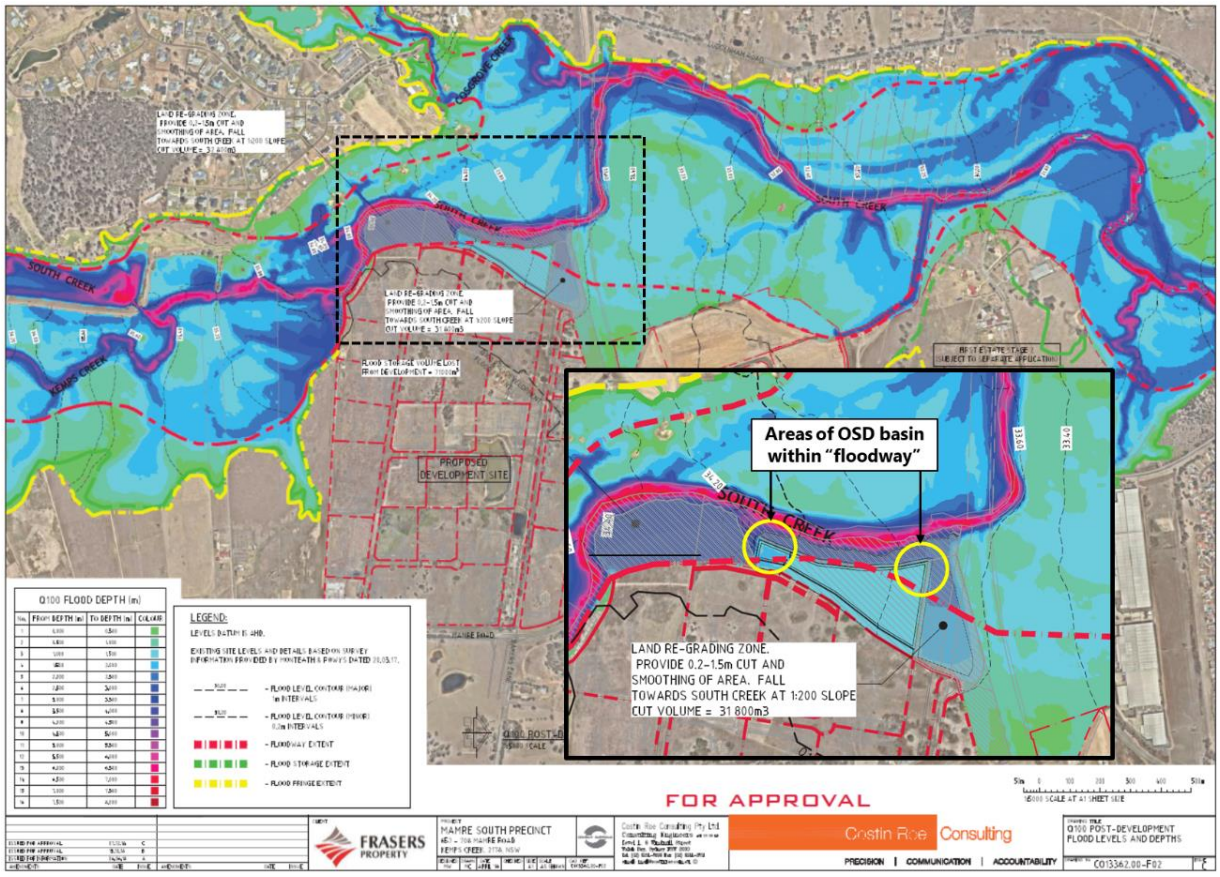

Figure 10 Reproduction of Overland Flow Report Appendix C figure showing fill within floodway

i) Flood levels are not increased (*onsite*) by more than 0.1 metres by the proposed filling (*and are not increased offsite by more than 0.01 to 0.02 m*)

The flood modelling results show that the proposed development/filling is expected to cause a maximum increase in 1% Annual Exceedance Probability (AEP) peak flood levels of:

- 0.08 m for areas within the site boundary,
- 0.07 m for areas outside of the site to the north.

Larger flood level increases of up to 0.14 m are evident several hundred metres north of the site adjacent to the proposed First Estate Stage 2 development. Costin Roe has attributed this flood impact to the First Estate Stage 2 development. As noted previously, the inclusion of this separate development in the post-development modelling scenario results in difficulty in assessing those flood impacts directly attributable to the proposed Mamre South Precinct development. Recommendations to resolve this issue are presented in **Table 2** under **Finding A7**.

The following comments are made in relation to the flood level increase criteria specified in DCP 2014 and specific criteria set for the Mamre South Precinct by Council and DPIE.

- The flood modelling undertaken by Costin Roe Consulting suggests that the proposed development/filling will result in increases in peak 1% AEP flood levels that are less than 0.10 m and from this it is inferred that the development proposal achieves the flood impact criteria specified in the DCP.

