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LOWER HUNTER FLOODPLAIN CUMULATIVE DEVELOPMENT IMPACT STUDY & PLAN

Stage 3 – Planning Framework

GLN Planning Pty Ltd Trading as GLN Planning
ABN 39 585 269 237

A Level 10, 70 Pitt Street Sydney NSW 2000
P GPO Box 5013, Sydney NSW 2001
E info@glnplanning.com.au
T (02) 9249 4109 F (02) 9249 4111

glnplanning.com.au

Lower Hunter Floodplain Cumulative Development Impact Study and Plan

Stage 3 – Planning Framework

Prepared for

Port Stephens Council in conjunction with Maitland City and Newcastle City Councils

By

ABN 39 585 262 237

A Level 10, 70 Pitt Street, Sydney 2000 P GPO Box 5013, Sydney NSW 2001

T (02) 9249 4100 F (02) 2949 4111 E info@glnplanning.com.au

glnplanning.com.au

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1 Summary & Recommendations

Aim of Study

The aim of this study is principally to contribute to improved flood risk management outcomes for the lower Hunter River floodplain by providing planning recommendations that address the management of cumulative impacts through an update of existing planning controls and by providing direction to assist strategic planning.

Summary

This report is for Stage 3 of a 3 stage Study. Stage 1 was a scoping study and was completed in 2021 by Water Research Laboratory of the School of Civil and Environmental Engineering at UNSW Sydney. Stage 2 was prepared by KBR and utilised computer models to assess the sensitivity of the floodplain to filling. Stages 2 and 3 were prepared concurrently and Stage 2 informed the planning recommendations required for Stage 3.

The Study has been prepared for the combined broader floodplain administered as part of the three separate Local Government Areas of Port Stephens, Maitland and Newcastle. The 3 study area Councils and the Department of Planning & Environment (DPE, now Department of Climate Change, Energy, the Environment and Water) providing direction for the Study.

There are over 40,000 properties within the study area, the majority (about 90%) are occupied. Approximately half of all properties are occupied residential-urban lots in the Newcastle LGA. The Hunter Regional Plan 2041 forecasts a population increase of 949,850 people over the next 20 years in the Hunter Valley, of which a proportion is expected to be located within the Hunter River floodplain study area. There are presently in the order of 2,300 vacant lots of varying size within the study area with development potential, together with land identified for urban release and major infrastructure projects.

The Study Area is diverse and complex. The subject floodplain has a ubiquitous and broad range of existing development potential imbedded in current planning controls, with relatively minor areas of future urban releases that extend into the floodplain. Avoidance of cumulative impacts by simply prohibiting any fill within hydraulically categorised parts of the floodplain (such floodway and storage areas) requires complex deliberations about how to delineate such areas and how to address existing development expectations in established areas. That approach is best suited to situations that involve the broadscale conversion of rural land to urban land, and not situations where some filling might be contemplated under existing and future planning controls and strategies, where a more nuanced response is warranted. While this study is limited to the scope assigned by the brief, this study should not be interpreted as implying that broader FRM issues beyond cumulative flood impacts need not be taken into consideration when assessing the acceptability of filling.

To facilitate development permissible under current planning controls filling of land to reduce flood liability is often proposed. The 3 study area Councils have different planning requirements for the consideration of the potential impact of such filling and recognise a lack of guidance on how to address the cumulative impacts of all such developments. This is particularly difficult if considering cumulative impacts that inevitably extend across LGA boundaries. Accordingly the 3 Councils have cooperatively commissioned this study through the NSW flood risk management program administered by the DPE.

High level assessments undertaken as part of the Maitland Floodplain Risk Management Study and Stage 1 Scoping Report anticipated that considerable filling of flood storage areas can be accommodated without causing significant impacts, but generally it was recognised that this could vary depending the specific location of filling. The Newcastle Floodplain Risk Management Study considered that there could be some places in the floodplain where filling would be acceptable but this would be generally unsuitable within floodways and flood storage areas despite there being extensive land zoned for urban purposes in such areas.

Current regional planning strategies do not specifically address the issue of cumulative flood impacts other than where it might impact evacuation capabilities, but advocate for local planning to align with state based planning polices and to ensure that future residential areas are not planned in areas exposed to a high risk from flooding, with climate change considered.

Impacts from filling could be generated as a consequence of development applications lodged with Council, State Significant development or Infrastructure applications or projects that are self-determined by government agencies or Councils under Part 5 of the *Environmental Planning & Assessment Act, 1979*. State Significant development or Infrastructure or Part 5 Projects are expected to have regard to Council planning controls and/or for councils to be consulted in their assessment process. As required by the brief this report provides recommended planning controls for the study area Council Development Control Plans which will directly apply to development applications lodged with the Councils but can also provide guidance in regard to proposals that follow other approval pathways.

The Council's LEPs contain the standard flood risk management clause 5.21 which includes an objective related to the management of cumulative impacts, however the majority of relevant guidance is contained within Development Control Plans (DCPs). Both the Maitland and Port Stephens DCPs include filling thresholds that if exceeded trigger a requirement for a site specific flood impact assessment. Newcastle restricts filling in floodways other than associated with minor alterations, and filling of onsite flood storage capacity by more than 20%. None of the DCPs provide quantitative controls for assessing the acceptability of any impact that could be determined by a site specific flood impact assessment.

Stages 2 and 3 of the Study were prepared in a collaborative process. The work undertaken in Stage 3 informed the extent and nature of filling to be expected in the floodplain associated with development or redevelopment on existing urban zoned land, the various filling activities associated with a rural house pad or a stock refuge area in a rural zone, and from new infrastructure. Stage 3 also provided an analysis of criteria to apply to determine what extent of impacts could be considered acceptable.

A review of existing policies and practices in NSW and other jurisdictions revealed that there is no single definitive existing guidance as to how to assess the acceptability of cumulative flood impacts. In principle this will vary depending on the economic, social and environmental context associated with each situation, consistent with the merit based approach of the Manual. The new Flood Risk Management Manual provides a comprehensive range of criteria, including examples of some numerical standards, as a "starting point", but there is an implied expectation that further analysis will ultimately determine the acceptability of potential impacts for individual floodplains.

Planning controls and assessments commonly undertaken for the purposes of assessing the acceptability of a development proposal (including the construction of infrastructure by public authorities) often conflate impacts associated with individual proposals and cumulative impacts. The assessments associated with individual proposals are commonly referred to as Flood Impact

Assessments (FIAs). Some planning controls require FIAs to also consider cumulative impacts, but there is no consistent approach to this across NSW. A FIA assessment could form part of a broader Flood Impact and Risk Assessment, where Council requires broader floodplain risk management issues (such as emergency management) to be reviewed.

The impacts generated by the testing of alternate development scenarios were not linear or homogeneous across the whole of the floodplain. The determination of what was an acceptable cumulative impact was consequently based on an iterative modelling process that sought to minimise impacts applying the starting point cumulative impact assessment criteria in the Manual. The flood modelling allowed for consideration as to what land uses were impacted and to what degree.

A flood level increase of 100mm was used as a maximum but generally flood level increases exceeding in the order of 50mm were avoided in urban residential areas which were considered to be relatively more sensitive to flood impacts than other areas. Changes in flood velocities were not significant when analysed on a cumulative impacts basis and other considerations outlined in the Manual were determined to be likely to be consequentially addressed if impacts on flood levels were managed. Avoidance of filling in floodways and flood storage areas were identified as key factors that should be reflected in the planning controls and guidelines to be prepared as an outcome of this study.

Stage 2 modelled a series of filling scenarios in an iterative process. The initial iteration investigated a worst case filling scenario that involved the filling of all urban land to the FPL, fill pads on all vacant rural lots and all known infrastructure projects, being the maximum conceivable volume of filling in the floodplain. The first modelling iteration revealed impacts beyond potential thresholds of acceptability while a significantly revised iteration for the worst affected part of the floodplain indicated that there could be further capacity in some parts of the floodplain. As the intent of the Study was to identify thresholds that allowed for equitable and sustainable filling across the floodplain that facilitated reasonable development outcomes based on current zoning and planning strategies, further modelling was undertaken to eventually identify acceptable thresholds of filling for different land use activities that allowed for equitable and sustainable filling across the floodplain and reasonable development outcomes.

Stage 2 also required simulation of assigned development examples for the assessment of localised flood impacts. Six scenarios were modelled to identify which situations result in localised adverse impacts on flood behaviour, such as heightened flood heights due to afflux effects or material increases in velocities. The range of scenarios chosen were those which were expected to provide sufficient information from the modelling outputs to guide the recommendation of planning controls that could minimise adverse impacts. The results of this modelling informed the proposed DCP controls.

Recommendations

Our recommendations relate to the establishment of a framework that can be applied by each council that ensures a consistent approach, and broader considerations not directly within the scope of the study, while allowing for appropriate tailoring to suit the circumstances of individual LGAs. Preliminary assignments of priority (high, medium or low) and time frames are also provided.

Recommendation	Priority	Timeframe
Base Principles		
1. Adopt as policy the following base principles for the purposes of preparing planning strategies and development controls, and for future flood risk management studies: i. The assessment of flood impacts should be based on consideration of the effects of development across the whole of the floodplain, irrespective of administrative boundaries. ii. Any change to the natural or built conditions in the floodplain should not have a material economic, environmental or safety impact on other properties or users in the floodplain. iii. When determining whether a change will have a material impact, an allowance should be made for tolerances in the accuracy of flood modelling and in consideration of the relative vulnerability of different properties and users that may be potentially impacted. (eg residential dwellings should be afforded lower tolerances than parks or rural land). iv. The criteria for assessing the acceptability of impacts from an individual development should be less than the criteria for assessing cumulative impact. This takes into account that there could always be further development in the floodplain that should be allowed for when assessing acceptability.	High	1 year
Development Control Plans		
2. Incorporate the Draft DCP controls provided as Appendix D into the DCPs of each of the 3 study area Councils. The process of amending the DCPs is to be undertaken by the individual Councils, in accordance with the process specified by the EP& A Act and Regulation.	High	2 years
3. The formatting and presentation of the controls may vary between each Council DCP but the substantive intent and metrics within should remain consistent. Where variations are sought, those amendments should be discussed between the individual Councils with the aim of maintaining consistency.	High	Ongoing
4. For the purposes of applying the recommended planning controls any reference to an FPL should be inclusive of added levels associated with climate change consistent with the approach taken by Stage 2 of this Study.	High	2 years
Technical Guidelines		
5. Adopt the Technical Guidelines provided as Appendix E to supplement the DCP controls.	High	2 years
6. The formatting and presentation of the Guidelines may vary between each Council but the substantive intent and metrics within should remain consistent and, where variations are sought, those amendments should be discussed between the individual Councils in the aim of maintaining consistency.	High	Ongoing

Flood Maps			
7.	Incorporate into Councils flood risk information maps, the floodway and flood storage areas delineated by the Stage 2 component of the Study. This will be required for the efficient application of the recommended DCP controls..	High	2 years
Strategic Planning			
8.	The study area Councils to collectively approach the Department of Planning & Environment to undertake a review, at a regional level, of existing zoned development and review options for reducing future development in areas where filling to the flood planning level would not be acceptable having regard to the findings of this study.	Medium	5 years
9.	Councils should apply a risk based approach to floodplain planning which would allow for the identification of suitable locations based on the flood sensitivity of a land use and the flood hazard characteristics of the floodplain.	Medium	Ongoing
10.	Ensure that no future new planning decisions would require filling that could result in unacceptable flood impacts. Any proposal that varied from current zoning potential would need to ensure that its contribution to the acceptable threshold limits is not worsened. The flood models established as part of Stage 2 of this Study, or updated equivalent versions, should be used to assess this, and this should ideally be undertaken as part of the broader flood risk management process specified by the Manual.	High	Ongoing
Data Base			
11.	Consider relying on LIDAR updates to review modelling periodically, and existing Council record systems to avoid approving future applications for filling of properties that have already taken up assessed filling potential.	High	1 year
12.	If Councils are not satisfied that the above processes will be adequate, collectively pursue the establishment of a centralised data base in accordance with the parameters outlined by this Study.	High	2 years
13.	Investigate the feasibility of establishing a register and system for the trading of filling allowances between properties.	Low	5 years
Communication Strategy			
14.	Pursue a coordinated communications strategy that provides consistent messaging between all Councils.	High	Ongoing
15.	The Councils should place draft DCP controls on public exhibition at the same time and liaise and agree in regard to any post exhibition amendments in the aim of maintaining consistency.	High	Ongoing
Coordination between Councils and Stage Agencies			
16.	When consulted in regard to state significant infrastructure and state significant development projects, Councils should require:	High	Ongoing

Flood Maps		
i. the findings of this Study, including the recommended planning controls, be taken into consideration; ii. the flood models established as part of Stage 2 of this Study, or updated equivalent versions, be used for assessment purposes.		
17. The Hunter Vally Flood Mitigation Authority, and the DPE delegates responsible for consideration of applications under Section 256 of the *Water Management Act 2000,* be advised of the outcome of this Study and recommend that it be considered when reviewing future applications.	Medium	1 year
18. Investigate the establishment a flood risk management user group comprising technical staff (development and strategic planners and engineers) from each of the Councils and DPE (EHG Group) to discuss matters related to the implementation and review of the Study recommendations and broader flood planning issues.	Medium	2 years
Monitoring and Review		
19. Monitor the extent to which development is progressing relative to the parameters adopted for the purposes of Stage 2 modelling and initiate when a review process would be appropriate.	Medium	Ongoing
20. Reviews should be considered every 5 years based on a comparison of modelled and updated LIDAR information and/or by reference to a data base, as recommended above.	Medium	5 years
Other		
21. That the study area Councils collectively consider the adoption of flood planning levels for all purposes based on the same criteria, including factoring in the effects of climate change.	Medium	5 years
22. While the recommended DCP controls refer to acceptable levels of filling based on flood frequencies, consider imposing a maximum level of fill in the planning controls to address potential amenity and environmental impacts.	Medium	2 years
23. As part of future flood risk management studies, the Councils examine the residual risks associated with filling in the floodplain, for example, determine whether a refinement to the controls that create the expectation for additional dwellings are warranted where they facilitate the construction of dwellings on isolated low flood islands.	High	3 years

2 Introduction

2.1 Commission

GLN Planning was commissioned by Port Stephens Shire Council, in conjunction with Maitland City Council, Newcastle City Council and the NSW Department of Planning & Environment (EHG) to prepare Stage 3 of the Lower Hunter Floodplain Cumulative Development Management Study and Plan.

2.2 Project Overview

The Study has been undertaken in three stages:

- **Stage 1** was completed by Water Research Laboratory (**WRL**) of the School of Civil and Environmental Engineering at UNSW Sydney. This stage was a scoping study that collated available information, identified and determined the needs of the stakeholders and recommend a methodology for the subsequent stages of the project.

- **Stage 2** utilised computer models to assess the sensitivity of the floodplain to filling. The assessment analysed the cumulative impact of future development (including any significant public infrastructure upgrades) on flood characteristics. The impact assessments examined a range of floods and climate change considerations to determine acceptable levels of fill in specific areas and the design considerations for fill works. Stage 2 informed the planning recommendations required for Stage 3.

- **Stage 3** provides recommendations for catchment-wide consistent strategies, policies and development controls to manage the cumulative filling of the Lower Hunter floodplain.

This report relates to Stage 3 of the project.

As part of this Stage of the project, a GIS data base was compiled to provide information required to undertake Stage 2. As outline in detail later, the GIS data base included a range of information such as existing flood study information, latest LIDAR, vacant lots with development potential, areas identified for new residential land and known major infrastructure projects.

2.3 Study Team

The study team comprised the following:

- GLN Planning – Study leader and Planning Review
- KBR - Specialist Flood Engineering Input
- Dr Danny Wiggins – Consultation specialist
- PolisPlan -Peer Review

Dr Steve Liaros of PolisPlan has undertaken a peer review of the Study. KBR has provided technical assistance in the preparation of Stage 3 of the Study and was also separately commissioned to prepare the Stage 2 component of the Study. Dr Danny Wiggins advised on the consultation components of the project.

2.4 Study Objectives

The Stage 3 Study Brief identified that the primary objectives of the project are to:

- *Assist Councils in managing future development and reduce the impacts of flooding and flood liability on communities and to reduce private and public losses resulting from floods, and*

- *Assist the Councils, and the State Government and Planning Assessment Commission in making informed decisions on managing flood risk for future development and reduce flood damages arising from development decisions.*

In the process of addressing the above objectives and satisfying the specific requirements of the brief, we have examined the potential for filling in the floodplain associated with long term growth as well as development opportunities under current planning controls. Consequently, the recommendations of the Study address the management of cumulative impacts through an update of existing planning controls and by providing direction to assist strategic planning.

2.5 Study Area

The Study has been prepared for the combined broader floodplain administered as part of the three separate Local Government Areas (**LGA**s) of Port Stephens, Maitland and Newcastle. The study area comprises the floodplain of the Hunter River and major components of tributary rivers and creeks. The extent of the floodplain is shown in **Figure 1**.

The Study focuses on mainstream flooding and consequently the study area does not include the network of smaller tributaries and overland flow paths that feed the Lower Hunter River floodplain.

As depicted by Figure 1, extensive areas zoned for urban purposes, including large parts of the major centres of Newcastle and Maitland, are located within the floodplain. The majority of the balance of the floodplain comprises rural zoned land where dwelling houses are ubiquitously located. This reflects the historical pattern of development in the region, which focused on locations near the Hunter River and its major tributaries that provided agricultural land, water and transportation.