However, Clause 14 of Part C of Section 3.5 of DCP 2014 lists a range of other criteria that need to be met when filling at or below the Flood Planning Level is proposed. These criteria include the need to also establish:

- that the cumulative effects of possible filling proposals in the area are minimal; and,

- that the development potential of surrounding properties is not increased.

It does not appear that the assessment of flood impacts has adequately addressed these additional requirements of Section 3.5 of DCP 2014.

In addition, it is noted that a local increase in peak flood level of 0.1 m is one (1) order of magnitude greater than the maximum increase typically accepted where the requirements of the NSW Government's Flood Prone Land Policy are being adhered to.

- The results of the modelling presented in the Coston Roe Consulting Report indicate that the predicted off-site flood level increases exceed the 0.01 to 0.02 m criteria set by Council and DPIE for the development. While it is possible that the flood level increases could be partially attributed to other developments, any such assertion would need to be substantiated through appropriate modelling that confirms that the proposed development, in isolation, does not cause off-site flood level increases of greater than 0.01 to 0.02 m (**Finding A9**).

ii) Downstream velocities are not increased by more than 10% by the proposed filling

The flood modelling results show that the proposed development/filling is expected to cause a maximum increase in 1% Annual Exceedance Probability (AEP) peak flood velocities of:

- About 23% for areas within the site boundary,
- 14% for areas outside of the site to the south (upstream).

Larger flood velocity increases of up to 270% are evident several hundred metres north of the site adjacent to the proposed First Estate Stage 2 development. Costin Roe has attributed this flood impact to the First Estate Stage 2 development. Flood velocities in this location do however remain low (about 0.8 m/s) and would not present significant additional risk of scouring.

The 14% peak velocity increase to the south of the site technically exceeds the DCP requirement, however it is noted that:

- The extent of velocity increases greater than 10% is limited,
- No increase is expected in the maximum peak velocity across the creek channel section at the location of the 14% increase (*refer* **Figure 7**)
- A significant proportion of the velocity increase may be attributable to filling on the western side of the floodplain associated with the Twin Creeks development. Recommendations to resolve the impact directly attributable to the proposed Mamre South Precinct development are presented in **Table 2** under **Finding A7**.

iii) Proposed filling does not redistribute flows by more than 15%

Flow distributions between the left overbank, main channel and right overbank are presented in the Overland Flow Report, Appendix C, Drawing No. C013362.00-F04.

An increase in flow through the right overbank of up to 18.5% is indicated. Depending on the method of Council's application of this criterion, this could be interpreted as an exceedance of the 15% flow redistribution threshold. However, it is noted that:

- The additional 30 m^3/s of flow redistributed through the right bank represents only 3% of the total flow of 1,020 m^3/s. This could therefore be interpreted as a flow redistribution of only 3%.
- The right bank area in question lies within the proposed development site.

iv) The potential for cumulative effects of possible filling proposals in that area is minimal

Costin Roe conclude that "cumulative effects of filling are not applicable to the proposed filling and development" (Page 23). This is based on the assertions that "downstream of the development area, the effects due to development grade out to zero through a defined extent", and that "the development provides compensatory flood storage of 87,800 m^3, noting that the displaced storage volume is 75,000 m^3.

While review of flood level impact mapping shows that there are essentially no flood level increases expected along the western side of the floodplain, increases are indicated along the eastern floodplain. It is recommended that the following be undertaken to further assess the potential for cumulative impacts of possible filling proposals in the surrounding area (**Finding A10**).

- That the recommendations of **Finding A7** be implemented to assess those impacts directly attributable to the proposed development
- That a 'cumulative impact' scenario be assessed including the proposed development, other proposed development on the eastern floodplain (i.e. First Estate Stage 2), and filling of properties on the western floodplain to above the 1% AEP peak flood level outside of the floodway corridor and high hazard areas.

v) There are alternative opportunities for flood storage

The Costin Roe report states that proposed filling associated with the development causes a displaced storage volume of 75,000 m^3 and that compensatory flood storage of 87,800 m^3 is provided along the south-west corner and north-west corner of the proposed development within the floodplain.

This suggests that additional flood storage is provided. However, it is noted the storage calculations are sensitive to the proportion of the OSD basin storage which is considered active (i.e. the proportion of the storage that remains empty and available for flood storage at the time that flooding from South Creek occurs). Assumptions about active storage in the OSD basin made in overall storage volume calculations should be provided along with justification for these assumptions (**Finding A11**).

The calculation of pre and post-development storage volumes should also be referenced against the flood event against which the comparison was completed. At minimum, it would be desirable to understand the balance of cut and fill up to and including the peak 1% AEP flood level and the PMF. This recognises that flood storage volumes are sensitive to the elevations at which cut and fill occur.

vi) The development potential of surrounding properties is not adversely affected by the filling proposal

The Costin Roe report states that "there is no effect on development potential of surrounding properties as a result of the proposed filling proposal" (page 23).

While review of flood level impact mapping shows that there are essentially no flood level increases expected along the western side of the floodplain, increases are indicated along the eastern floodplain that would result in increases in flood planning levels, and therefore development potential, at adjacent properties. To determine if these flood level increases are directly attributable to the proposed development, the recommendations of **Finding A7** should be implemented.

vii) The flood liability of buildings on surrounding properties is not increased

The Costin Roe report states "surrounding buildings and properties are not affected by flooding changes due to the proposed filling and no reduction in flood immunity has been shown in the analysis" (Page 24).

While review of flood level impact mapping shows that there are essentially no flood level increases expected along the western side of the floodplain, increases are indicated along the eastern floodplain that would result in increases in flood planning levels. To determine if these flood level increases are directly attributable to the proposed development, the recommendations of **Finding A7** should be implemented.

viii) No local drainage flow/runoff are created by the filling

The Costin Roe report states that "no local drainage flow/runoff problems are created by the proposed filling. All local tributaries and flow paths will either operate in a similar manner to the existing regime or form part of the overall stormwater management system for the estate" (page 25).

Given that significant filling is proposed across much of the site there will be considerable changes to local drainage. This will need to be appropriately accounted for by the local stormwater management system.

ix) The filling does not occur within the drip line of existing trees

The Costin Roe report states that "filling is proposed within rezoned rural land and existing trees outside of the proposed rezoning areas are not affected by proposed filling activities" (page 25).

Notwithstanding, cut and re-grading works are proposed to offset the loss of flood storage associated with the proposed filling. As shown in **Figure 11**, the proposed areas of cut and re-grading include a significant area of riparian vegetation. While the works affecting the vegetation do not technically constitute "filling", it is evident that these trees would be affected by the proposed development and it is not clear why this criterion would not be applicable (**Finding A12**).

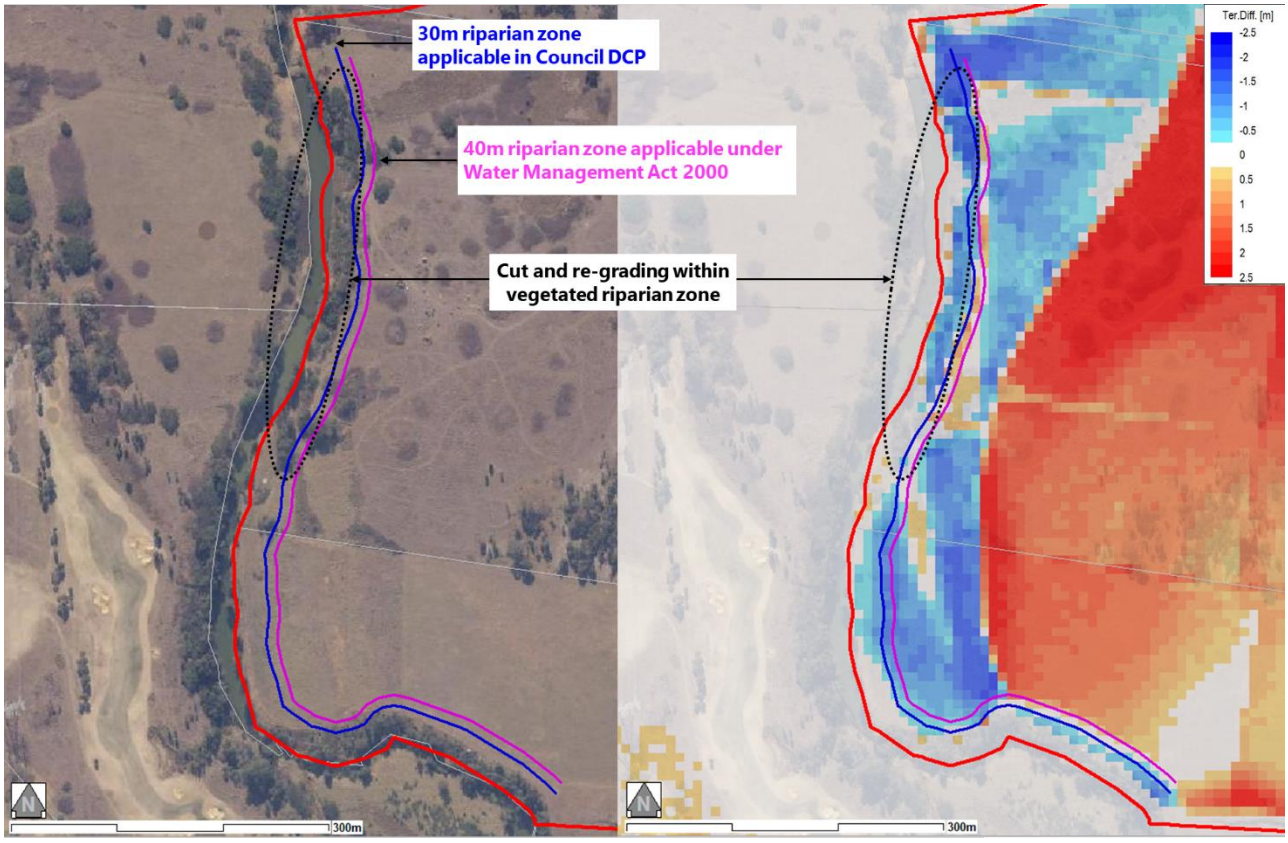

Figure 11 Proposed cut affecting area of riparian vegetation

3.2 Penrith City Council DCP (2014), Chapter C3.5

Chapter 3.3 of Penrith City Council's DCP (*2014*) provides information on controls applicable to watercourses, wetlands and riparian corridors both under the DCP and the *Water Management Act 2000*.