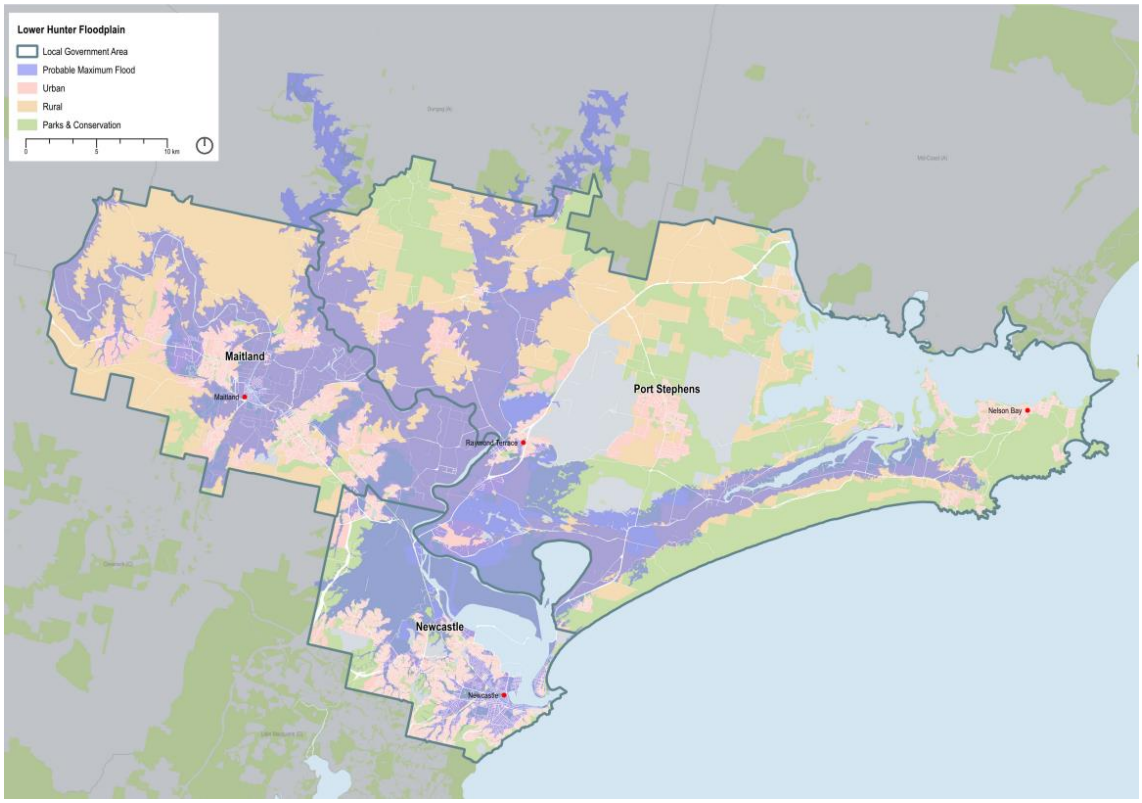

Figure 1: Study Area (GLN Study GIS)

To address the requirements of the brief, various data was compiled into a GIS based mapping system that included the following information:

- Zoning
- Vacant lots (based on Council derived information)
- Planned release areas
- Current LIDAR (2014 and 2021)
- Flood extents
- State Significant Development and Infrastructure projects.

Based on the above, the following information was derived regarding occupied and vacant lots within the study area:

Table 1: Study Outcomes for Committed & Potential Development

Study area(PMF Extent)	Port Stephens LGA	Newcastle LGA	Maitland LGA	Total
Occupied Properties				
Residential urban	2,174	21,487	5,326	28,987
Residential rural	1,209	1,108	3,656	5,973
Industrial	240	1,859	122	2,221
Other	-	2,006	424	2,430
Sub Total	3,623	26,460	9,528	37,181
Vacant Properties				
Residential urban	1,061	370	244	1,675
Residential rural	1,326	248	268	1,842
Industrial	402	229	4	635
Other	153	166	-	319
Sub Total	2,942	1,013	516	4,471
TOTAL	6,565	27,473	10,044	41,652

Note: The above lot numbers were determined by interrogating GIS information and should be considered approximate due to the potential for lots being double counted from split zoning or cadastre misalignment with zoning.

The above data shows that there are over 40,000 properties within the study area, the majority (about 90%) are occupied. Approximately half of all properties are occupied residential-urban lots in the Newcastle LGA. While there are substantially fewer residential–rural and industrial lots than residential-urban lots, these lots are much larger and therefore occupy a greater proportion of the study area.

2.6 Background

The *Hunter Regional Plan 2041* (**the HRP**, DPE December 2022) forecasts a population increase of 949,850 people over the next 20 years in the Hunter Valley (the HRP, pg.54), of which a substantial proportion is expected to be located within the Hunter River floodplain study area. There are presently in the order of 2,300 vacant lots within the study area with development potential, together with land identified for urban release and major infrastructure projects.

Filling within the floodplain is generally not done for the sake of filling - it is typically undertaken in association with development permitted under the planning controls and includes filling of vacant land or lots being redeveloped to facilitate development with the required flood immunity, filling adjacent to a new residential area to define an urban edge to the floodplain, or filling in association with rural properties to create elevated pads for building dwellings or stock refuge areas. Future filling within the floodplain could occur:

- when progressing development opportunities under the existing planning controls,
- as part of future urban development that could occur under Planning Proposals to help accommodate the housing needs

- where owners want to build resilience into their properties, recognising that flooding impacts are likely to worsen in the future
- in association with the delivery of infrastructure required to support urban growth in an area or the broader community.

The Stage 1 *Scoping Study for the Lower Hunter River Cumulative Development Impact Study and Plan* identified a number of circumstances where filling has occurred within the floodplain to facilitate permissible development, some of which have adverse impacts on flood behaviour. The Stage 1 study identified the importance for the Stage 3 Study to confirm the extent of filling expected in association with the various types of development permissible under the planning controls so that these can help inform possible future filling scenarios and the consequent loss of flood storage, as well as the exploration of solutions where applicable to limit impacts on flood behaviour.

The management of development activities within the floodplain are spread across three different local government administrations charged with implementing existing planning controls, policies and practices and planning for growth consistent with Local Strategic Planning Statements (**LSPS**s) that also reflect NSW Government's Strategies and expectations for growth in the area.

As outlined later, the planning controls in each study area Council allow development, including filling, within the floodplain to some extent. The types of development vary from area to area, including elevated pads for rural dwellings and agricultural activities in the Maitland and Port Stephens LGAs, filling of industrial land in the Newcastle and Port Stephens LGAs, and infill development, redevelopment of existing flood affected properties and provision of supporting infrastructure across all LGAs. In most cases, an assessment of flood impacts is required, and this often extends to the consideration of cumulative impacts, but these assessments inevitably conclude that development can proceed in some form with no unacceptable impacts. However, such assessments are undertaken for individual projects and consequently cannot practically consider the full extent of potential cumulative impacts across the 3 LGAs and into the long term.

There is a pressing need for the mutual consideration of the impacts of filling in the floodplain, across the 3 study area Councils, including aligning planning controls regarding filling for existing development and levering opportunities through the Planning Proposal process to manage future filling activities associated with new development. The Study also provides an opportunity to collect information that can help inform future planning decisions for the environmental health and hydraulic functioning of the floodplain.

2.7 Study Scope

The project brief for Stage 3 has required GLN to undertake a range of tasks including briefing the consultants to complete Stage 2 which has involved additional specialist modelling to inform the Study and to contribute to providing the following specific outputs:

- Prepare DCP amendments for the Councils managing cumulative filling of the Lower Hunter River floodplain.
- Prepare guidelines that show practitioners how to assess the impacts of cumulative development of the floodplain.
- Provide recommendations for developing a database to record filling of the floodplain.

The brief and study refers to the assessment of impacts based on the filling of land. The filling of land in this context means the placement of additional material on the existing or modified land surface resulting in the net raising of the existing land surface. For the purpose of assessing flood impacts any material or object (such as building, road or other structure) that is introduced onto the floodplain, could have an impact. Consequently, while this study refers to filling, consideration is also given to any building or structure that also might occur in association with development, as far as practical.

The assessment of cumulative flood impacts is needed because while flood impact assessments for individual development or infrastructure proposals might show that there are no material impacts, the cumulative impact of multiple proposals in the same floodplain over time could result in significant impacts. Such proposals were investigated at 2 levels:

- Existing committed infrastructure and development based on approved but unconstructed DAs and current or imminent zoning and planning controls.
- Potential future development including infrastructure based on strategic plans that are yet to be translated into zoning and planning controls.

The response for each of these will vary. This is discussed in greater detail later in the Study but generally can be understood to comprise for the following:

Table 2: Study Outcomes for Committed & Potential Development

Committed (ie Existing, Approved & Permissible) Development	Potential Development
• Submission requirements for development applications • Rules for compensatory flood storage based on assessment of cumulative impacts • Controls on proximity and continuity of filling • Mitigation measures to avoid unacceptable localised flood behaviour changes. • Consequential flood risk implications (eg isolation and emergency management considerations)	• Review longer term cumulative flood impacts and provide recommendations regarding refinement of urban footprints • Consequential flood risk implications (eg isolation and emergency management considerations). • Broader consideration of the implications of the suitability of development generally in the floodplain having regard to the possible consequences of extreme floods and climate change.

Existing planning controls provide the basis to determine the potential for filling in established urban areas, the urban edge, and in association with rural development. Local and regional planning strategies were reviewed to identify the existing committed and future urban release areas by mapping these as new incursions into the floodplain. We have also identified what infrastructure proposals are to occur within the floodplain.

An assessment of cumulative impacts is an exercise which is best undertaken as part of the strategic planning of an area, which is often linked with the preparation of a government funded floodplain risk management study (**FRM Study**) and floodplain risk management plan (**FRM Plan**). This

approach is reflected in the Floodplain Management Australia's (**FMA**'s) Land Use Planning Position Policy (FMA, May 2021).

An FRM Study and FRM Plan would be expected to take into consideration broader FRM matters, such as emergency management issues. For example, as discussed in the Stage 1 report, fill pads on the open floodplain can constitute "Low Flood Islands" that could be inundated unless constructed to a level above the probable maximum flood (**PMF**). The Stage 1 report estimated that of 411 fill pads identified in the Port Stephens and Maitland LGA 343 (ie 83%) would be overtopped by a PMF (excluding future climate change) which poses substantial flood safety issues. This study should not be interpreted as implying that broader FRM issues beyond cumulative flood impacts need not be taken into consideration when assessing the acceptability of filling.

The Study Area is diverse and complex. The subject floodplain has a ubiquitous and broad range of existing development potential imbedded in current planning controls, with relatively minor areas of future urban releases that extend into the floodplain. Avoidance of cumulative impacts by simply prohibiting any fill within hydraulically categorised parts of the floodplain (such the floodway and critical flood storage areas) requires complex deliberations about how to delineate such areas. That approach is best suited to situations that involve the broadscale conversion of rural land to urban land, and not situations where some filling might be contemplated under existing and future planning controls and strategies, where a more nuanced response is warranted. Accordingly, the outcome of this Study is to provide recommendations for the augmentation of existing planning controls and guidance for strategic planning that is specific to the Lower Hunter River floodplain.

An important component of the Study has been to establish the extent of impact, detectable through modelling, that is considered to be an acceptable cumulative flood impact. While the most common theoretical approach based on literature research is to avoid any increase, the wording of policies typically accepts some minor numerical increases to all or some of the following flood characteristics - flood extents, levels, flow velocities and distributions, and flood hazard. While there is variability in policies and practices, this generally arises in recognition of the need to build tolerances into standards due to accepted limitations on the accuracy of models and the potential inconsequential nature of numerically minor changes in flood characteristics when evaluating the impact on flood risks to existing and future development and the environment.

2.8 Impact of Fill on Flooding

As discussed in the Stage 1 Scoping Study, the importation of fill onto the floodplain can potentially affect flood behaviour by two mechanisms:

a) by displacing the capacity of the floodplain to store flood water causing an equivalent increase in flood levels across the floodplain (**storage impact**); and

b) by impacting on the flow path conveyance capacity, direction or velocity of flood waters by causing floodwaters to back up behind the fill and change how it would otherwise behave (**conveyance impacts**).

The approaches that could be applied to assessing the storage and conveyance impacts of flooding can vary from simplistic and qualitative assessments to complex computer modelling.

Simplistic approaches to assessing impacts often focus on the consideration of storage impacts by applying a volumetric calculation to ensure that the altered landform does not result in a net

decrease in the storage capacity of the floodplain. This approach could, for example, allow for filling to occur in a part of the floodplain provided that compensatory excavation occurs in another hydraulically linked part of the floodplain, such that there is no net change to the storage capacity of the floodplain. The assessment could also compare the proportion of net fill in the floodplain to the total floodwater storage capacity of the floodplain to determine whether this would be numerically significant. Further, a professional engineer with expertise and experience in flood modelling might be able to identify the potential for conveyance impacts based on information derived from existing flood studies.

The assessment of volumetric impacts can be complemented by the qualitative considerations of an experienced flood engineer that identify the potential for conveyance impacts by reference to the outputs of existing flood models. This could include an analysis whether the fill is located within parts of the floodplain that have hydraulic characteristics that are expected to be sensitive to the placement of fill, such as floodways or critical flood storage areas (as discussed further below).

These simplistic approaches can be fit for purpose in some circumstances but have the following limitations:

a) The impact on the volumetric capacity of the floodplain alone does not take into account the broader changes to conveyance of flood waters. Placement of quantitatively small volumes fill in some locations could have significant broader impacts, while larger volumes in some locations could have no material impacts.

b) As noted in the Stage 1 Report (pg.17) while conveyance impacts are typically localised, depending on the relative proportion of the flow deflected and the location within the floodplain, the flow redirection may cause a broader impact on floodplain flow behaviour, sometimes affecting flood levels many kilometres away.

The more complex, but more accurate approach is to apply a computer model to simulate what could wholistically occur to the behaviour of floodwaters when there is a change in the floodplain. While computer modelling provides the best approach to assessing flood impacts, there are several factors to be taken into consideration when applying them:

a) Such assessments are typically limited to a part of the floodplain such as the extent of the 1% AEP flood (ie the 1 in 100 per year chance flood) in which case they do not consider the impacts that might arise with rarer but more extreme floods or smaller more frequent floods.

b) The assessment of individual fill proposals do not typically take into account cumulative impacts. Even when a cumulative impact assessment is included, this would have significant limitations due to the practicality and cost of determining and modelling the ultimate potential for development across the whole of the floodplain, as has been required by this study.

c) Flood models necessarily rely on the adoption of various parameters and assumptions that can vary from model to model, resulting in inconsistencies between the outputs of models.

The Stage 1 report (pg.17) calculated that the total capacity of the floodplain that would contain a 1 in 100 per year chance flood is 1,154 million m^3 and estimated the volume of the fill that has been placed in this part of the floodplain over time is 5.4 million m^3 or 0.47%. On that basis the Stage 1 report anticipated the impact would be “very small” but recognises that this will be dependent on the amount and location of individual incursions of filling.

The Stage 1 report also undertook a preliminary review of potential conveyancing impacts based on flood modelling completed by BMT (pg.18). This identified situations where localised impacts could occur. The report also noted the potential for broader scale impacts within the floodplain. However, the Stage 1 report recognises the limitation of that review due the coarseness of the grid size of the modelling and that an analysis of the broader scale impacts within the floodplain were not part of the scope of that report.

The brief for the Stage 2 modelling was designed to address the above limitations while remaining practical. The parameters and assumptions that have been adopted by KBR for modelling purposes have been collectively reviewed by the Councils and DPE personnel that have provided technical direction during the preparation of the study to ensure it provides robust and fit for purpose results.

2.9 Flood Risk Management Manual

The *Flood Risk Management Manual* (Environment and Heritage Group (EHG) Department of Planning and Environment, June 2023) (**the Manual**) was gazetted during the preparation of this Study. This current Manual superseded the *Floodplain Development Manual* (**FDM**) which was gazetted in 2005.

The Manual (pg.15) recognises that there can be existing, future and continuing flood risk, where future flood risk "may be managed through the development and implementation of land-use planning instruments and policies that effectively consider the full range of floods and the cumulative impacts of development." A core activity of Council is expected to include the preparation of studies under the FRM process that include "…examining future scenarios to consider changes in risks due to climate change, and enabling consideration and management of the cumulative impacts of new development on flood risk" (pg.27).

This study is consistent with the requirements of the Manual. However, this study does not deliver all outcomes expected by the Manual which would include the preparation of Floodplain Risk Management Studies and Plans (**FRM Studies** and **FRM Plans**) in accordance with the NSW FRM process, but will provide an important input into the preparation and review of FRM Studies and FRM Plans in the future.

2.10 Determination of Acceptable Impact

A key element of this study has been the determination of what is an acceptable cumulative impact when assessing the findings of the Stage 2 modelling.

The Manual outlines matters to consider when assessing whether cumulative impacts could be acceptable, and provides examples of numeric criteria as a starting point for this assessment, but ultimately requires acceptability to be determined having regard to the particular circumstances of individual floodplains.

The determination of acceptable impact has been determined based on literature research, liaison with technical representatives of the study area councils, DPE and study team and workshops involving Council staff, as discussed later.

2.11 Limitations

Given the focus of the project brief and the scale of the study area, the following limitations to the Study are recognised:

- The Study is not intended to supplant the role of an FRM Study and FRM Plan prepared in accordance with the NSW FRM process, but is expected to provide an important contribution to the preparation or review of FRM Studies and FRM Plans in the future. Consequently, the Study will not address all potential cumulative flood impact considerations outlined in Guideline FB01, such as the effect on evacuation capacity

- Consequently, the Study does not investigate, or provide recommendations in regard to the broader range of FRM management measures, such as structural mitigation options, emergency management and flood awareness programs and FRM planning responses beyond measures to address cumulative filling impacts. Specifically the modelling undertaken to inform the Study is not intended to be used to establish or review flood planning levels (**FPL**s).

- The Study is informed by flood modelling undertaken within Stage 2 of the Study and is consequently subject to the limitations of that modelling as outlined within the Stage 2 Study Report.

- The Study has not investigated cumulative impacts associated with possible future changes to catchment characteristics such as the impervious percentage, roughness and volume of available flood storage which can impact runoff and the shape and peak magnitude of flow hydrographs. However, given the scale of the study area and disparate nature of existing and likely future development, investigation of these characteristics has not been considered essential for the purposes of this Study.

- Changes to the roughness of the floodplain through vegetation regrowth which can slow or speed up the velocity of floodwaters has not been investigated. As above, given the scale and nature of the study area, investigation of this characteristic has not been considered essential.

Despite the above limitations, the Study is considered to be fit for purpose. While, not all the potential effects of cumulative impacts are to be investigated, the overall outcome sought by the study is to contain future land filling cumulative impacts which by default will contribute to managing effects not assessed in the Study, such as impact on required evacuation warning times.

2.12 Peer Review

Dr Steve Liaros of PolisPlan was consulted at various stages in the preparation of this stage of the Study. Interim comments provided at these times were taken into consideration in the finalisation of the Study and this report. A copy of the final report on the peer review undertaken by Dr Liaros, is included as **Appendix A**.

3 Planning Context

3.1 Planning Strategies

3.1.1 Regional Planning Strategies

Greater Newcastle Metropolitan Plan 2036

The *Greater Newcastle Metropolitan Plan* (**GNMP**) was published in September 2018 to complement the then *Hunter Regional Plan 2036*. The GNMP outlines growth strategies applicable to the study area Councils and other adjoining LGAs, being Cessnock City, Lake Macquarie City, Maitland City, Newcastle City and Port Stephens communities, which together make up Greater Newcastle.

The GNMP (pg.43, Action 16.1) seeks to focus new housing in existing urban areas, particularly within strategic centres and along urban renewal corridors. As outline later, for the purposes of this Study, the impacts associated with filling all existing urban zoned land to the FPL level will be investigated. The *Hunter Regional Plan 2041* (**HRP**), discussed below, has been relied on for the purposes of identifying new areas for urban growth given its recent adoption.

Hunter Regional Plan 2041

The HRP was first published in December 2022, after the commencement of this Study, superseding Hunter Regional Plan 2036. The HRP is a 20-year land use plan prepared under the *Environmental Planning and Assessment Act 1979* (**EP&A Act**). It applies to the LGAs of Cessnock, Dungog, Lake Macquarie, Maitland, MidCoast, Muswellbrook, Newcastle, Port Stephens, Singleton and Upper Hunter.

The HRP forecast of an additional 949,850 people by 2041 would require an additional 101,800 dwellings over the next 20 years in the Hunter Valley (the HRP, pg.54). The minimum required additional dwellings in the study area Councils are outlined in **Table 3**.

Table 3 Required Additional Dwellings to 2041 (Extract from the HRP, pg.54)

Local Government Area	Required Additional Dwellings to 2041
Maitland	25,200
Newcastle	17,850
Port Stephens	11,100
TOTAL	**54,150**

Required dwelling growth has increased from the forecast of 40,400 dwellings by the GNMP, for the combined study area Councils.

Figure 2 depicts the areas identified for new residential land and housing investigation areas in the HRP. The GIS Database complied for this project identifies the location of these areas relative to other information such as flood extents. In general, areas identified for future urban growth have excluded land affected by the 1 in 100 year chance flood, other than minor incursions expected to be conserved for open space and drainage purposes.

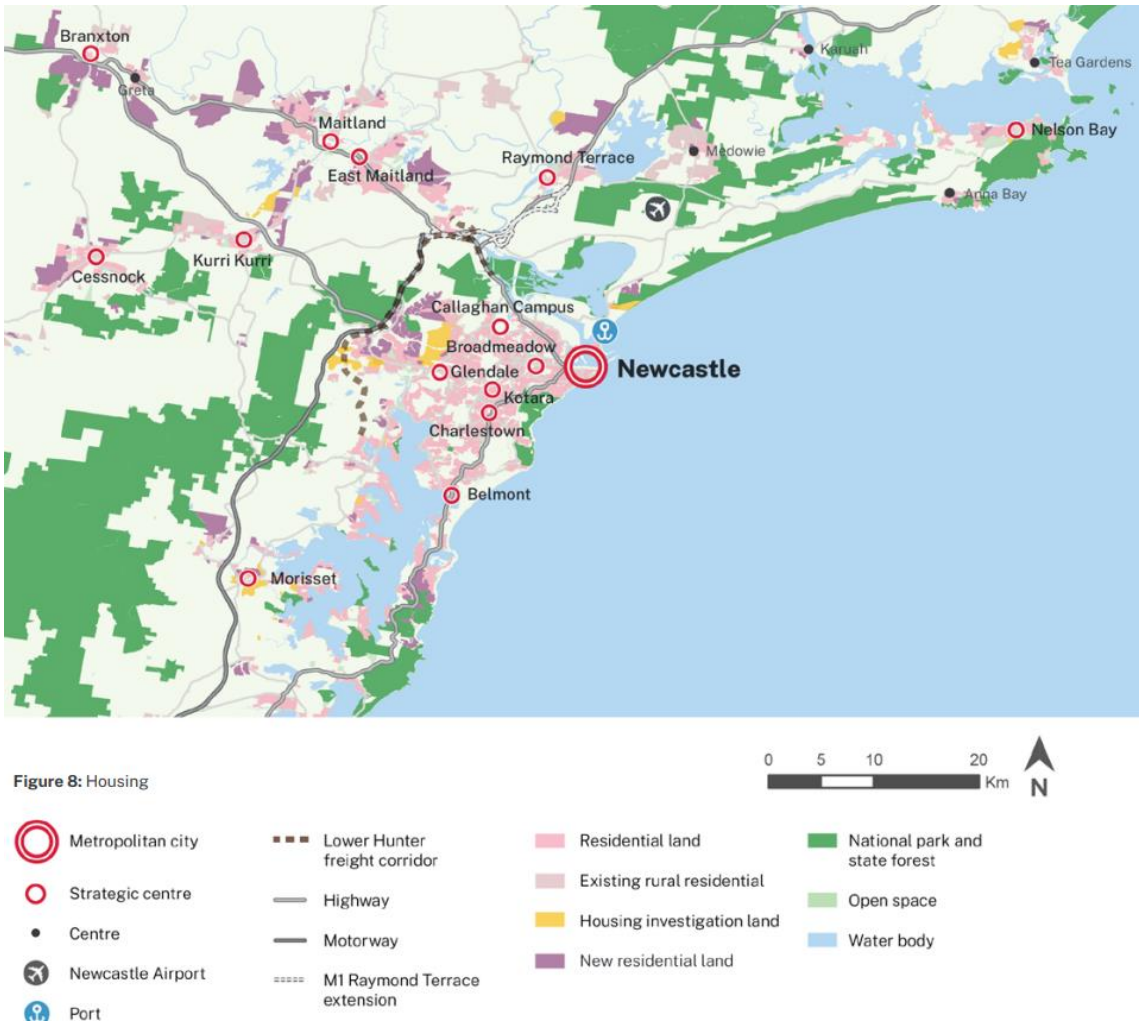

Figure 2 The HRP Housing Strategy (Extract from Figure 8 of the HRP)

In terms of flood risk management related commentary and recommended actions, the HRP provides for the following:

- Local strategic planning should identify opportunities to rehabilitate critical waterways in partnership with Local Land Services (Strategy 6.8, pg.71)

- While the potential effects of climate change on natural hazards such as flooding are recognised, no specific planning guidance has been stipulated. The HRP (pg.76) notes that given the uncertainty of exactly how and when these hazards will manifest, common sense solutions such as ensuring sensitive uses are appropriately located should be pursued.

- Local strategic planning will demonstrate alignment with the NSW Government's natural hazard management and risk mitigation policy framework including: ...*Floodplain Development Manual and the Flood Prone Land Policy* and *Planning for a more resilient NSW: A strategic guide to planning for natural hazards* (Strategy 7.7, pg.78).

- Local strategic planning will ensure future residential areas are not planned in areas where: exposed to a high risk from flooding (with climate change considered); evacuation is likely to be difficult; "any existing residential areas may be placed at increased risk"; and increased development may exacerbate evacuation issues (Strategy 7.8, pg.78).

- The HRP refers to the recommendations of the 2022 NSW Flood Inquiry and recognises the future role of the NSW Reconstruction Authority.

- In regard to the Maitland LGA, the HRP states "Additional residential development and urban renewal must consider flood mitigation infrastructure and initiatives" (Planning Priority 4, pg.101).

- Various specific flood related issues are identified for the Newcastle LGA (pg.106)

- Generalised statements are also made in regard to the hinterland district (pg.153):

  The district's floodplains are an important part of the district, and shape how [sic] *future development in the district, both on and adjoining these floodplains. Care must be given to resilience of communities connected to floodplains.*

- While the HRP seeks to diversify and expand employment opportunities, recommendations associated with employment generating industries are too broad to provide input into this Study.

Importantly, Strategy 7.8 effectively requires the consideration of cumulative flood impacts if the impact of the flood risk and evacuation capability of others is to be properly understood. This study provides a basis for that consideration.

The Six Cities Region Discussion Paper

This Discussion Paper was published by the (former) Greater Cities Commission in September 2022, to explore planning opportunities for the Six Cities Region (Lower Hunter and Greater Newcastle City, the Central Coast City, the Illawarra-Shoalhaven City, the Western Parkland City, the Central River City and the Eastern Harbour City). This region encompasses 43 local government areas, including the study area Councils.

The discussion paper identifies the Lower Hunter as within a "Future renewable energy zone" noting (pg.53) an intent to draw on existing initiatives and promote renewable energy industries in this zone. The Paper also recognises the need to consider the recommendations of the NSW Climate Change Adaptation Strategy and the 2022 NSW Floods Inquiry (pg.62).

3.1.2 Maitland City Council Strategies

The Maitland Local Strategic Planning Statement (LSPS) was published in June 2020 and provides the overall direction for the LGA that provides a line of sight back to the GNMP and now superseded HRP 2036. The LSPS Structure Plan (**Figure 3**) identifies "Planned Investigation" areas for employment and residential uses, "Future Investigation" areas generally, committed "Greenfield Development" areas and the "GNMP 2036 Catalyst Area." These have been taken into consideration in the identification of potential future urban development in the Study Area for Stage 2 of the Study.

As evidenced by the Structure Plan substantial parts of the LGA, including some existing and future urban areas, are located within the 1 in 100 per year chance floodplain. Flooding is recognised as a key constraint to residential development (pg.26). Local Planning Priority 12 (pg.48) discusses the need to consider flood risk in the planning process. However, no specific policy direction is provided in regard to addressing cumulative flood impacts associated with development.

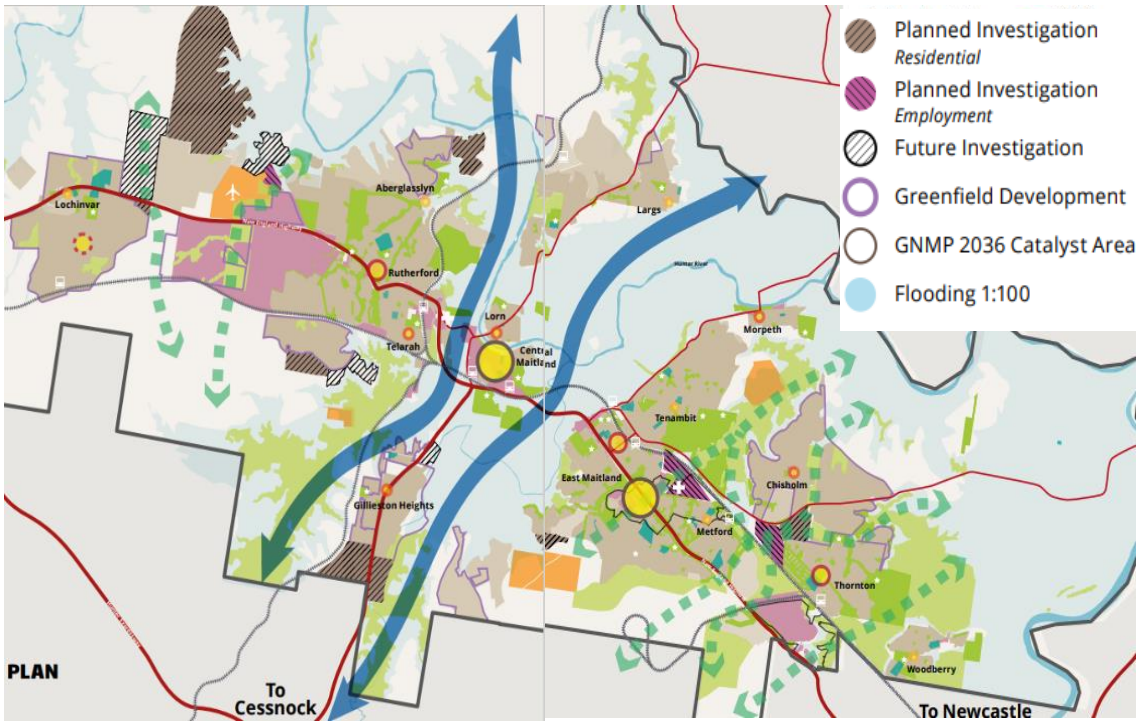

Figure 3 Maitland LSPS Structure Plan (Extract from LSPS, pgs 24-25)

The LSPS is informed by preceding Council strategies including "Maitland Urban Settlement Strategy 2012" (**MUSS**). More detailed Structure Plans have also been prepared for Lochinvar and Thornton which have also informed Stage 2 of this Study. These detailed structure plans generally exclude development from with the extent of the 1 in 100 per year chance flood.

3.1.3 Newcastle City Council Plans Strategies

The Newcastle LSPS was published in March 2021 and caters for a population projected to grow from 164,104 in 2016 to 202,049 in 2040. The Structure Plan (**Figure 4**) provides for the majority of residential growth to occur within urban renewal corridors in established urban areas, with a single "Housing Release Area" located in the western part of the LGA, effectively outside of the study area floodplain.

Employment growth is also forecast for the LGA. However, increased employment opportunities are planned for existing commercial centres, and specialised precincts such as Newcastle Port, as opposed to new urban release areas. There is significant industrial floorspace capacity in Newcastle overall, mostly located in Mayfield North, Hexham and Beresfield. There is 2,276 hectares of industrial and employment zoned land in the LGA of which about 1,000 hectares reportedly remains undeveloped for various reasons including environmental constraints such as flooding (Newcastle Employment Lands Strategy, November 2019).

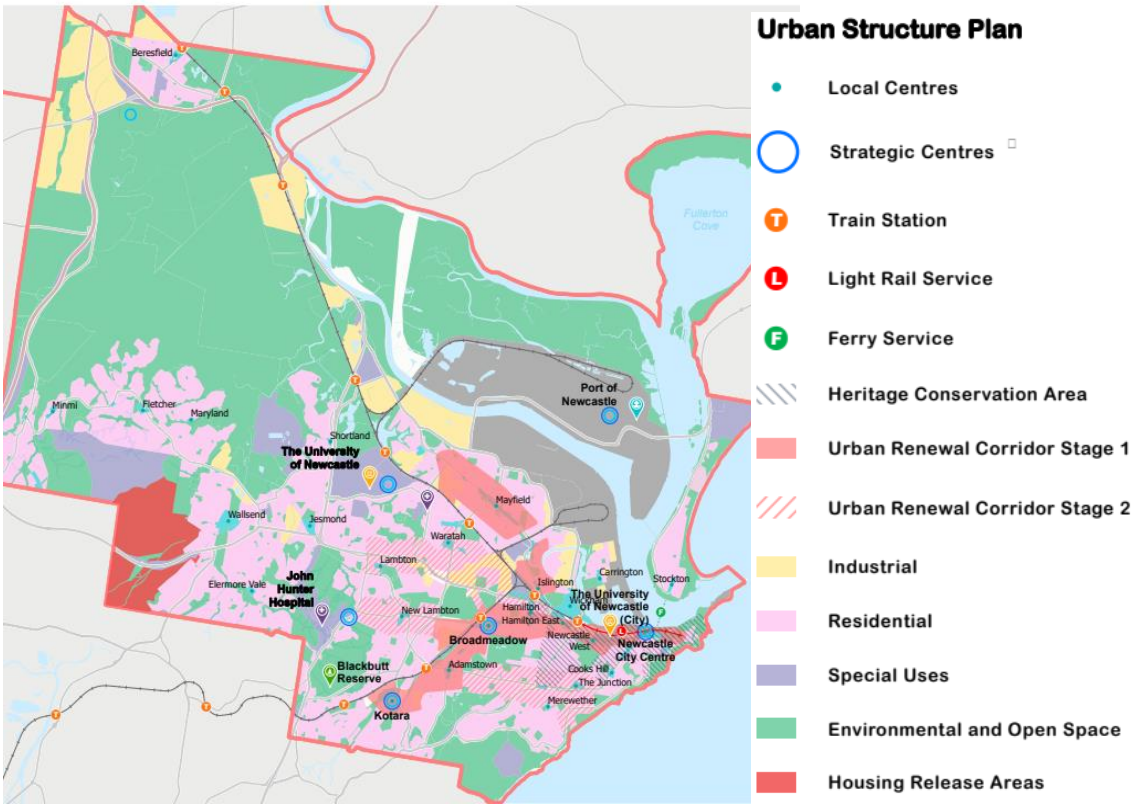

Figure 4 Newcastle LSPS Structure Plan (Extract from LSPS, pg. 18)

Significant new industrial development in the floodplain is committed to by way of existing zonings such as the Hexham Industrial Area. These areas have been considered in Stage 2 of the Study.

The LSPS has only minor references to flooding. Reduced flooding impacts is seen as a potential benefit asscoiated with enhancing green spaces (pg.33) while the worsening of natural hazards such as flooding as a consequence of climate change is recognised (pg.37). These references do not specifically refer to cumulative flood impacts.

Council has also prepared specific planning strategies for Fern Bay, North Stockton and Wickham and these have been taken into consideration to the extent relevant to this study.

3.1.4 Port Stephens Council Plans Strategies

The Port Stephens LSPS Structure Plan (**Figure 5**) does not identify any new urban release areas. However, existing zonings provide for potential greenfield housing development in Fern Bay, Kings Hill, and Medowie.

Major employment areas are located at Williamtown, Tomago, Heatherbrae and the Tomaree Peninsula. Strategic centres are identified at Raymond Terrace and Nelson Bay, as well as an emerging strategic centre at Medowie. Williamtown and Tomago are identified as 'Catalyst Areas' in the GNMP, and are likely to be the focus for employment growth over the next 20 years.