If any activities/land uses are proposed near a watercourse, the *Water Management Act 2000* may apply. A Controlled Activity Approval may be required from the Office of Water for various activities, or if there is an exemption from this requirement, approval from Council may still be required.

A review of the criteria presented in Chapter 3.3 of the DCP (2014) indicates that the proposed Mamre South Precinct development would not meet the following criteria (**Finding A13**):

1) Controlled Activity Approval under the Water Management Act 2000

b) Excavation in a river, estuary or lake, or within 40m from the top of its bank or shore;

c) Removal of material (including vegetation) from the bank or shore of any river, estuary or lake or from within 40m from the top of the bank or shore;

d) Deposition of material, whether by way of landfill operations or otherwise on or within the bank or shore of any river, estuary or lake or within 40m from the top of the bank or shore (*i.e. part of the OSD basin embankment lies within the 40m buffer zone*)

3) Avoiding Modification to Natural Waterbodies

a) There should be no modifications to a natural (or historic) waterbody in its dimensions, depth or bank height unless it seeks to enhance the ecological outcomes of the waterbody (*i.e. the proposed development should not modify the existing South Creek bank height*)

4) Protection and Enhancement of Riparian Corridors

a) All riparian corridors should comprise a vegetated riparian zone along each side of the waterway waterbody (*i.e. the proposed development should not remove riparian vegetation along South Creek*)

b) The vegetated riparian zone should retain or be vegetated with, fully structured native vegetation (trees, shrubs and groundwater species).

c) In relation to activities within the vegetated riparian zone, such as cycleways and paths, detention basins, stormwater management devices and essential services, compliance is required with the 'riparian corridor matrix' in the NSW Office of Water's Guidelines for riparian corridors on waterfront land (July 2012).

d) A managed buffer zone outside the vegetated riparian zone should be provided (where possible), to provide an additional buffer between development and the vegetated riparian zone. Land uses within the managed buffer zone could include roads, paths, playgrounds and stormwater management devices.

f) Appropriate widths for vegetated riparian zones will depend on the specific ecosystems being managed. Council's approach to determining the Order of Stream is based on the Strahler methodology, which is consistent with the NSW Office of Water. Council reserves the right to assess each riparian corridor and each development on its merits. In general, however, the width will depend on the order of the stream/watercourse (*see Figure C3.2, 30 m for South Creek*) which provides an indication. The width should be measured from the top of the highest bank on both sides of the stream/watercourse, excluding any managed buffer zone, and shall comply with the requirements outlined in Table C3.3.

3.3 Mamre South Land Investigation Area DCP (2019)

The primary aim of the Mamre South DCP is to facilitate the redevelopment of the land subject to the provisions of State Environmental Planning Policy (Western Sydney Employment Area) 2009.

Part 5.1 Flood Management describes the requirements for development and assessment of impacts from a flooding perspective. These requirements directly reflect those in the Penrith City Council DCP (2014).

Part 5.2 Stormwater Quality Management describes the requirements for development rom a stormwater quality perspective. Control (f) under this chapter confirms that "*where stormwater treatment measures are located in riparian corridors, they must be installed in a manner consistent with the requirements of the NSW Office of Water*" (**Finding A14**).

Accordingly, controlled activity approval under the Water Management Act 2000 (*refer* **Section 3.2**) would be required for any excavation, removal of material including vegetation, or deposition of material within the 40m riparian corridor from the top of the eastern bank of South Creek.

Other potential issues relating to the proposed development are also raised as follows:

- Figure 2 of the Mamre South DCP (2019) shows site constraints which includes the presence of land classified as 'Threatened Species (High Condition)' within the riparian corridor of the site (*refer* **Figure 12**). The proposed development should consider any additional requirements that arise from this (**Finding A15**).
- Figure 5 of the Mamre South DCP (2019) shows that the "Future Southern Line Road" passes through the site (refer **Figure 13**). Similarly, a possible future freight rail corridor passes along the northern boundary of the site. The proposed development includes cut and re-grading within the possible future freight rail corridor and road reserve, and this cut volume is used to offset flood storage lost to filling of the site. For this cut area to be considered as an offset to lost flood storage, Council and/or DPIE would need to be confident that the provided volume would not later be lost associated with any future freight rail or Southern Line Road development (**Finding A16**).
- Excavation of the future freight rail or Southern Line Road corridors could also lead to an increase in construction costs should either, or both corridors proceed as intended. Increased costs would be associated with a greater requirement for re-filling the floodplain to create road or rail embankments and/or larger bridge structures.