While some existing urban areas are affected by the 1 in 100 per year chance flood extent to some degree, newer areas are generally excluded from this part of the floodplain. Planning Priority 8 of

the LSPS (pg. 31) identifies various actions to manage risks from natural hazards such as flooding. These actions do not specifically require a consideration of cumulative flood impacts.

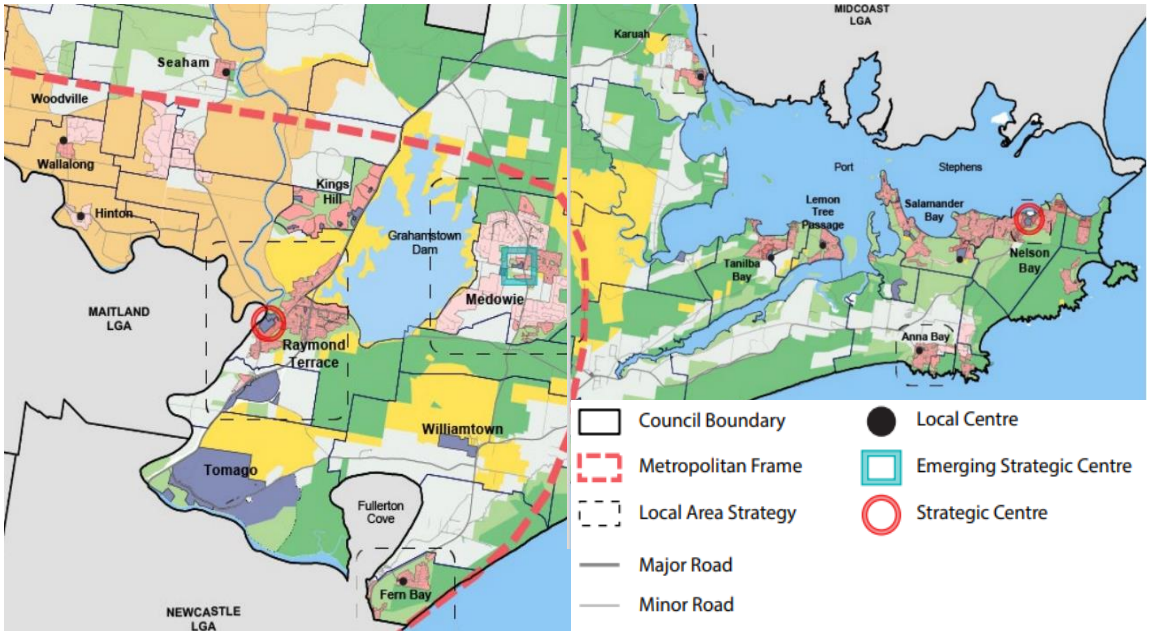

Figure 5 Port Stephens LSPS Structure Plan (Extracted from LSPS, pgs 10-11)

3.2 Floodplain Risk Management Studies and Plans

3.2.1 Maitland City Council

The "Hunter River Floodplain Risk Management Study and Plan" (WMA for Council, November 2015) applies to the Study Area (**Maitland FRM Study and Plan**).

The Maitland FRM Study and Plan recommended adopting the 1% AEP plus 0.5 m freeboard as the FPL for the purposes of defining the FPA and for applying prescriptive floor level standards for residential, commercial and industrial development (pg.79-80). It was also recommended that land inundated by the PMF should be identified and that certain types of development such as critical public infrastructure be restricted within this area.

A substantial part of the Maitland urban area is affected by the 1 in 100 per year chance flood. Consequently, the FPL is typically applied to the lowest habitable floor of a dwelling, or commercial and industrial premises, and not filling to achieve the FPL. However, the implications of filling all zoned urban land to the FPL were investigated as part Stage 2 of this Study, to understand the possible long term issues with cumulative filling, consistent with the requirements of the brief.

The Maitland FRM Study and Plan undertook a high level assessment of the potential cumulative impacts of filling. While a range of scenarios were considered, based on a consideration of what was likely to occur, the FRM Study and Plan concluded that "…considerable filling of flood storage areas can be accommodated without causing significant impacts on peak flood levels" (pg.89-90). It was concluded that changes to flood levels and velocities would not extend beyond the LGA boundaries. Consequently the FRM Study and Plan recommended that hydraulic modelling for individual DAs could be dispensed with under the following conditions:

- *Filling of flood storage areas (up to say 7,000 m^3 per lot) associated with construction of a dwelling in Rural zones, where construction of a new dwelling is otherwise permitted in line with other requirements (such as evacuation) in flood liable areas.*

- *Filling of flood storage areas (up to say 3,000 m^3 per lot) associated with construction of a mound to provide refuge for stock during floods, or to provide storage for plant/machinery for example.*

- *Filling of lots to the 1% AEP flood level for the purposes of dwelling construction in lots currently zoned R1 General Residential.*

As recommended by the FRM Study and Plan, the DCP was amended in line with the above. It was also recommended that Council establish a database of fill imported into floodplain areas, which is an outcome pending this Study.

3.2.2 Newcastle City Council Plans

The "Newcastle City-wide Floodplain Risk Management Study and Plan" (June 2012) was prepared to manage all flood prone lands across the City of Newcastle. The primary focus of that FRM Study and Plan was to reduce the exposure of people to life threatening situations associated with flooding. Risks associated with damage to property was seen to have been primarily managed by existing planning controls (pg.vii).

Various mitigation measures were considered by the FRM Study and Plan. Relevant to this Study, the following property modification measure was considered for future development under the heading "Property fill" for flash, riverine and ocean flooding (pg.108):

> *Limited amounts of fill could be used to help raise future development, providing that the development is not located within floodway or flood storage areas. Within Newcastle LGA there may be some small isolated areas that can be filled within the river floodplain, but generally, this would be unsuitable within floodways and flood storage areas.*

The following specific recommendation was made (pg.139) in regard to Council's DCP controls:

> *Redevelopment within a 1% AEP floodway should discouraged (with existing properties earmarked for possible future voluntary purchase), while redevelopment within a PMF floodway should be restricted to the footprint of the current building (or smaller). Similarly, redevelopment within 1% AEP flood storage areas should be limited to not increase the current building footprint by more than 20% (subject to site specific confirmation).*

In regard to future zonings, the FRM Study (pgs 139-140) recommended consideration of the following principles for flash flooding catchments when undertaking planning studies:

- *New development is not proposed in areas that are floodways;*

- *New development is not proposed to impede flood storages beyond an acceptable or tolerable level;*

- *Redevelopment removes existing development from floodways or other areas that have unacceptable flood risks; and*

- *Redevelopment replaces existing development with development that is commensurate with the flood risks.*

Specific proposals were outlined for the Wallsend Business District that delineated the 1% floodway as a corridor to be kept clear, which captured some existing development identified for removal under the Wallsend FRM Plan (pg.142). Areas within the PMF floodway were also identified as at risk during extreme floods but these risks could be managed through appropriate development controls including emergency management measures.

In regard to riverine flooding, the FRM Study recommended a strategic planning review of the following specific issues (pg.153):

- *New buildings or substantial alterations to existing buildings or filling within floodways (either the 1% AEP or PMF floodways);*
- *Non-floodways in Hexham could be rezoned for employment land uses only*
- *New residential development should not be permitted on land which can be isolated by river flooding;*
- *Restrictions should be maintained on fencing within floodways;*
- *Vehicle parking and storage of non-buoyant, non-polluting materials that are not susceptible to water damage (e.g., concrete products) may be permitted in areas below the riverine 1% AEP flood level;*
- *All buildings should have minimum floor levels at or above the current planning level; and*
- *New energy and communications infrastructure should be constructed above the planning level and critical infrastructure, including major energy and communications infrastructure components, should be above the PMF level.*

"Filling within floodways and flood storages", together with a range of other options put forward by the community, stakeholders or the study team such as a "moratorium on all future development in the floodplain", was one of several options that was assessed as impractical or ineffective for Newcastle (pgs 160-161).

The above were partly reflected in generalised recommendations provided within the FRM Plan, particularly "Ex.2 Reinforce controls on building footprints in floodways and flood storages" which requires:

a. *Undertake expert interpretation of existing flood modelling and other hydrologic assessments to further refine the delineation of floodways, flood storages and flood fringes.*

b. *Undertake investigative scenario testing using existing flood modelling to refine requirements of current Flood DCP for flood storage 'volume' to optimise development potentials without undue impacts on risks to life and property.*

This Study would contribute, in part, to satisfying the above aspects of the FRM Plan.

3.2.3 Port Stephens Council Plans

Port Stephens Council published its "Floodplain Risk Management Policy" on 31 May 2022. This Policy provides an integrated mix of FRM measures consistent with that typically contained in a FRM Plan.

Clause 5.3 of the Policy requires:

> *Keeping the Flood Hazard Maps up-to-date by incorporating relevant information from Council adopted Flood Studies, Floodplain Risk Management Plans, flood modification measures and approved filling within the floodplain which may change the categorisation of floodplain risk.*

This Study will contribute to this policy outcome and will provide an important input to the development of a FRM Plan as required by clause 5.1(e) of the Policy.

3.3 Statutory Planning Framework

3.3.1 State Environmental Planning Policies

A State Environmental Planning Policy (**SEPP**) is a planning document prepared in accordance with the EP&A Act by the DPIE and eventually approved by the Minister, which deals with matters of significance for environmental planning for the State. Regional Environmental Plans (**REP**s) were previously a type of environmental planning instrument prepared under the Act (since repealed) and existing REPs are now deemed SEPPs.

No SEPP has been prepared dealing specifically with the issue of flooding, but some regulate development in response to potential flood risks. Those SEPPs of potential relevance to the study area are discussed below.

SEPP (Transport and Infrastructure) 2021

Chapter 2 of *State Environmental Planning Policy (Transport and Infrastructure) 2021* (**TISEPP**) aims to facilitate the effective delivery of infrastructure across the State by identifying development permissible without consent.

Clause 2.13 governs public authorities' consultation with councils for development with impacts on flood liable land (as defined by the PMF).

Clause 2.56 specifies that development for the purpose of flood mitigation works may be carried out by a public authority without consent. Clauses 2.136 and 2.137 specify that development for the purpose of stormwater management systems may be carried out by a public authority without consent and for any purpose on any land with consent.

Housing SEPP

State Environmental Planning Policy (Housing) 2021 (**Housing SEPP**) was recently introduced and reincorporates (after some revisions) provisions of pre-existing SEPPs such as the Seniors Living SEPP. Part 5 of the Housing SEPP now deals specifically with housing for seniors and people with a disability.

Part 5 of the Housing SEPP applies to a range of urban type zones, including SP1 Special Purposes, Zone SP2 Infrastructure, and Zone RE2 Private Recreation. These provisions no longer apply to land adjoining urban land, as they did under the Seniors Living SEPP. The Housing SEPP would apply to parts of the study area and would effectively override Council's planning controls to permit residential development for older persons and persons with a disability, to a scale permitted by the SEPP. Notwithstanding, Clause 80(1)(b) and Schedule 3 of the SEPP restricts its application if land is identified in another instrument (eg the Council LEP) as:

(a) land to which the Standard Instrument, clause 5.22 applies in relation to seniors housing specified as sensitive and hazardous development,

(b) open space,

(c) natural wetland.

As discussed below, none of the study area Councils have sought the inclusion of Clause 5.22 in their LEP at this stage.

Council DCP provisions can provide complementary FRM considerations, provided that they are not inconsistent with the SEPP. The new LEP flood clause and the 2021 Guideline now allow Councils the flexibility to identify alternate FPLs/FPAs for different land uses.

Codes SEPP

The specification of exempt and complying development is primarily governed by *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008* (the **Codes SEPP**). The Codes SEPP effectively provides approval pathways as alternatives to a full development application (**DA**) for certain development presumed to be low impact. Exempt development requires no approval provided it complies with certain criteria. Complying development must meet certain criteria but also requires an approval in the form of a complying development certificate (**CDC**) which must be issued by Council or a private certifier subject to specified conditions.

The Codes SEPP is divided into a number of "Codes" that deal with exempt development and different types of complying development. Those Codes of specific relevance to the Study or study area are the Exempt Development Codes (Part 2), the General Housing Code (Part 3), and the Commercial and Industrial (New Buildings and Additions) Code (Part 5A).

The relevant clauses of the Codes SEPP apply to "flood control lots" defined as:

flood control lot *means a lot to which flood related development controls apply in respect of development for the purposes of industrial buildings, commercial premises, dwelling houses, dual occupancies, multi dwelling housing or residential flat buildings (other than development for the purposes of group homes or seniors housing).*

Note. This information is a prescribed matter for the purpose of a certificate under section 149 (2) [now 10.7] *of the Act.*

Flood control lots are required to be noted as such on a S10.7 Planning Certificate.

Some development (e.g. earthworks, retaining walls and structural support is not exempt development on a flood control lot per clause 2.29 of the SEPP).

The General Housing and Commercial and Industrial (New Buildings and Additions) Codes also provide several exclusions as to what can be complying development on a flood control lot. Most complying development is permitted with a CDC on Flood Control Lots where a Council or professional engineer can certify that the part of the lot proposed for development is not a:

- flood storage area
- floodway area
- flow path
- high hazard area
- high risk area (see Clause 3.36C).

The above terms are defined directly by the Codes SEPP or indirectly by the Manual which is referred to by the Codes SEPP for that purpose. These definitions are:

flood storage areas [means] *Areas of the floodplain that are outside floodways which generally provide for temporary storage of floodwaters during the passage of a flood and where flood behaviour is sensitive to changes that impact on temporary storage of water during a flood.* [the Manual].

floodway areas [means] *Areas of the floodplain which generally convey a significant discharge of water during floods and are sensitive to changes that impact flow conveyance. They often align with naturally defined channels or form elsewhere in the floodplain.* [the Manual].

flow path *means a flow path identified in the council's flood study or floodplain risk management study carried out in accordance with the Floodplain Development Manual.* [Codes SEPP].

high hazard area *means a high hazard area identified in the council's flood study or floodplain risk management study carried out in accordance with the Floodplain Development Manual.* [Codes SEPP].

high risk area *means a high risk area identified in the council's flood study or floodplain risk management study carried out in accordance with the Floodplain Development Manual.* [Codes SEPP].

The Codes SEPP specifies various controls in relation to floor levels, flood compatible materials, structural stability, flood affectation, safe evacuation, car parking and driveways (see Clause 3.36C). These controls must be imposed on a CDC where the development is located on a flood control lot. The minimum floor level must be adopted by Council as part of a DCP in order for it to be imposed on a CDC[1]. Despite this, it is expected that a Certifier would seek to impose a minimum floor level that a Council would normally apply, and consequently it is desirable that such information be broadly and clearly publicised.

[1] See for example clause 3.5(2)(a) of the Codes SEPP that specifies "(a) if there is a minimum floor level adopted in a development control plan by the relevant council for the lot, the development must not cause any habitable room in the dwelling house to have a floor level lower than that floor level,"

Filling is permitted as complying development under the Codes SEPP for industrial and business developments (clauses 5A.6H and 5.20) where not on a flood control lot or on a flood control lot but outside of a flood storage area, a floodway area, a flow path, a high hazard area, or a high risk area. Filling under these provisions could be extensive (e.g. Clause 5A.6H allows for raising the ground level for a site area less than 10,000m^2 by up to 2m, or for a site area equal to or more than 10,000m^2 by up to 6m). Such development could be located within the floodplain (ie up to the PMF) including up to the 1% AEP flood extent subject to the above limitations.

Important considerations for this Study, is to provide recommendations as to how to better address development under the Codes SEPP to ensure consistency with the controls to be prepared in response to the findings of Stage 2.

3.3.2 Local Environmental Plans (LEPs)

The Study area councils are subject to following LEPs:

- *Maitland Local Environmental Plan 2011* (**MLEP**)
- *Newcastle Local Environmental Plan 2012* (**NLEP**)
- *Port Stephens Local Environmental Plan 2013* (**PSLEP**)

These LEPs are subject to the standard flood related provisions of the Standard Instrument LEP, introduced with the Flood Prone Lands Package on 14 July 2021, which are:

- Existing flood planning LEP clauses were deleted (by an amending State Environmental Planning Policy) and replaced with a standard (compulsory) flood planning clause 5.21 inserted in all LEPs in NSW by way of an amendment to the *Standard Instrument—Principal Local Environmental Plan (2006 EPI 155a)*.
- The flood overlay maps previously existing within the LEPs have been deleted.
- Councils can choose to have inserted into their LEPs, an optional "Special Flood Considerations" clause 5.22 (**SFC**) inserted into the *Standard Instrument—Principal Local Environmental Plan (2006 EPI 155a)* provided they have appropriate information and justification. This SFC effectively replaces a similar clause that had been agreed with the DPIE for those Councils who obtained an "exceptional circumstances" waiver under the 2007 Guideline (none of which were located within the study area).

As at 14 July 2021, the LEPs of each of the Councils within the Study Area, have been amended as above to insert the standard flood clause 5.21 and to delete Flood Planning Maps.

The objectives at subclause 5.21(1) include:

> *(c) to avoid adverse or cumulative impacts on flood behaviour and the environment*

Subclause 5.21(2) stipulates the following considerations that are jurisdictional prerequisites (ie the consent authority must be satisfied that the proposed development will comply with these matters before consent can be granted)

- *(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and*

- *(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood…*

While the objectives of the clause specifically refers to cumulative impacts, the matters requiring assessment do not. This creates potential ambiguity as to the relevance of considering cumulative impacts in association with individual development applications. While the draft DCP provisions required as part of this Study cannot change the meaning of clause 5.21 in the LEPs, they will clarify how cumulative impacts are required to be assessed.

The flood impacts associated with individual or cumulative development proposals could alter flood behaviour in a way that affects evacuation routes. However, subclause 5.21(2) applies only to development on land "within the flood planning area" (**FPA**). Subclause 5.21(5) provides the "***flood planning area*** has the same meaning as it has in the Manual. The Manual provides the following definitions:

- Flood planning area means - *The area of land below the FPL.*

- Flood planning level means - *The combination of the flood level from the DFE and freeboard selected for FRM purposes.*

- Defined flood event (DFE) means - *The flood event selected as a general standard for the management of flooding to development.*

Subclause 5.21(4) also provides that unless otherwise defined in clause 5.21, a word or expression used in the clause has the same meaning as it has in the "Considering Flooding in Land Use Planning Guideline" (dated 14 July 2021). The 2021 Guideline (pg.5) provides:

> *Councils should define their FPAs and FPLs in their development control plans (DCPs) and outline if there are multiple FPAs/FPLs and where they apply. For example, a council may have a different FPAs for different catchments based on the flood risk identified through the FRM process. Council may also have different FPLs based on the land use type (for example, residential, industrial, commercial developments) these should be documented in their DCP. Council may have a range of development controls to suit the flood constraints and different types of development.*
>
> *Councils can attach their adopted flood policies, flood studies and floodplain risk management studies and plans to their DCPs to ensure they are considered by the consent authority when determining a development application under section 4.15 of the Environmental Planning and Assessment Act 1979.*
>
> *The DFE is selected by council for floodplain risk management purposes for an area/catchment, generally through the FRM process outlined in the manual. DFEs form the basis for determining the level of exposure to flooding and associated risks to life and property damage. The manual identifies the 1% AEP flood event, or an equivalent historic flood, as an appropriate starting point for determining the DFE for development controls, including for residential development. The manual allows the selection of a rarer DFE to address broad scale flood impacts in consideration of the social, economic, environmental and cultural consequences associated with floods of different probabilities.*

The typical freeboard for residential development due to flooding from waterways, such as rivers or creeks, is 0.5m. A lower freeboard or an alternative approach to freeboard may be used where the consequences to people and property of low probability flood events are assessed as minor through the FRM process.

Where councils propose alternative FPLs, they are required to demonstrate and document – in a flood study and/or floodplain risk management study – the merits of this approach, based on a risk management approach that is consistent with the FRM process and the principles of the manual.

Consequently, the above definitions expect that the FPA could be based on an FPL or FPLs adopted as part of a FRM Plan but ultimately that these will be reflected in a DCP. While a 1% AEP flood plus 0.5m freeboard would be a starting point, the process of preparing a FRM Plan should determine what FPL is appropriate for each floodplain based on the merits based approach. While FPLs (and FPAs) applied by the study area Councils are relevant, this Study is not intended to review existing FPLs or the FPAs identified by each study area Council.

3.3.3 Maitland Development Control Plan 2011 (MDCP 2011)

Part B.3 of the MDCP 2011 specifically addresses issues associated with development in the Hunter River Floodplain. The DCP continues to refer to the FRM provisions of the MLEP 2011 prior to state wide amendments implemented in July 2021 as part of the NSW Flood Prone Land Package. It is expected that the DCP will be updated in due course.

In accordance with clause 1, this DCP chapter applies to the area of the Maitland LGA "that is within the FPA identified in the LEP and for critical infrastructure and facilities within the Probable Maximum Flood (PMF) area". Clause 3.8 of the DCP identifies the following types of development as "critical infrastructure and facilities:"

- hospitals and ancillary services
- regional communication centres
- State Emergency Services stations
- sewage plants
- electricity plants or substations unless the plant is designed for controlled failure or shut-off when flooding occurs
- installations containing control equipment for critical infrastructure; and
- operational centres for flood emergency response

Clause 2.1 identifies 4 key factors associated with "risk to property" one of which is "the potential for the development to increase the flood affectation and likely damages for existing and future development on the floodplain, including consideration of cumulative development of an area."

The development controls in clause 3 of relevance to this study are:

- the proposed development will not increase the flood hazard or flood damage or adversely increase flood affectation on other properties, as assessed by a suitably qualified hydraulic engineer;

- the design of the proposed development is such that the risks of structural failure or damage in the event of flooding (including damage to other property) up to the FPL would be minimal, as assessed by a suitably qualified structural engineer;

- details of any proposed filling to be provided.

Clause 2.2 provides specific controls for development within a floodway. These controls essentially restricts any building, structure or filling within a floodway other than minor landscaping that has no impact on flood behaviour and flood mitigation works. Fencing is discouraged in the floodway but if provided must be open type fencing that does not restrict the flow of flood waters.

Clause 2.3 of the DCP addresses filling in flood storage or flood fringe areas and requires an impact assessment using a fully dynamic computer flood model unless:

- *There is no net importation of fill within the 1:100 ARI flood extent; or*

- *Filling up to 7,000m^3 or 20% of the total 1:100 ARI flood storage/flood fringe volume of the lot (whichever fill volume is lower) that;*

  - is associated with construction of a dwelling in rural zones, and

  - where construction of a dwelling is permitted; and

  - all of other flood requirements (such as evacuation) is achieved; and/or

- *Filling up to 3,500m^3 or 10% of the total 1:100 ARI flood storage/flood fringe volume of the lot (whichever fill volume is lower) associated with construction of a mound to provide refuge for stock during floods..*

Therefore, MDCP 2011 could allow for up to 10,500m^3 or 30% of the 1:100 ARI floodplain within a single lot without any further flood modelling assessment.

Despite the above, clause 3.9 of the DCP provides overriding dispensation for a proposed development that is permissible with consent where "full compliance with the flood-related development controls is impossible or unreasonable". The DCP requires this to be justified with appropriate studies and provides examples of situations that may be considered which include where a dwelling is required to support an enterprise or simply where a dwelling is permitted on the land.

Where filling is proposed in an urban residential situation, clause DC.8.3 of the DCP specifies an "absolute maximum fill depth of 2m."

3.3.4 Newcastle Development Control Plan 2012 (NDCP 2012)

Section 4.01 of NDCP 2012 specifically addresses FRM. This section of the DCP applies to all development on "flood prone land" (being land within the PMF extent) except minor additions to existing buildings.

Relevant controls in this DCP include:

- No filling in floodways except minor alterations to ground levels which do not significantly alter the fundamental flow patterns for: roads, parking, below ground structures and landscaping (cl.4.01.01 -1).
- Where dividing fences across floodways are unavoidable, they are constructed only of open type fencing (cl.4.01.01 -2)
- Not more than 20% of the area of any development site, in a flood storage area, is filled. The remaining 80% is generally developed allowing for underfloor storage of floodwater by the use of suspended floor techniques such as pier and beam construction (cl.4.01.02 -1)
- Where it is proposed to fill development sites, the fill does not impede the flow of ordinary drainage from neighbouring properties, including overland flow (cl.4.01.02 -2).
- Floor levels of all occupiable rooms of all buildings are not set lower than the FPL, being the 1% AEP plus 0.5m freeboard, while the minimum garage floor level is the 1% AEP.

Note, storage areas and floodways will be identified on flood certificates which can be obtained from Council.

3.3.5 Port Stephens Development Control Plan 2014 (PSDCP 2014)

Part B5 of PSDCP 2014 applies to all development on flood prone land, which is defined as land that is likely to be inundated by the PMF. The DCP adopts the 1% AEP flood event in the year 2100 plus 0.5m freeboard as the FPL for riverine floodplains and defines the land between the FPL and PMF as "minimal risk flood prone land". The planning horizon for residential development can reduce to 50 years if designed to be adaptable (cl B5.9).

Part "B5 Flooding" of the DCP defines flood categories as follows, based on mapped hydraulic and hazard categories

Hydraulic category	Flood hazard	
	Low hazard	High hazard
Flood Prone	Minimal Risk Flood Prone Land	
Flood Fringe	Low Hazard Flood Fringe	High Hazard Flood Fringe
Flood Storage	Low Hazard Flood Storage	High Hazard Flood Storage
Overland Flow Path	Low Hazard Overland Flow Path	High Hazard Overland Flow Path
Floodway	Low Hazard Floodway	High Hazard Floodway

Figure 6 Port Stephens DCP Flood Categories (DCP Part 5, Figure BG)

Figure BI of the DCP outlines the suitability of land uses based on the above flood categories. Fill and farm buildings are considered suitable in all categories. Dwelling houses and non-residential subdivision is considered suitable in all categories except Low Hazard floodway and High Hazard Floodway for which a "performance based solution" might be able to be provided.

The DCP defines "flood refuge" as "an approved and well-designed mound to provide temporary refuge for humans and livestock during flooding". This is distinct from a "on-site refuge" which is defined to infer reference to a refuge within a building.

Relevant controls in Part B5 of the PS DCP 2014 include:

- Development that is vulnerable to emergency response, and critical infrastructure, is identified as unsuitable within the FPL extent.
- Residential subdivision and residential accommodation (other than a dwelling house) are identified as unsuitable in floodways. A performance based solution can be provided for a dwelling house proposed in a floodway.
- The minimum floor level is the PMF for development that is vulnerable to emergency response, and critical infrastructure.
- The FPL (ie the year 2100 1% AEP plus freeboard) is adopted for subdivision (presumably the ground level of new lots), the habitable floors of residential, commercial and industrial development.
- The current day 1% AEP flood level is adopted for garages and parking spaces, and the onsite waste water level for farm buildings (cl B5.2).
- Fencing is to be stable in events up to the current day 1% AEP flood event and not obstruct the flow of floodwater (cl B5.4).
- A flood impact assessment is required for (cl B5.8):
    - filling on floodways, and in flood storage areas unless
        - the net volume of fill does not exceed the lesser of 20% or 2000m^3 of the flood volume of the lot in the 1% AEP flood event in the year 2100 (this includes consideration of previous fill volumes); and
        - It is demonstrated that the fill does not adversely affect local drainage patterns of all events up to the 1% AEP flood event in the year 2100.
        - Note: Fill in flood storage areas greater than the abovementioned volume can be offset by compensatory flood storage.
    - a livestock flood refuge mound, unless:
        - it is in a flood fringe area, and the following criteria are met

Size of mound	Distance from nearest property
20m x 20m (at current day 1% AEP flood level and 0.5m below the current day 1% AEP flood level)	> 180m
20m x 20m (1.0m below the current day 1% AEP flood level)	> 40m
20m x 20m (1.5m below the current day 1% AEP flood level)	> 25m
40m x 40m (at current day 1% AEP flood level, 0.5m below the current day 1% AEP flood level and 1.0m below the current day 1% AEP flood level)	> 830m
40m x 40m (1.5m below current day 1% AEP flood level)	> 170m

  - Where the proposed development could change flood behaviour, affect existing flood risk, or expose people to flood risks that require management.
  - If Council determines a flood impact and risk assessment is necessary for any other reason.

- Access from the building envelope to the public road is to have a minimum finished access level of the flood immunity of the connecting public road or the current day 1% AEP flood event level for the site (cl B5.11).
- Earthworks for driveways and access must satisfy the objectives of B3.D of the DCP (ie minimise environmental impacts) and the LEP (cl B5.12).
- Subdivision that creates the ability to erect additional dwellings is to indicate building envelopes above the FPL and comply with the requirements of B5.11, B5.12 and B5.14 of this Part B5 of the DCP (cl B5.13).

The DCP generally provides that an applicant can provide performance based solutions. This is also now the case in accordance with s 4.55(3A) of the EP&A Act.

A flood certificate can be obtained from Council that identifies the flood hazard category and hydraulic category of the land to inform the assessment of proposed development.

3.4 Hunter Valley Flood Mitigation Scheme

In the years following repeated flooding from 1949 to 1952, the Lower Hunter Valley Flood Mitigation Scheme was planned and constructed to mitigate flood risk and provide some flood protection to Central Maitland and Lorn. The scheme was completed following the devastating 1955 flood. The levee scheme is therefore yet to be tested in a major flood (i.e. larger than a 2% AEP or 1% AEP flood) but the levees and flood control banks are not expected to be sufficient to protect against a flood of the magnitude of those that occurred in 1955, 1952, and possibly 1930, 1857 and 1820 (WMA, Maitland FRM Study, 2015, pg2).

WaterNSW is the owner of the scheme assets and the DPE manages the scheme under delegation from the NSW Minister for Water.

Any proposed development works (including fences) located in, on or adjacent to levees or within declared floodplains (as gazetted under the *Hunter Valley Flood Mitigation Act 1956*) must be referred to the DPE for consideration under Section 256 of the *Water Management Act 2000*.

Consequently, development applications that fit these criteria, including those involving land filling, are regularly referred to the DPE for concurrence.

3.5 Major Infrastructure Projects

3.5.1 State Infrastructure Projects

The following State Infrastructure Projects that could impact on flood conveyance or storages were identified from a review of government websites and in consultation with the study area Councils and DPE:

- *The Kings Hill interchange and drainage channel*. The interchange would provide grade separated intersection access to the Kings Hill Urban Release Area in the Port Stephens LGA to and from the Pacific Highway. The drainage channel would divert urban stormwater from the Kings Hill Urban Release Area from reaching Grahamstown Dam. These works are the subject of a voluntary planning agreement between the developers of Kings Hill and relevant government departments.

- *The M1 Pacific Motorway extension to Raymond Terrace*. This project would connect the existing M1 Pacific Motorway at Black Hill and the Pacific Highway at Raymond Terrace within the City of Newcastle and Port Stephens Council LGAs. The highway extension would cross the Hunter River at Tomago. This is the subject of an Environmental Impact Statement (EIS) prepared for TfNSW dated July 2021.

- *Nelson Bay Road from Williamtown to Bobs Farm - Nelson Bay Road*. This is a TfNSW project proposing the duplication of Nelson Bay Road between Williamtown and Bobs Farm to improve safety. TfNSW sought comments from the community and stakeholders on three proposed route options for the project in November 2020 and is presently finalising the preferred route.

- *Williamtown Special Activation Precinct* – A Draft Masterplan dated 2022 was prepared by DPE for an area of 395 hectares focusing on Newcastle Airport and the adjoining RAAF Base Williamtown, being Australia's largest combined defence and civilian airport. The precinct is to provide a wide range of employment uses within the Regional Enterprise Zone to support defence, aerospace, industry, advanced manufacturing, commercial, freight and logistics.
- Minor shoulder works associated with blackspot improvements on Raymond Terrace Road between Government Road and McFarlanes Road.
- Testers Hollow raising road (under construction).

In addition to the above infrastructure projects, two relevant state significant development proposals (previously referred to as Major Projects) were assessed and approved at a state government level under the former Part 3A provisions of the EP&A Act. These are both large industrial estates close to the northern banks of the lower Hunter River within the port Stephens LGA , known as the Northbank Enterprise Hub Major Project (MP10_0185) and Westrac Major Project (MP07_0086).

The Northbank Enterprise Hub is understood to be close to commencement of construction. This site has an approximate area of 241 hectares and the initial proposal was for the importation of approximately 3.7 million m^3 of fill to raise 154 hectares of the site above the 1 in 100 year flood level.

Only Stage 1 is approved to be filled to the 1% AEP flood level. Stage 2 was deferred pending further flood impact analysis.

The whole of the Westrac project was approved to be constructed in 3 stages allowing filling to the 1% AEP flood level, excluding land required to be removed from the development proposal for the purposes of conserving an existing saltmarsh community. This site has an area of 116 hectares and the proposal as submitted involved the filling of approximately 107 hectares, requiring 1.8 million m^3 of imported fill. Stage 1 was constructed in 2010 while the balance of the estate is yet to be developed. Only 85 hectares of the site was approved for development after the 22 hectares of saltmarsh land is excluded. The whole of the site has been subdivided into superlots to reflect the approved staging and conservation lands.

These infrastructure and development projects are wholly or partially located on flood prone land and consequently their potential impacts have been considered in Stage 2 of this study as discussed further below.

3.5.2 Council Infrastructure Projects

The potentially relevant council infrastructure projects that were identified are:

- New pedestrian bridge on Wollombi Road, Farley over Stoney Creek (MCC)
- New access road or raising of Scobies Lane to improve flooding access to Oakhampton Heights (MCC)
- Replacement of Melville Ford Bridge (subject to grant funding) (MCC)
- Newcastle Low Lying Lands Levee – Option C High Level Levee (NCC).

The Newcastle Low Lying Lands Levee is a proposal for a combination of flood gates, pumps and a levee to protect Carrington, Maryville, Wickham and Islington in the Newcastle LGA in the event climate change causes sea and ground water levels to rise. The intention is to have completed the levee system prior to sea levels rising 0.3m above the mean sea level base date as opposed to a specified date. Council is currently in the process of installing equipment to monitor sea and groundwater levels and is undertaking interim works in Carrington. The preferred levee option (Option C) will exclude flood waters in a similar way as would land filling up to the design flood level, and has been taken into account in Stage 2 Study.

4 Stage 2 of the Study

4.1 Introduction

As part of the study process for Stage 3, GLN was required to prepare a brief for the Stage 2 flood modelling specialist consultant to help inform Stage 3 work. A copy of the brief is included as **Appendix B**.

The Stage 2 flood modelling and assessment was undertaken by KBR. And a copy of their report, being one of 3 reports prepared for each stage of the Study, is provided as a separate volume.

4.2 Aim of Stage 2 Brief

Stage 2 was required to prepare hydraulic modelling to inform:

a. *An analysis of the potential cumulative impacts associated with filling within the floodplain in association with:*

   i. *development permitted by existing planning controls*

   ii. *development that could be permitted by future planning controls in fulfilment of current local and regional planning strategies.*

b. *The preparation of appropriate of planning controls in Stage 3 of the Study that addresses:*

   i. *the quantum of fill associated with individual developments that could be acceptably allowed in the floodplain, or parts of the floodplain, with or without compensatory excavation*

   ii. *design parameters to guide the manner any fill is placed in the floodplain to mitigate against unacceptable localised impacts due to potential changes in flood behaviour.*

c. *Complementary planning recommendations such as the refinement of future urban release areas to avoid the necessity for filling within the floodplain or matters to address in the consideration of major public infrastructure projects.*

The brief for Stage 2 was specifically formulated to provide input into the preparation of guidelines for assessing the cumulative impacts of flooding and associated planning recommendations required of this Stage (ie Stage 3) of the Study.

4.3 Background

Part of Stage 3 involved the preparation of a GIS and compilation of relevant information to provide the necessary data to explain the nature of filling activities that have occurred in the past and what filling pressures may unfold in the future, to enable the Stage 2 modelling to be undertaken. The existing planning controls and strategic planning initiatives identified the likely future filling opportunities over a planning horizon of up to 50 years.