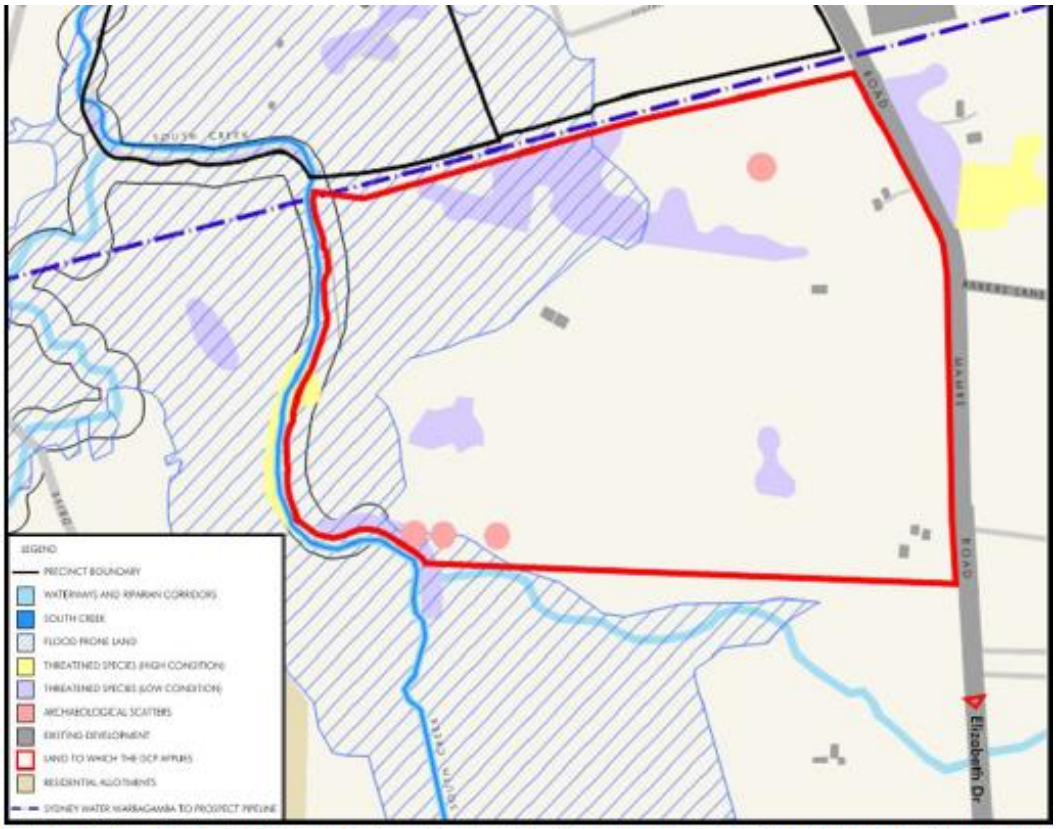

Figure 2 Site Opportunities and Constraints Map Concerning the Subject Site and Surrounding Area (Source: Nettleton Tribe, 2018)

Figure 12 Reproduction of Mamre South DCP Site Opportunities and Constraints Map

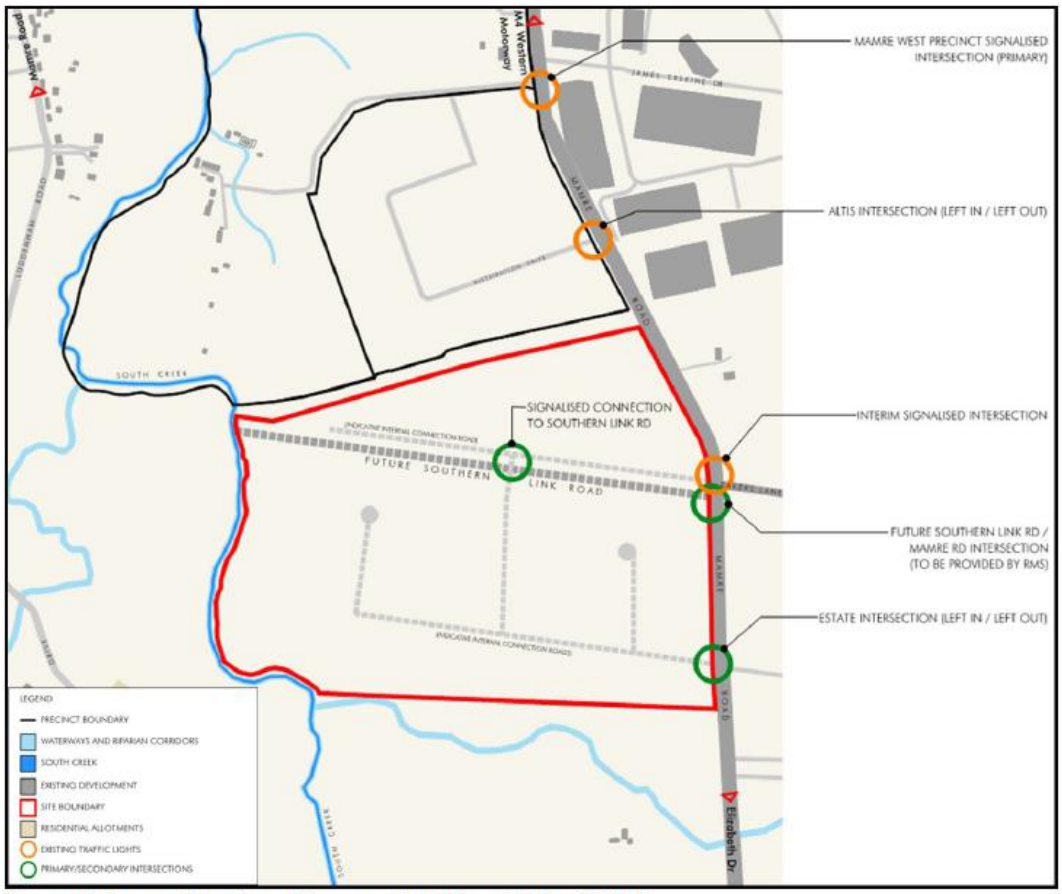

Figure 5 Access Strategy (Source: Nettleton Tribe, 2018)

Figure 13 Reproduction of Mamre South DCP Access Strategy

4 Review of Flood Safety and Evacuation

Chapter 10 of the *Overland Flow Report* provides commentary on safety and evacuation for the Precinct.

In general, the provided information and response measures appear to be appropriate, notwithstanding the following:

- Section 10.2, Paragraph 3 (page 27) provides commentary on peak velocity-depth product and the relative safety of such values for pedestrian egress. While the quoted values appear to be in the expected range, no velocity-depth product mapping is provided to confirm this. It is recommended that hazard mapping per the combined general hazard curves presented in Book 6, Chapter 7 of Australian Rainfall and Runoff 2019 (ARR2019) be prepared for the PMF to help inform safety and evacuation (**Finding A17**). These hazard categories are intended to indicate the relative vulnerability of pedestrian, vehicles and buildings to flood conditions. The hazard can be directly output from TUFLOW (output type 'ZAEM1').
- Section 10.2 (page 29) states that Erskine Park Drive provides the preferred route for egress during flood events. Review of RMA model PMF results indicates that peak PMF flood level along Blind Kemps Creek at Erskine Park Drive is 33.22 mAHD, and review of LiDAR data shows that the roadway would be inundated for a distance of about 160 m with peak depths of about 0.4 to 0.6 m. Such conditions would be unsafe for vehicular passage. However, this is recognised in the Costin Roe report and a trigger (Trigger 5) is specified after which no further evacuation would be recommended, and any remaining occupants would move to an on-site refuge zone above the PMF.

5 Conclusions and Recommendations

Table 2 to **Table 5** summarise the findings of Advisian's peer review of the Overland Flow Report prepared by Costin Roe Consulting. The comments and actions listed in each table are a summary only and should not be read in isolation of the more detailed discussion provided in earlier sections of this report.

Of the seventeen comments raised, the following four are considered to be major and their resolution is critical for the development proposal to be able to proceed.

(1) Parts of the proposed OSD basin are located within the designated "floodway" and in areas classified by the *Updated South Creek Flood Study* (*2015*) as "high hazard". Those parts of the basin that encroach into the designated floodway include the OSD basin embankments. The embankments will be formed by fill which constitutes "development" in the floodplain that would create an impediment to the free flow of floodwaters. This is in direct violation of Chapter C3 Section 3.5 of the Penrith City DCP (2014) which states that "*Council will not grant consent to filling of floodways or high hazard areas*".

(2) The post-development model terrain indicates that excavation is proposed in close proximity to South Creek and within the riparian corridor as defined by the Penrith City Council DCP (2014) and the Water Management Act (2000). This excavation is considered to be significant and potentially detrimental to maintaining the local ecology and environment of the watercourse. Accordingly, there is potential for the proposed excavation to be contrary to the objectives of Council's DCP and the Water Management Act 2000.

The Costin Roe Consulting Report does not directly address this excavation. Hence, it is unclear if the extent of earthworks that has been modelled by Costin Roe Consulting is a true reflection of the proposed works. It is also likely that Costin Roe Consulting's conclusion that that the development proposal will result in "acceptable flood impacts" is contingent on this excavation being allowed. Hence, it is imperative that:

(a) the potential for approval of the proposed excavation to be established prior to the modelling being accepted as is; and,

(b) if the proposed excavation is approved, that evidence be provided confirming that the associated change to the landform has been incorporated within the post-development flood model.