The nature of these different filling activities, as specific incursions into the floodplain needs to be understood so that modellers can determine the impacts these might have on flood levels and behaviour. In other words, the modellers were informed as to the extent and nature of filling to be expected in the floodplain associated with expansion of the urban edge and for new residential areas, development or redevelopment on existing urban zoned land, the various filling activities associated with a rural house pad or a stock refuge area in a rural zone, and from new infrastructure.

4.4 Stage 2 Modelling Parameters

As outlined in the Stage 2 Report, various criteria were adopted or assumed in an iterative process when assessing the effects of committed development, possible future development areas and localised impacts on flood behaviour for the purposes of the modelling undertaken in Stage 2. A range of modelling iterations were considered and these are outlined below. Discussion of how to assess the acceptability of the impacts identified by the Stage 2 modelling is provided later in this study.

4.4.1 Existing and Future Development

Initial Modelling Iteration

The brief required modelling of specific scenarios determined with regard to the findings of Stage 1 and discussion with the project steering group. However it was also recognised that additional modelling may be required to ultimately determine the acceptable cumulative limits of filling, as part of an iterative process that reacted to preceding modelling results.

The brief and study steering group required the adaptation and use of existing flood models. As outlined in the Stage 2 report this resulted in the use of 2 separate models – one for the upper catchment that related primarily to the Maitland LGA and done for the lower catchment that related primarily to the lower catchment.

As required by the brief, the Stage 2 modelling considered filling scenarios associated with "Committed Development" (ie existing, approved and permissible development under current planning controls, and associated infrastructure needs) and "Future Development" based on future urban release areas identified by local or regional planning strategies.

The recommendations of this Study are intended to provide long term guidance for the management of the lower Hunter River floodplain. Therefore, based on the conclusions reached in the Stage 1 Scoping Report, it was considered appropriate to initially investigate a worst case filling scenario that involved the maximum conceivable volume of filling in the floodplain.

It was nonetheless recognised that the maximum development outcomes adopted and assumed above may not eventuate due to non-flooding constraints such as heritage and biodiversity, or due to the personal circumstances of individual land owners. However, the study team and project steering group considered it was appropriate to initially conservatively consider the maximum possible planning outcomes for the purposes of this Study. Further, this was considered reasonable as the study is intended to investigate long term flooding effects and it could be assumed, for example, that heritage properties could be flood proofed in some way which would reduce floodplain storage capacity even if not demolished and redeveloped on filled ground.

Accordingly, consistent with the brief for Stage 2, the criteria adopted for the first iteration of modelling runs are those outlined below.

- Existing development based on latest LIDAR, plus
- All approved DAs yet to be constructed, plus (if not covered already)
- All Approvals issued by the Hunter Valley Floodplain Management Authority, plus
- All existing urban developed lots below the FPL and non-urban lots with no fill pads being redeveloped to current FPL standards.
- All known major infrastructure projects.

In undertaking the modelling, the following assumptions were adopted:

1. That all urban lots will be filled completely to the FPL currently applicable in the LGA. This included currently developed urban lots , assuming that they would be redeveloped.
2. Vacant non-urban lots are developed with a pad/house, pad/shed and access road. Lots with an area of less than 4,000m^2 in the Port Stephens LGA were assumed to be developed with only a pad/shed, as clause 4.2B of the Port Stephens LEP provides this as an overall minimum area for the erection of a dwelling house in a rural zone.
3. The FPL applied was that adopted by each of the Councils, inclusive of climate change factors where applied.

This initial modelling revealed that there would be significant and unacceptable impacts. These impacts specifically included increases in flood levels ranging from about 100mm to 300mm across the floodplain. The impacts were primarily a consequence of constraining flood flow conveyance (ie blocking floodways) and mainly occurred within the upper catchment. There were effectively no impacts arising from planned urban release areas, as these have been designed to avoid the 1% AEP floodplain.

Revised Modelling Iteration

Given these initial results a further iteration of modelling was undertaken for the upper catchment that assumed:

1. No change to existing developed lots.
2. Vacant non-urban lots are redeveloped consistent with the above parameters.
3. All vacant urban residential zoned lots are developed with a 70% site coverage. Given there was no R2 zoned land and while R1 zoned land is mostly developed with single dwellings at a lower site coverage, the potential for more dense development was assumed.
4. All vacant industrial zoned is developed and on average 70% of a lot is filled.

The modelling was undertaken for the 1% AEP current year and 2100 year to account for climate change and the PMF. This iteration revealed that there could be further capacity for filling in parts of the floodplain before unacceptable impacts emerged.

Final Modelling Iteration

As discussed further below, and in the Stage 2 Report, the first iterations of modelling revealed impacts beyond potential thresholds of acceptability while a significantly revised iteration for the worst affected part of the floodplain indicated that there could be further capacity in some parts of the floodplain. As the intent of the Study was to identify thresholds that allowed for equitable and sustainable filling across the floodplain that facilitated reasonable development outcomes based on current zoning and planning strategies, further modelling was required. The thresholds need to be based on the acceptable limits of filling, after considering the potential cumulative impacts of all development, to avoid future assertions that any individual development could acceptably sustain greater levels of fill. Accordingly, further and final iterations of modelling were undertaken that adopted the alternate criteria outlined below.

Non-urban Zoned Land

1. In this iteration all vacant, and 10% of currently developed, non-urban lots in the floodplain and without fill pads are assumed to be developed with a pad/house, pad/shed and access road as for the first modelling iteration. It was considered reasonable to assume that a portion of existing developed non-urban lots without raised pads would redevelop with raised pads in the future.

2. The 10% criteria was based on an analysis of the rate of dwelling demolition occurring in the study area LGAs and NSW as tabulated in **Appendix F**. This shows that within a 50 year time horizon 10% of existing dwellings in NSW could expect to be demolished, based on round numbers. Port Stephens and Maitland LGAs both have much lower rates of dwelling demolition while the Newcastle LGA is higher than the NSW average. This could be due to the development cycles of the LGAs or because the Port Stephens and Maitland LGAs are more rural where less redevelopment occurs. This also assumes that the rate of redevelopment in flood prone areas will be the same for the LGAs as a whole and therefore 10% should be considered to be a conservative assumption.

3. The FPL adopted for non-urban fill pads is consistently based on the 1% AEP flood projected for the year 2100 based on climate change factors (plus freeboard). While not all Councils currently have climate change factored into their FPLs, given the long term nature of the impacts being assessed, and the need for consistency when determining an equitable distribution of fill capacity in the floodplain, this approach was considered appropriate and is consistent with preliminary peer review comments. A recommendation of this study is that the councils works towards adopting FPLS based on the same criteria, in particular the inclusion of climate change factors.

Industrial Zoned Land

4. Filling of industrial land is to take into consideration both vacant and existing industrial lots. This is only relevant to the lower catchment model given the location of zoned industrial land The relevance of this criteria became apparent during the study having regard to the increasing number of development applications received by Newcastle City Council for the redevelopment of existing industrial properties within the floodplain. The initial scenario considered redevelopment of existing industrial lots in the Newcastle LGA only. Given the need to provide equity between the councils and anticipating that the redevelopment of industrial lots being experienced in the Newcastle LGA at present may be experienced in the Port Stephens LGA in the future, this was considered an appropriate approach.

5. Assume 70% of the area of an industrial lot is filled. This was based on a review of recent industrial developments and discussion with Council officers, to determine generally what was likely to happen on a typical industrial lot within the floodplain. This allows for the potential for landscape and setback areas and car parking to remain at lower levels.

6. Modelling undertaken for the initial iteration determined that filling of zoned industrial land in the study area to the FPL would result in unacceptable impacts. Initial modelling also examined the impacts associated with filling industrial zoned land by a specific depth of fill (300mm and 900mm) which revealed impacts approaching acceptability in broad areas and isolated incidents of unacceptable impacts. However, it was agreed by the Study team and steering group that it is preferable to determine the threshold for filling based on a specified recurrence of flooding to ensure a consistent level of flood immunity is achieved. Separately, a maximum level of fill could also be specified in the planning controls to address potential amenity and environmental impacts if required.

7. While it is recognised that some proponents developing industrial land would prefer to build at or above the FPL, this would not necessarily be essential in all cases, but where required this would need to be met by elevating floor levels on piers, and/or investigating site specific solutions that avoided floodways and retained an equivalent amount of on-site flood storage through compensatory excavation. This approach is reflected in the proposed planning controls.

8. In regard to the Northbank Enterprise Hub Major Project it has been accepted that all of Stage 1 is filled to the 1% AEP flood level as approved under MP10_0185. However, the same assumptions adopted above for industrial land is assumed for the balance of the industrial zoned land within the Northbank Enterprise Hub on the basis that it is expected that any future development will have regard to the findings of this Study.

9. In regard to the Westrac Major Project, it is assume that the whole of the site, excluding land required to be removed from the development proposal for the purposes of conserving an existing saltmarsh community, is filled to the 1% AEP flood level in accordance with MP07_0086.

10. Consequently, this iteration of modelling was required to determine the extent of fill that could equitably be placed on all zoned industrial land in the study area LGAs, based on a specified recurrence of flooding, without having acceptable flood impacts. As it was expected that this threshold could be reached in a 5% AEP flood, this formed the initial iteration of modelling, followed by a further iteration based on a 2% AEP flood.

Residential Zoned Land

11. For urban residential zoned land, assume that 80% of a lot zoned for higher density housing (ie residential flat buildings, town houses, etc) and that 100% of lots zoned for predominantly single dwelling houses will be filled. This is based on discussions with Council officers and experience with these forms of development where larger higher density housing sites can often retain a portion of the site at existing ground levels for landscaping whereas it is typically undesirable to fill only a part of a smaller single dwelling house lot.

12. Assume that all existing vacant, and 10% of currently occupied, urban residential zoned lots are filled. It should be expected that all existing urban residential zoned lots will be developed. It is also reasonable to anticipate the redevelopment of a portion of existing occupied properties zoned for urban residential purposes, and the 10% criterion was based on the same analysis outlined above in regard to non-urban lots.

Other Potential Development

While assumed filling of land for other land uses was considered, this was agreed by the study team and steering group to be unnecessary given the low likelihood of such filling being required and the conservatism of the assumptions adopted above.

There is minimal opportunity for commercial development within the study area and, where potential exists, filling is typically unlikely or irrelevant in the context of this study. Commercial uses are mainly limited to existing traditional commercial areas where redevelopment involving filling is unlikely due to the need to remain consistent with street footpath levels. Larger existing commercial complexes are typically monolithic structures built to the property boundaries that already have the same effect as filling. There would be few other land use opportunities within the study area floodplain, many of which, such as public open space, would not require filling.

Infrastructure Projects

Existing approved major public infrastructure projects (the M1 Motorway extension) were included. Other state infrastructure projects that were identified included were minor shoulder works associated with blackspot improvements on Raymond Terrace Road between Government Road and McFarlanes Road (not proceeding at present but expected in the future), Testers Hollow Road raising (under construction) and Nelson Bay Road upgrade from Williamtown to Bobs Farm.

In regard to local infrastructure projects, the following projects that are likely to occur within the floodplain have been factored into the modelling, some of which were expected to have negligible to minimal impacts:

- New pedestrian bridge on Wollombi Road, Farley over Stoney Creek (MCC).
- New access road or raising of Scobies Lane to improve flooding access to Oakhampton Heights (MCC).
- Replacement of Melville Ford Bridge (subject to grant funding) (MCC).
- Newcastle Low Lying Lands Levee – Option C High Level Levee, Upgrade of all Flood Gates & Pumps to be implemented prior to a sea level rise of 0.3m (NCC).

The consideration of these projects involved sourcing best available information, which varied dependent on the stage of planning that they were at.

Planning Horizon

A 50 year planning horizon was adopted by the study team and steering group. This is reasonable given the uncertainty of further redevelopment in flood prone areas in the long term, whether the assumed filling for other land uses is taken up and the conservativeness of all the assumptions. This will need to be monitored and reviewed periodically and if necessary, the planning controls adjusted across the proposed development types nominated in the DCP controls.

Assessment of Future Development Flood Storage Impacts

Each modelling iteration required modelling the potential impacts of all existing and proposed urban release areas. Available structure plans and/or land use zonings have been used to determine what

parts of these areas could be developed and require filling. As all future urban release areas were found to be located outside of the 1 in 100 chance per year flood extent, such additional lands were not included in the flood modelling.

4.4.2 Assessment of Localised Conveyance Impacts

The brief for Stage 2 also required simulation of assigned development examples for the assessment of localised flood impacts.

KBR modelled 6 scenarios to identify which situations result in localised adverse impacts on flood behaviour, such as heightened flood heights due afflux effects or material increases in velocities. The range of scenarios chosen were those which were expected to provide sufficient information from the modeling outputs to guide the recommendation of planning controls that could minimise adverse impacts.

The intent was to provide a range of scenarios that considered:

- The lower and upper end of floodplain
- Situations that include at least 3 adjacent lots with DCP compliant development on each so that the interaction of impacts can be identified to guide preparation of planning controls
- Non-urban situations with lots developed with a pad/house, pad/shed and access road.
- An urban industrial situation such as the filling of, or large format industrial development on, large lots in the outskirts of Newcastle.
- Encroachment of an urban release area into the floodplain.

The 6 specific scenarios are outlined in **Appendix C**. To the extent possible, examples were chosen that reflected what was achievable under current planning controls, which was effectively the case for all scenarios other than encroachment of an urban release area into the floodplain.

4.5 Determination of Acceptable Impacts

Overview

For the purposes of assessing whether impacts identified during the Stage 2 modelling were acceptable, a range of existing qualitative and quantitative criteria were reviewed. This was undertaken with reference to publicly available policies and planning controls, guidelines and Court decisions, and the input of the technical representatives of the study area councils, DPE and study team.

There is no single definitive existing guidance as to how to assess the acceptability of cumulative flood impacts. In principle this will vary depending on the economic, social and environmental context associated with each situation, consistent with the merit based approach of the Manual. The new Manual provides a comprehensive range of criteria, including examples of some numerical standards, as a "starting point", but there is an implied expectation that further analysis will ultimately determine the acceptability of potential impacts for individual floodplains.

Planning controls and assessments commonly undertaken for the purposes of assessing the acceptability of a development proposal (including the construction of infrastructure by public authorities) often conflate impacts associated with individual proposals and cumulative impacts. The assessments associated with individual proposals are commonly referred to as Flood Impact Assessments (**FIA**s). Some planning controls require FIAs to also consider cumulative impacts, but there is no consistent approach to this across NSW.

Existing criteria applied by various authorities for assessing the acceptability of a flood related impacts on other land and occupants in a floodplain, for either individual or cumulative development proposals, are either qualitative or quantitative, and sometimes both. The criteria might initially request a FIA in regard to an individual proposal but include a requirement to the effect that the assessment should also take into account the cumulative impact of multiple similar proposals that could occur in the floodplain. For example, a control might require a FIA to determine whether a proposal would satisfy a qualitative criteria of "no material adverse impact" and require that this assessment also take into consideration the cumulative impact of multiple similar proposals.

Criteria for the assessment of flood impacts can be qualitative or quantitative, but are typically qualitative. This is not to say that quantitative criteria are not necessary, but rather that the assessment often needs to have regard to the context of individual floodplains and the particular circumstances. Ultimately, the impacts are measurable when assessments rely on testing impacts with a computer model.

Impact assessment criteria may also be applied in 2 steps. This firstly establishes a numerical threshold which if not exceeded provides confidence that impacts will not be unacceptable. If exceeded a FIA would be required. This approach has the advantage of avoiding the imposition of unnecessary costs on development proponents and minimising the administrative burden for the assessing authority, but still requires predetermination of suitable numerical threshold criteria.

In addition to the above, the impacts can be dichotomised into broadscale changes to flood levels and velocities within a major portion of the floodplain and localised changes to flood behaviour between adjacent developments as identified and discussed above in regard to the findings of the Stage 1 Scoping Study.

This study provides the opportunity to assess, upfront, the cumulative broadscale flood impacts that could eventuate in association with all committed and potential development proposals in the floodplain into the foreseeable future. This needs to be followed by an assessment of the acceptability of those impacts before deciding on what controls should be applied to development in the future and whether a review of the strategic planning direction of any longer term strategies is needed. Additionally, localised impacts need to be considered.

Flood Risk Management Manual

A series of Guidelines were published to provide technical support for the Manual. *Understanding and managing flood risk Flood risk management guideline FB01* (DPE, June 2023) outlines matters to be considered when preparing cumulative impacts assessments. Guideline FB01 (pg.17-18) outlines key considerations for assessing cumulative impacts and provides some initial values for allowable cumulative changes in flood behaviour, but emphasises that these values should not be used to test the impacts of individual proposals. These considerations and initial numeric assessment standards are outlined in **Table 4**.

Table 4: Key Considerations in Assessing Cumulative Impacts (Guideline FB01, Table 6, pg.18)

Key considerations in determining allowable cumulative impact	Reasons for consideration	Starting point for determining allowable cumulative impact through the FRM process, *not* for specific developments or projects
Flood level change	May identify: • a change in flood behaviour • increased inundation and damage to existing development • inundation of additional existing development • the creation of new or larger floodways or flowpaths • isolation of new areas	e.g. 0.1 m
Change in duration of flooding	May identify increased damage or increased duration of isolation	e.g. 10% increase
Velocity change	May identify increased scour potential and/or damage to structures and waterways	e.g. 10%
Flood extents	May identify increased extent of area inundated and more properties impacted	
Warning and evacuation time	May identify a decrease in available warning time and in the time available for evacuation	
Change in frequency of inundation	Properties may become flood affected in more frequent events Access may be cut more frequently Areas may be isolated more frequently	
Flood function categorisation change	May change flood function (e.g. flood storage to floodway) and change impacts of flooding on existing development	e.g. change of category
Hazard categorisation change	May reduce safety of vehicles, people or buildings	e.g. change of category

The Manual (pg. 49-50) also defines the following relevant terms:

> ***Flood storage areas**: Areas of the floodplain that are outside floodways which generally provide for temporary storage of floodwaters during the passage of a flood and where flood behaviour is sensitive to changes that impact on temporary storage of water during a flood*
>
> ***Floodways**: Areas of the floodplain which generally convey a significant discharge of water during floods and are sensitive to changes that impact flow conveyance. They often align with naturally defined channels or form elsewhere in the floodplain.*

In general, and definitionally, the current Manual and previous versions have consistently sought to discourage any constriction to floodways or to allow a reduction in flood storage areas on the basis that any changes, individually or cumulatively are expected to adversely impact flood behaviour. The

Stage 2 Study has investigated this position in the context of the Study Area and the nature of existing and possible future development.

Existing Polices in Study Area

The criteria currently applied by the study area Councils have been outlined earlier in this Study, and in summary are:

- Both Maitland and Port Stephens Councils specify thresholds which if exceeded would trigger the need for a FIA (see sections 3.3.3, 3.3.4, and 3.3.5 of this report).

- In the Maitland LGA, the net importation of fill within the 1 in 100 per year chance flood extent would require an FIA unless the filling was to provide a stock refuge, in which case filling up to 3,500m^3 or 10% of the total 1 in 100 per year chance flood storage volume of the lot becomes the trigger. The maximum fill depth allowed in an urban area is 2m.

- In the Port Stephens LGA, a FIA would only be required if filling was proposed in a floodway or flood storage area that exceeded 20% or 2,000m^3 of the flood volume of the lot in the 1 in 100 per year chance (year 2100) flood and local drainage is unaffected, or if for stock refuges then this is determined based on the height and size of the mound and setback from the boundary. There is also an overriding provision that states that Council could require a FIA for any reason.

- The Newcastle LGA controls restrict filling or new development in floodways other that in association with minor alterations, and filling of onsite flood storage capacity by more than 20%. Consistent with the requirement of s4.15(3A) of the *Environmental planning & Assessment Act 1979* to flexibly apply DCP controls, Council could also consider each case based on the findings of an FIA.

- Based on a review of a range of past development applications, the Maitland and Port Stephens Councils have a practice of requiring an assessment of cumulative impact with each FIA associated with fill pads, while Newcastle Council will determine the need for this based on the circumstances of the case.

None of the Councils provide quantitative controls for assessing the acceptability of any impact that could be determined by a FIA.

Existing Literature, Guidelines and Court Decisions

There are substantial differences in criteria for assessing flood impacts adopted across the various policy and guideline documents we have sourced from outside the study area Councils. To provide a general analysis of existing polices of other Councils, we reviewed the relevant flood related planning controls in the DCPs or related policy documents of those Councils in NSW with a population of over 70,000 persons at the last census (34 Councils excluding the study area Councils) and state government agency policies. In summary, this revealed the following:

- The majority (about 74%) required a merit based assessment to determine if the flood impacts external to a development site would be acceptable.

- Three of the Councils had specific numerical criteria to assess flood impacts external to a development site.

- The remainder of the Councils had no specific provisions relating to the assessment of flood impacts external to a development site.
- About a third of the Councils required an assessment of cumulative impacts in some form.
- Only 3 of the Councils specifically required the assessments to take into account climate change, but some of the other Councils have general references to climate change that could be referred to.

Of the above Councils and other guidelines we have sourced from within NSW and other states[2], we have identified a range of quantitative criteria that are applied in the assessment flood impacts external to a development site, but these do not relate specifically to cumulative impacts. These are summarise in **Table 5**.

Table 5: Existing Impact Assessment Criteria Outside Study Area

Criteria	Document
No flood level increase of 10mm or more	• Mamre Road Precinct DCP 2021 • Port Macquarie-Hastings Council Flood Policy (2018)
No flood Level Increase of 20mm or more	• Chapter 15, Water Sensitive Urban Design Handbook for Blacktown City Council
No flood Level Increase of 100mm or more	• Penrith City Council DCP
Downstream velocities are not increased by more than 10%	• Penrith City Council DCP
Impact on flood velocities is less than 0.1 m/sec, at the property boundary	• Port Macquarie-Hastings Council Flood Policy (2018)
Flows are not redistributed by more than 15%	• Penrith City Council DCP
Impacts outside the site during any flood event up to and including the 1% AEP flood, to: (a) a maximum increase in inundation time of one hour; (b) a maximum increase of 10 mm in above-floor inundation to habitable rooms where floor levels are currently exceeded; (c) no above-floor inundation of habitable rooms which are currently not inundated; (d) a maximum increase of 50 mm in inundation of land zoned as residential, industrial or commercial; (e) a maximum increase of 100 mm in inundation of land zoned as rural, primary production, environment zone or public recreation; (f) no significant increase in the flood hazard or risk to life; and	Criteria repeated in the following relevant documents. • TfNSW Construction Flood Management Plan March 2023 • M1 Pacific Motorway extension to Raymond Terrace Conditions of Approval SSI-7319 Issued 08.01.2022 (Condition E33).

[2] The additional policy documents we have identified are Western Sydney Aerotropolis DCP 2022; Ropes Creek Precinct DCP 2022; Brisbane City Council City Plan 2014; West Gippsland CMA – Guidelines for development in flood prone areas (2020; and Guidelines for Floodplain Cut and Fill within the Glenelg Hopkins CMA Region (2012)).

Criteria	Document
(g) maximum relative increase in velocity of 10%, where the resulting velocity is greater than 1.0 m/s, unless adequate scour protection measures are implemented and/or the velocity increases do not exacerbate erosion as demonstrated through site-specific risk of scour or geomorphological assessments.	

The application of quantitative criteria is uncommon. The more common approach is to specify qualitative criteria such as "no adverse affect" on flood behaviour, no "material increase" in flood levels or flood hazard or "no significant increase or re-direction in flood flow." Typically this would be required to be demonstrated as acceptable by a site specific flood impact assessment (**FIA**) which then determines whether the quantified impact is acceptable in the circumstances of the case.

Some policy documents generally discourage development based on hydraulic categorisation such as being in a floodway and/or high hazard area. The policies vary from perfunctorily restricting any development, including filling, in such areas to applying a flexible approach that discourage development in such areas unless demonstrated as acceptable by a FIA. In some, but not all cases, the criteria includes the need to provide compensatory excavation.

In most cases the, the criteria in NSW council DCPs, that have been reviewed, require FIA's to take into consideration the cumulative impact of development in the floodplain, when an FIA needs to be prepared. Of these, the criteria were not specific as to which design flood is to be used in the FIA or whether climate change factors are to be considered. Where criteria refer a specific design flood, this is typically to indicate that consideration of floods greater than the 1 in 100 per year chance flood may also be required.

In the assessment of the Northbank Enterprise Hub (Major Project MP10_0185) the Secretary's Environmental Assessment Report (June 2014, pg.4) determined the following:

> *The Department considered two key aspects with respect to flooding; the Project's influence on the overall flood risk in the region and the Project's impact on increased flood depths. On the first point, the flood impact assessment and the Department's independent flooding specialists confirmed that the Project would not change the overall flood risk profile in the Lower Hunter region. However, the Project would marginally increase flood depths across the Hexham area. Specifically, the Project is estimated to increase flood depths by up to 40mm in the 1 in 100 year flood event. To provide context, many properties would already experience flood waters up to 4m in depth during the 1 in 100 year event without the Project. Notwithstanding the marginal increase resulting from the Project, the Department notes that the City of Newcastle has identified a cumulative target for flood level increases of no more than 40mm across the region.*
>
> *Acknowledging the importance of the site in delivering major employment land to the region, the Department, with advice from its specialists and in consultation with OEH, sought to establish the extent of development that would result in an acceptable flood level increase, consistent with other recently approved developments in the Hexham area. These recently approved developments in Hexham established 20mm as an acceptable flood level increase, beyond which mitigation and/or compensation would be required. NEH revisited the flood modelling to establish the limit of development to achieve no more than a 20mm flood level increase across the region. This development extent is referred to as Stage 1. The*

Department has recommended conditions to allow Stage 1 to proceed without requiring any further flood modelling, mitigation or compensation.

There have been few Court cases, that have been sourced, that include a discussion of how to assess acceptable flood impacts. The findings in *Rothshire Pty Ltd v Blacktown City Council [2022] NSWLEC 1125* [58] concluded that while new development in flood prone areas should ideally manage its flooding effects entirely within its own site, this should be assessed with some tolerances such as a 20mm allowance. The 20mm allowance was derived from the Water Sensitive Urban Design (WSUD) Handbook referred to in Councils planning controls. In that case, the court was told [40] that "Areas of flood level increase are isolated and directly adjacent to the site boundaries and driveways, and hence there is no potential for cumulative flood impacts…" This criteria was again accepted in *So v Blacktown City Council [2023] NSWLEC 1020* but in that case the Court decided the impact was unacceptable as off-site flood level increases of up to 110mm were predicted [63].

"Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia Handbook 7" (Australian Institute of Disaster Resilience, 2017, pg.43) recognises that one of the roles of the freeboard component of a FPL could be to offset the "…cumulative effect of subsequent infill development of existing zoned land." This provides further validation that while the general principle of not having a flood impact on other properties in the floodplain is sound, this should be applied with some tolerances.

As outlined above, most of the above considerations, and in particular the quantitative criteria, relate to the preparation of a FIA for individual development and not specifically to assessing cumulative impacts. The Manual suggests various criteria as a starting point to determining the acceptability of cumulative impacts. It specifically notes that these criteria apply to cumulative impacts and not to the assessment of individual proposals.

Technical Representatives and Study Team Input

Separate workshops were held with each of the three study area Councils, involving Council engineers and town planners, DPE, KBR and GLN to obtain input into:

- base principles to be adopted
- criteria to be applied in determining acceptable cumulative flood impacts.
- potential planning controls to address cumulative impacts.

Base principles and Cumulative Impact Assessment Criteria Applied

The following base principles were derived from the review of existing literature and guidelines, and discussions with each of the Councils:

1. The assessment of flood impacts should be based on consideration of the effects of development across the whole of the floodplain, irrespective of administrative boundaries.
2. Any change to the natural or built conditions in the floodplain should not have a material economic, environmental or safety impact on other properties or users in the floodplain.
3. When determining whether a change will have a material impact, an allowance should be made for tolerances in the accuracy of flood modelling and in consideration of the relative

vulnerability of different properties and users that may be potentially impacted. (eg residential dwellings should be afforded lower tolerances than parks or rural land).

4. The criteria for assessing the acceptability of impacts from an individual development should be less than the criteria for assessing cumulative impact. This takes into account that there could always be further development in the floodplain that should be allowed for when assessing acceptability.

These base principles provided a relevant platform for determining acceptability criteria for assessing cumulative impacts and the preparation of development controls as well as for the formulation of strategic planning guidance and broader direction for other related Council policies.

As shown above there are no established criteria for the assessment of the acceptability of the cumulative flood impacts. As inferred by the Manual this needs to be determined based on the context of individual floodplains.

The impacts generated by the testing of alternate development scenarios were not linear or homogeneous across the whole of the floodplain. The determination of what was an acceptable cumulative impact was consequently based on an iterative modelling process that sought to minimise impacts applying the starting point cumulative impact assessment criteria in the Manual. The flood modelling allowed for consideration as to what land uses were impacted and to what degree.

A flood level increase of 100mm was used as a maximum but generally flood level increases exceeding in the order of 50mm were avoided in urban residential areas which were considered to be relatively more sensitive to flood impacts than other areas. Changes in flood velocities were not significant when analysed on a cumulative impacts basis and other considerations outlined in the Manual were determined to be likely to be consequentially addressed if impacts on flood levels were managed. Avoidance of filling in floodways and flood storage areas were identified as key factors that should be reflected in the planning controls and guidelines to be prepared as an outcome of this study.

Consistent with the fourth base principle, the criteria for assessing cumulative impacts should be different to the criteria for assessing the impact from an individual development. FIAs associated with individual development should be limited to the consideration of localised effects and should not supplant the broader assessment of cumulative impacts. The assessment criteria for FIAs do not need to directly relate to those used in the assessment of cumulative impacts but are generally expected to be more stringent given that they relate to individual development. The assessment of cumulative impacts should be undertaken as part of a catchment wide study at a government level, such as this study, as its primary purpose is akin to the establishment of policies that takes into consideration a broader range of social, economic and environmental factors consistent with the merit based approach espoused by the Manual.

The more detailed findings of the modelling investigations are provided in the Stage 2 report prepared by KBR.

5 Stage 3 Planning Review

5.1 Strategic Planning

5.1.1 Overview

Some Councils have produced FRM Plans that provide strategic planning direction relative to the social, economic and environmental context of their LGA that can be associated with filling in the floodplain. For example the Newcastle FRM recommends against new residential development on land which can be isolated by river flooding, whereas the creation of fill pads in the rural areas of Maitland Port Stephens effectively permits this. Considerations relating to rural fill pads involve balancing development expectations and the need to support agricultural activities with the flood risks associated with occupying the pads and external flood effects.

This study is limited to examining the external flood effects only. While the intent of fill pads is specifically to mitigate flood risks to dwellings and rural activities it is recognised that this could have consequential residual risks such as facilitating rural residential development that might be isolated and possibly inundated during a flood. A recommendation of this study is to examine the residual risks to, for example, determine whether a refinement to the controls that create the expectation for additional dwellings are warranted, preferably as part of a broader future FRM Study review.

5.1.2 Regional Planning

The focus of the GNMP is to consolidate new housing in existing urban areas. The analysis undertaken as part of this study has determined that there are about 30,000 urban residential lots currently within the study area floodplain. A substantial proportion of these properties are below the FLP and most are occupied. It would not be possible to fill these lots to the FPL without having significant and unacceptable cumulative impacts on other properties within the floodplain. Accordingly if pursued, redevelopment of these properties to increase residential densities will require atypical design solutions for higher density housing such as elevated suspended habitable floors and the need to address residual flood risk issues such as isolation during major floods, increased demand on emergency management and localised flood impacts. These considerations are in addition to other matters such as amenity and streetscape issues associated with ameliorative design measures required to minimise flood risks.

While the GNMP provides high level recommendations associated with floodplain risk management, it does not provide clear direction as to whether redevelopment of existing urban residential properties below the FPL to increase densities would be acceptable. Based on the findings of this study, and limited to the consideration of cumulative flood impacts, it is concluded that this would not be acceptable in the majority of cases. Redevelopment to achieve higher densities may be acceptable in limited circumstances where properties are located outside of floodways and, where located within flood storage areas can be strategically planned to ensure there is no net loss in flood storage capacity.

Similar considerations arise in regard to the development of vacant or redevelopment of existing industrial properties. There are extensive areas of zoned industrial land close to the Hunter River within the Newcastle and Port Stephens LGAs. Past assessments of individual applications for the development or redevelopment of these industrial properties (such as the Northbank Industrial Hub and various sites in the Hexham and Sandgate areas) have revealed that it would be able to wholly fill these properties to the FPL without creating unacceptable impacts. This study has affirmed this

to be the case but has also identified a maximum level of fill that could be allowed without causing unacceptable cumulative flood impacts. Depending upon the nature of the industrial development, this may not be sufficient to allow for development with a tolerable level of risk and alternative measures may need to be considered such as elevated floors that allow flood flows to be unobstructed or reducing development footprints to allow for onsite compensatory excavation.

The planning controls proposed by this Study have been developed to accommodate development to the extent found acceptable, on the basis of existing development and land use zoning. The alternate solution is to progressively pursue the rezoning of urban land to non-urban land that would not have the same expectation for development and filling. This would need to focus on urban land located within floodways and then critical flood storage areas. Consideration of such an alternative approach is beyond the scope of this study and should commence at a regional planning level to determine firstly the social and economic impacts that such an approach would have and how the needs of the community could continue to be met through alternate planning strategies. This would need to be a collaborative approach involving the 3 local Councils and key government agencies such as the DPE and NSW Reconstruction Authority.

5.1.3 Local Planning

There is presently about 41,000 lots within the floodplain the subject of this Study, of which over 33,000 (80%) are zoned for urban development. Most (93%) of these urban zoned lots are occupied. The initial iterations of flood modelling in Stage 2 determined that the filling of all urban land to the FPL applicable to the relevant LGA would result in unacceptable flood impacts. All newly planned areas are already limited to areas above the currently applicable FPL and it is evident that the issues associated with allowing (or not allowing) filling of land to achieve flood immunity to the same level is a consequence of legacy decisions.

A continued application of policies that ensures that any future rezoning of land ensures that future development will be able to be located on land at or above the applicable FPL, is essential. This should ideally involve the application of a risk based approach to floodplain planning which would allow for the identification of suitable locations based on the flood sensitivity of a land use and the flood hazard characteristics of the floodplain. This might for example mean that sensitive uses and critical infrastructure is located with no flood risk (ie outside of the PMF extent) consistent with the "Considering flooding in land use planning Guideline" (DPE, May 2021). The implication for this Study is that this would ensure that no future new planning decisions would require filling that could result in unacceptable flood impacts.

The flood modelling undertaken in Stage 2 has determined that filling of rural pads to the FPL would be acceptable given the limited potential and ubiquitous nature of such development, but filling of all existing zoned urban land to the FPL would result in unacceptable cumulative flood impacts.

In terms of managing the continued use or redevelopment of existing zoned urban land, no ideal outcome is achievable. Either a moratorium is imposed on the development of urban zoned land where filling to the applicable FPL cannot be acceptably undertaken or alternate flood risk mitigation measures are imposed.

Accordingly a range of planning controls is recommended below to deal with existing zoned urban land in a way that provides for the equitable and suitable sharing of fill potential across all LGAs within the floodplain.

The assessment of any local planning initiative that might for example involve the redevelopment of an older flood affected area with poorly designed buildings having regard to the flood hazard, could be considered on a site by site basis. This would need to be a carefully considered strategic planning exercise that ensures that there would be no net increase in flood risk on the site or to other properties within the floodplain. There would be a range of flood risk matters to consider, but within the context of this Study, the 'cumulative flood impact assessment threshold criteria' and 'local siting criteria' provide a base line for assessing when cumulative impacts associated with any rezoning proposal would be excessive. Any proposal that varied from the current zoning potential would need to ensure that its contribution to the acceptable threshold limits would be unchanged or preferably reduced. The flood models established as part of Stage 2 of this Study, or updated equivalent versions, should be used to assess this. Such an assessment should ideally be undertaken as part of the broader flood risk management process specified by the Manual.