(3) The proposed development includes excavation within the "Future Southern Line Road" corridor and future freight rail corridor, both of which pass along the northern boundary of the site. The associated cut volume appears to have been used to offset flood storage lost to filling of the site and to maintain the conveyance capacity of the floodway corridor. Should either or both corridors be developed in the future as intended, the excavation with likely be filled and any associated flood storage benefits lost. Accordingly, it is inappropriate to use this "cut" to offset the loss of flood storage due to the proposed filling.

(4) Review of the post-development model terrain indicates that the OSD basin embankment and crest level is poorly defined. The Overland Flow Report is silent on this issue. As there is no evidence of a 'break-line' being used within the provided TUFLOW files, it appears that the modelling does not adequately define the basin and the obstruction it could cause to floodwaters. This suggests that the impacts associated with the development are underestimated.

Table 2 Findings Related to Review of Flood Modelling and Results

ID	Finding	Proposed Action
A1	The South Creek TUFLOW inflow boundary lies within both the South Creek Dam and adjacent Kemps Creek channel. Comparison of RMA and TUFLOW 1% AEP peak flood levels shows that this results in significantly lower (1.3 m) TUFLOW peak flood levels within South Creek Dam and indicates that a greater proportion of flow is being directed into Kemps Creek than in the RMA model.	The South Creek TUFLOW inflow boundary should arguably be moved further upstream to ensure flow behaviour is properly resolved in the vicinity of the South Creek Dam and Kemps Creek confluence, however relatively low differences in flood level upstream of the proposed development site indicate that this may not be critical
A2	The post-development scenario has not accounted for changes in landuse and Manning's 'n' associated with new and proposed commercial/industrial development. While the post-development terrain is predominantly above the 1% AEP peak flood level, the changes in landuse may affect larger floods such as the 0.5% AEP and PMF.	Post-development modelling to include changes in land use and corresponding changes in Manning's 'n'
A3	Section 6.1 of the Overland Flow Report states that TUFLOW modelling adopted a 7 m grid size. Review of the provided TUFLOW geometry control file reveals that a model grid size of 8.5 m was adopted.	Reporting to reflect true TUFLOW model grid size
A4	The 8.5 m model grid size is considered coarse, particularly for a relatively small model extent where model run times do not place any significant constraint on grid size. This contributes to poor topographic representation of the proposed OSD basin (*refer* Finding A5)	It is recommended that future modelling adopt a grid size of not more than 5 m.
A5	Review of the post-development model terrain indicates that the OSD basin embankment and crest level is poorly defined. Without any further information within the Overland Flow Report or any indication of a 'breakline' used within the provided TUFLOW files, it appears that the modelling does not adequately define the basin and the obstruction it could cause to floodwaters.	"2d_zsh" lines should be used to enforce topographic elevations of hydraulically important features such as the OSD basin embankment crest and overflow weir that may not otherwise be reliably captured by the TUFLOW grid.
A6	The Overland Flow Report (refer Table 9.1, Criteria 5) states that the OSD basin was modelled as 80% full on the basis that the peak of local flows into the basin would be unlikely to align with the peak of flooding in South Creek. The post-development model terrain adopted a level of 32.5 mAHD to represent this 80% full condition. From the available information it could not be confirmed how this level was determined. Drawing DA414 suggests that an 80% full condition would equate to an RL of at least 32.72 mAHD.	Additional justification of the 80% full initial basin condition should be provided along with calculation of the corresponding RL.

ID	Finding	Proposed Action
A7	In addition to the proposed Mamre South Precinct development, the post-development scenario adopted by Costin Roe includes two recently constructed developments (Twin Creeks and First Estate Stage 1) and another unapproved development subject to a separate Development Application (First Estate Stage 2). This presents difficulties in assessing the flood impacts that are directly attributable to the proposed Mamre South Precinct development. Similarly, the pre-development scenario does not include the now constructed Twin Creeks and First Estate Stage 1 developments.	To allow flood impacts directly attributable to the subject development to be assessed, it is recommended that: - The pre-development scenario include recently constructed developments (Twin Creeks and First Estate Stage 1) - The post-development scenario include the above and the proposed Mamre South Precinct development - Any unapproved developments not included in this DA (e.g. First Estate Stage 2) be included only in scenarios investigating the cumulative impact of development.

Table 3 Findings Related to Review of Council DCP (2014) Requirements

ID	Finding	Proposed Action
A8	Chapter C3 Section 3.5 of the Penrith City DCP (2014) states that "Council will not grant consent to filling of floodways or high hazard areas. Parts of the proposed OSD basin are located within areas that are designated as both "floodway" and "high hazard". The embankments of the proposed basin would raise the topography above the existing level, obstruct flood flows and potentially reduce flood storage. Accordingly, this would be considered filling of a floodway area and would not be permitted under the DCP.	The proposed design should not have any fill, including that associated with the OSD basin, encroach upon areas designated as "floodway" or "high hazard".
A9	There are difficulties assessing the proposed development against the merit-based criteria under Chapter C3 Section 3.5 of the Penrith City DCP (2014) as flood impacts directly attributable to the subject development are not known. Offsite flood level impacts exceed the 0.01 to 0.02 m criterion set by Council and DPIE, and any assertion that these impacts are related to other developments would need to be substantiated.	It is recommended that future modelling follow the guidance presented under **Finding A7**. This would be required to determine whether flood level impact requirements for the development as set by the DCP, Council and DPIE are met.
A10	Additional assessment of the potential for cumulative impacts of possible filling proposals in the surrounding area is recommended.	The following is recommended: - That the recommendations of Finding A7 be implemented to assess those impacts directly attributable to the proposed development - That a 'cumulative impact' scenario be assessed including the proposed development, other proposed development on the eastern floodplain (i.e. First Estate Stage 2), and filling of properties on the western floodplain to above the 1% AEP peak flood level outside of the floodway corridor and high hazard areas.

ID	Finding	Proposed Action
A11	The Costin Roe report states that proposed filling associated with the development causes a displaced storage volume of 75,000 m^3 and that compensatory flood storage of 87,800 m^3 is provided along the south-west corner and north-west corner of the proposed development within the floodplain. This suggests that additional flood storage is provided. However, it is noted the storage calculations are sensitive to the proportion of the OSD basin storage which is considered active (i.e. the proportion of storage that remains empty and available for flood storage at the time that flooding from South Creek occurs). It is also not clear to what elevation or design flood event these calculations apply.	Assumptions about active storage in the OSD basin made in overall flood storage volume calculations should be provided along with justification for these assumptions. Storage calculations should also provide a reference against which they are based. It is recommended that any calculations of pre and post-development storage be undertaken for elevations up to and including the 1% AEP flood and the PMF.
A12	Cut and re-grading works are proposed to offset the loss of flood storage associated with the proposed filling. The proposed areas of cut and re-grading include a significant area of riparian vegetation. While the works affecting the vegetation do not technically constitute "filling", it is evident that these trees would be affected by the proposed development and it is not clear why this criterion would not be applicable.	It is recommended that the proposed development avoid disturbance of riparian vegetation.
A13	A review of the criteria presented in Chapter 3.3 of the DCP (2014) indicates that the proposed Mamre South Precinct development would not meet various criteria relating to the riparian corridor.	All requirements under Chapter 3.3 of the DCP (2014) relating to the riparian corridor are to be considered in the proposed design.

Table 4 Findings Related to Review of Mamre South DCP (2019) Requirements

ID	Finding	Proposed Action
A14	*Part 5.2 Stormwater Quality Management* describes the requirements for development from a stormwater quality perspective. Control (f) under this chapter confirms that "*where stormwater treatment measures are located in riparian corridors, they must be installed in a manner consistent with the requirements of the NSW Office of Water*".	Controlled activity approval under the Water Management Act 2000 would be required for any excavation, removal of material including vegetation, or deposition of material within the 40m riparian corridor from the top of the eastern bank of South Creek
A15	Figure 2 of the Mamre South DCP (2019) shows site constraints which includes the presence of land classified as 'Threatened Species (High Condition)' within the riparian corridor of the site	The proposed development should consider any additional requirements that may arise from this.
A16	Figure 5 of the Mamre South DCP (2019) shows that the "Future Southern Line Road" passes through the site. Additionally, a possible future freight rail corridor passes along the northern boundary of the site. The proposed development includes cut and re-grading within the possible future freight rail corridor and road reserve, and this cut volume is used to offset flood storage lost to filling of the site.	Council and/or the Department of Planning, Industry and Environment should determine whether areas of cut within the possible future freight rail corridor and road reserve can be considered as an offset to lost flood storage. That is, that the provided cut volume would not later be lost associated with any future freight rail or Southern Line Road development.

Table 5 Findings Related to Review of Flood Safety and Evacuation

ID	Finding	Proposed Action
A17	Section 10.2, Paragraph 3 provides commentary on peak velocity-depth product and the relative safety of such values for pedestrian egress. While the quoted values appear to be in the correct order of magnitude, no velocity-depth product mapping is provided to confirm this.	To help confirm flood safety and evacuation constraints, it is recommended that hazard mapping per the combined general hazard curves presented in Book 6, Chapter 7 of Australian Rainfall and Runoff 2019 (ARR2019) be prepared for the PMF. These hazard categories are intended to indicate the relative vulnerability of pedestrian, vehicles and buildings to flood conditions. The hazard can be directly output from TUFLOW (output type 'ZAEM1').

6 References

- Costin Roe Consulting (*2019*), *'Overland Flow Report SSD 9522 Mamre Road & Southern Link Rd Orchard Hills NSW'*, Rev G, 16 May 2019
- Penrith City Council (*2015*), *'Updated South Creek Flood Study'*, prepared by WorleyParsons for Penrith City Council, in association with Liverpool, Blacktown and Fairfield City Councils and the Department of Environment, Climate Change & Water.
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