The alternative to the acceptance of legacy planning issues is to rezone urban land to non-urban land to increase the capacity to fill the balance of zoned urban land. This could have substantial economic and social consequences, and as recommended above should be initially considered at a regional planning level, if to be pursued. Such considerations above beyond the scope of this Study.

5.2 Statutory Planning

5.2.1 Overview

The primary aim of this study is to develop consistent DCP controls for the study area Councils to manage cumulative filling of the Lower Hunter River floodplain. Cumulative impacts are an extension to the consideration of flood impacts that development could have on properties external to the development site.

Cumulative impacts relate to the impacts that all potential development in the floodplain, considered together, could have as opposed to the impacts that relate to individual developments. The modelling undertaken in Stage 2 determined the extent of development that could cumulatively occur before unacceptable impacts arose. The stage 2 modelling also considered where localised effects of development could have unacceptable impacts because of proximity to other development or structures. This established thresholds, which if not exceeded, are not expected to result in unacceptable off site impacts.

As discussed later, "Flood Impact Technical Guidelines" have also been prepared as part of this Study to guide the preparation of a site specific flood impact assessment, where required.

A flood impact assessment (typically abbreviated as a **FIA**) is focussed on considering the effect that development could have on flood behaviour, commonly through the use of a computer model. The "Flood impact and risk assessment Flood risk management guideline LU01" published in association with the new Manual, provides advice on the preparation of a *flood impact and risk assessment* (**FIRA**). A FIRA addresses broader floodplain risk management considerations than solely the impact on flood behaviour, such as emergency management. A FIRA may be required by Councils to deal with broader FRM issues associated with development, and could effectively incorporate a FIA.

This study provides the opportunity to standardise submission and assessment requirements for each DCP within the study area Councils, as far as practicable. It is recognised that the formatting and presentation of the controls and any associated mapping may vary between each Council DCP but the substantive intent and metrics within the controls should remain consistent. Ideally the

amendment processes of each of the Councils, in particular the timing for public consultation and adoption/commencement of the DCP controls, should occur in tandem. Where variations are sought as a consequence of the public participation process, those amendments should be discussed between the individual Councils in the aim of maintaining consistency.

As outlined previously the recommended planning controls relate only to cumulative flood impacts as required by the Study brief, and it is expected that these will apply alongside other floodplain risk management planning controls.

5.2.2 DCP amendments.

Draft DCP controls are provided as **Appendix D**.

These controls have been prepared for incorporation into the DCPs of each of the 3 study area Councils. The process of amending the DCPs is to be undertaken by the individual Councils, in accordance with process specified by the EP& A Act and Regulation.

The prescriptive controls specify measures that if complied with are expected to ensure the performance criteria are satisfied. Where alternative solutions to the prescriptive controls are proposed, the proponent would be expected to justify how the development will still satisfy the performance criteria and remain consistent with the objectives of the control and the objects of the Act.

The application of the recommended DCP controls is set out in a matrix format as illustrated by **Figure 7**, and would apply in the following way:

1. If the cumulative flood impact threshold criteria are not exceeded then no further assessment of cumulative flood impacts is required.

2. If the cumulative flood impact threshold criteria are exceeded then:

    a. Any additional fill in flood storage areas above that allowed for by the threshold criteria must be addressed.

    b. No additional fill, than otherwise allowed for by the cumulative flood impact threshold criteria, is permitted in the floodway.

    c. Any proposed changes to ground levels and the height of a building must also be acceptable having regard to all other applicable requirements of the DCP and Local Environmental Plan.

3. A site specific FIA is required to be prepared and submitted with the development application only where local siting criteria are not satisfied, to demonstrate that there will not be localised unacceptable impacts because of proximity to other development or structures.

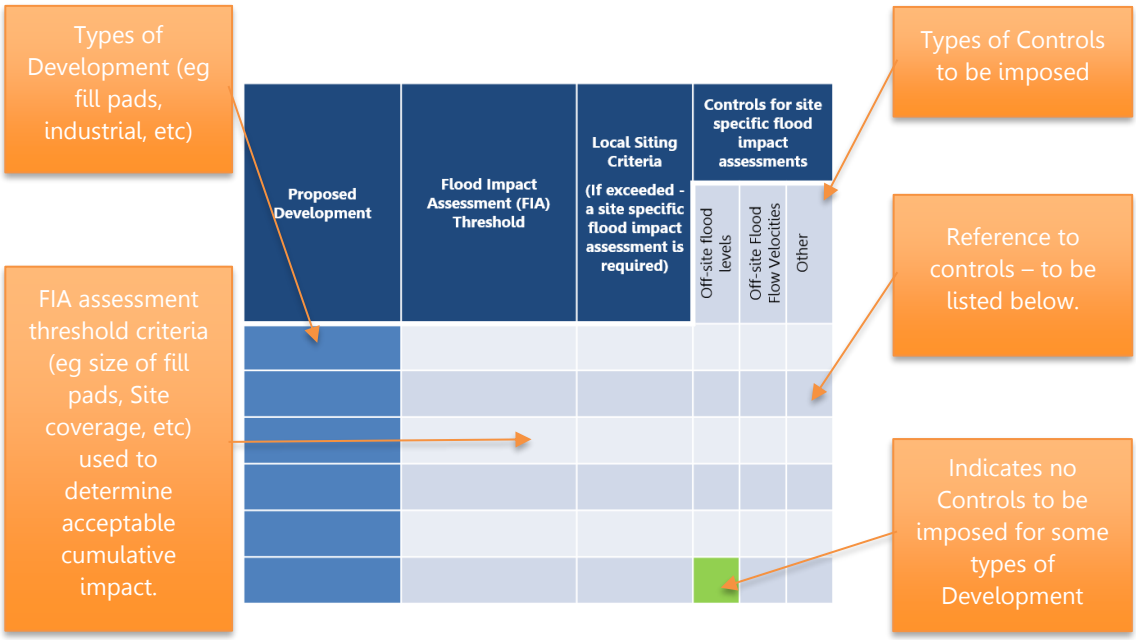

Figure 7 Format of DCP Controls

The cumulative flood impact threshold criteria provides for filling based on a range of flood frequencies, and have been formulated based on the previously described iterative process that determined what would be an equitable and sustainable distribution of fill potential across the floodplain. If the threshold criteria are exceeded then:

- No additional fill would be permitted in the floodway to ensure no further impact on the conveyance of flood waters or loss of flood storage capacity in the floodplain beyond that determined as acceptable by the Stage 2 modelling.

- Any additional fill in flood storage areas above that allowed for by the threshold criteria must be addressed to ensure there would be no further loss of flood storage capacity in the floodplain beyond that determined as acceptable by the Stage 2 modelling. For example, compensatory excavation and/or the floors of a proposed building is to be elevated in a manner that maintains flood storage capacity in the 1% AEP floodplain if required to achieve a minimum flood planning level.

There would be no utility in allowing a site specific flood study when the cumulative flood impact threshold criteria were exceeded. These criteria were determined based on the cumulative effect of an adopted level of filling across the Study Area. To then allow a reassessment of these thresholds on an individual development basis would allow for cumulative impacts again. The exception to this is for the isolated occurrences of public infrastructure for the reasons discussed previously. Any future review of the cumulative flood impact threshold criteria should be undertaken only by the Council's at a strategic level, and ideally as part of the broader flood risk management process specified by the Manual.

As the cumulative flood impact threshold criteria are based on a uniform flood frequency, it would allow for filling to a wide range of depths. Consequently, the study area Councils could also consider imposing an overall maximum fill depth in certain circumstances where it would be expected that excessive depths of filling would have undesirable amenity and environmental impacts. This would

vary depending on the size of the lot and whether the filling is occurring as part of the redevelopment of isolated parcels of land or as part of broadscale greenfield development. Maximum fill depths would unlikely be necessary for greenfield development or for larger lots given that surrounding land would be expected to be filled to similar levels, or amenity and environmental impacts could be internalised.

A FIA assessment would be required only when local siting criteria are not satisfied. These criteria were formulated as part of the Stage 2 modelling, and indicate that if exceeded, localised impacts may arise. These impacts arise due to the proximity of filling works to other filling works or structures.

In accordance with the Study brief, the DCP controls were required to relate specifically to addressing potential cumulative flood impacts that development could have on properties external to the development site. The controls will however necessarily also refer to potential external flood impacts in general. but should have no effect on all other provisions of the Councils' DCPs that relate to flood risk management

5.2.3 Other Recommendations

State Significant Infrastructure

While future major projects such as state significant infrastructure (**SSI**) projects could potentially have significant impacts, there are no committed projects that have been identified in addition to those considered as part of the Stage 2 modelling. Typically, various projects may be mooted at a political level and discussed at a high level in regional planning strategies but are then subject to a range of further considerations before proceeding to planning approval. Consequently, it would be reasonable to allow for these types of projects to be considered on merit, given potential public interest benefits and in recognition that they would be required to consider cumulative impacts, and would be guided by this study.

The "Cumulative Impact Assessment Guidelines for State Significant Projects" (Department of Planning and Environment, 2022) provides direction in regard to the assessing cumulative impacts. Clause 171(2)(o) of the *Environmental Planning & Assessment Regulation 2021* specifically requires, where no environmental factors guidelines apply, consideration of "the cumulative environmental effect with other existing or likely future activities". Further, it would be expected that the findings of this study, including the recommended planning controls would be taken into consideration when undertaking the required assessment of such major projects.

The assessment of any future state significant infrastructure projects should utilise the flood models established as part of Stage 2 of this Study, or updated equivalent versions. This would allow for the consideration of the same parameters that were adopted for the purposes of establishing acceptable parameters for development generally, having regard to cumulative flood impacts.

State Significant Development

Under the EP&A Act, all State Significant Development (**SSD**) projects require development consent from either the Independent Planning Commission or the Minister. All DAs for SSD projects must be accompanied by an Environmental Impact Statement (**EIS**) that addresses the environmental assessment requirements (**SEAR**s) for the project. Industry specific SEARs have been prepared for commonly occurring development, otherwise the DPE will issue a project specific SEARs.

In all cases it is expected that a SEARS will require consideration of a Council's DCP controls, which will include the cumulative flood impact controls developed as part of this study. Otherwise it would be appropriate for Council to seek consideration of the recommended controls as part of the standard consultation process.

It is recognised that in the assessment of SSDs broader public interest considerations may have a role, in determining the acceptability of such developments. However, as outlined above the guidelines prepared for the assessment of state significant projects require consideration of cumulative impacts and this Study has determined the acceptability thresholds for cumulative flood impacts. Accordingly, it is expected that these threshold criteria will be given substantial weight in the evaluation of such projects.

Any impacts associated with any deviation from the threshold criteria should be tested using the models established in Stage 2 of this Study or equivalent updated models. The level of impacts determined for the whole of the floodplain in Stage 2 should not be exceeded. Localised impacts should also be addressed in the same manner as that outlined for standard development in the DCP and Technical Guidelines. Where unavoidable impacts on isolated properties are identified and determined to be acceptable, it is assumed that compensation to the owners and occupants of the affected properties would be required in a similar manner to that required for the Northbank Enterprise Hub.

Hunter Valley Flood Mitigation Scheme Assessments

As outlined above, DPE is required to provide concurrence under Section 256 of the *Water Management Act 2000* to development applications that involve land filling in substantial part of the study area floodplain.

The guidance provided by this Study, in particular the DCP controls and Technical Guidelines could be used by the DPE when reviewing whether to provide concurrence. While this would be doubling up on the assessment otherwise required by the Council assessment process, it would provide for an independent review and ensures consistency.

Consideration of Climate Change

At present there is an inconsistency between the Study area Councils as to whether FPLs factor in climate change. This could result in differential levels of fill where filling to the FPL is allowed. The final iteration of flood modelling undertaken in Stage 2 has assumed that all FPLs have climate change considerations factored in.

Accordingly, it is recommended that for the purposes of the recommended planning controls any reference to an FPL be inclusive of added levels associated with climate change consistent with the approach taken by Stage 2 of this Study. Separate to this Study, the Councils may wish to review the methodology for the formulation of all FPLs to achieve a consistent catchment wide approach and not that this is also now an expressed function of the newly established NSW Reconstruction Authority.

5.2.4 Guidelines.

Draft Technical Guidelines are provided as **Appendix E** to supplement the DCP controls. The Guidelines outline requirements for the preparation of site specific flood impact assessments and to

assist in the process of assessing flood impacts as part of the development application assessment process.

The following matters are addressed by the Guidelines:

- General considerations including who can prepare a FIA and reference to departmental guidelines.
- When a qualitative assessment might be acceptable as opposed to a quantitative assessment based on computer modelling.
- The computer model that must be used.
- The assessment criteria to be used in determining the acceptability of any impact.
- The requirements of the FIA report to be submitted to Council, including an outline of mitigation measures required to address any identified impacts.

The Guidelines have been prepared for incorporation in the policy documents of each of the 3 study area Councils in a manner that suits each Council. It is recognised that the formatting and presentation of the Guidelines may vary between each Council but the substantive intent and metrics within should remain consistent. Where variations are sought, those amendments should be discussed between the individual Councils in the aim of maintaining consistency.

The Technical Guidelines were specifically prepared for flood liable land within the Hunter Valley Catchment. However, each Council may choose to apply them generally to development in all floodplains within their local government area.

The Technical Guidelines supplement DCP controls that were prepared to specifically address potential flood impacts that development could have on properties external to a development site. A site specific FIA may form part of a broader flood impact and risk assessment (**FIRA**), where Council requires broader floodplain risk management issues (such as emergency management) to be reviewed.

5.2.5 Recommendations for developing a database.

The flood modelling undertaken in Stage 2 was based on projections of development that would require filling within the floodplain and a range of assumptions. The recommended planning controls allow for limited filling works on individual properties based on existing site conditions. Accordingly, the monitoring and review process, that should form a part of any planning process, is particularly important in this case because:

- The rate of filling associated with development might vary from that predicted, in which case modelling could be reviewed to determine revised cumulative flood impact threshold criteria for the planning controls.
- A centralised data base would allow for verification as to whether filling works approved to the limit prescribed by the recommended planning controls have been undertaken, so that additional filling works are not allowed.

The simplest review process would be to rely on LIDAR updates and review modelling periodically. However, there will be lag times between approvals and latest LIDAR information and this would not provide a process of tracking approvals granted under the proposed controls to ensure that proponents do not seek repeat applications for filling. If Council's are satisfied with the frequency of updated LIDAR data and are confident of managing applications to avoid repeating filling applications over time, then there would be no need to establish a centralised data base. Otherwise, as required by the brief the following outlines considerations for the establishment of a data base.

All Development Applications are typically supported by data specifically used to inform flood modelling and/or the extent of proposed filling for development in the floodplain. The extent of proposed filling may be varied through the development application assessment process through amendments to the application or conditions imposed on development consent.

Where filling works are proposed as part of a subdivision development, a subdivision works certificate (**SWC**) would be required to be submitted after the issue of a development application and prior to the commencement of works. Similarly, if filling works are proposed as part of a building development, a construction certificate (**CC**) would be required to be submitted after the issue of a development application and prior to construction. Where a SWC or SC is issued by a private certifier, copies are required to be submitted to a Council. In some cases a SWC or a CC is not required to be submitted prior to the commencement of filling works, where for example the filling is not associated with subdivision or building works.

Further verification would be required at the completion of works. A subdivision certificate would be required at the completion of subdivision works while an occupation certificate would be required at the completion of building construction works. These final certificates are effectively verification that work has been completed in accordance with the approved SWC or CC. Accordingly they would not normally provide additional details of the works.

In limited circumstances filling works might occur as part of a development that is permissible without consent under Part 5 of the EP&A Act. These are typically public works undertaken by either Council or a government agency. The works are self-approved and would not normally require a SWC or CC.

Similar information as that discussed above may also be provided in Planning Proposals (submitted in support of an application to change the zoning controls applying to land) or other studies. However, this information is provided too early in the planning process to be able to be relied upon as that information would be available years before any potential works and a development proposal may change or not proceed. Accordingly, it is our view that there is no utility in recording information from such sources in a dedicated floodplain filling data base.

The best information to record in the data base would be that sourced closest to the completion of the filling works. The information should also be easy to source and extract. Accordingly, it is recommended that sources of filling works information be as follows:

- A SWC - where filling is proposed as part of a subdivision development
- A CC – where filling is proposed as part of building construction development
- A DA – where works can commence without a SWC or CC
- At the time of approval in regard to Part 5 development.

The Technical Guidelines will be clear about the information requirements to support these development applications including volume of imported fill and changes to ground levels. The Technical Guidelines should be referred to by the relevant divisions of Councils or to Government agencies during the consultation phase of Part 5 development proposals.

A single regional a geodatabase that is available to all Councils should be established to capture this information to help update broader modelling and inform of impacts across the floodplain (see above). The database should be collectively populated by the three study area Councils, progressively as information form the above sources becomes available and would include the following information:

- LGA,
- Property Description,
- Proposed Development,
- Brief description of filling required (ie for residential of rural purposes),
- volume of fill to be imported,
- changes in surface levels,
- whether supported by flood study and the model used,
- any offsetting, compensatory excavation/storage or bridge and culvert structures were proposed to reduce impacts, and duration of consent.

A further potential use of a data base would be to establish a register for the trading of filling allowances' between properties. This would be similar to floor area trading schemes such as that providing the City of Sydney Council to allow for the sale of floor space rights that apply heritage properties to accrue funds for conservation purposes while ensuring the planned floor space potential of the city is realised without impacting heritage values. This requires relatively complex legal and administrative consideration beyond the scope of this Study but is recommended for further consideration.

5.2.6 Communication & Consultation Strategy

Dr Wiggins and GLN have worked with the Port Stephens Council's communication team to provide input into a short audio-visual explanation of the Study. The information compiled as part of that process could be adapted for the preparation of plain English communication material for inclusion on each Council's website and as part of a broader communication strategy

Ultimately the Study and draft DCP controls are expected to be placed on public exhibition as part of a broader community consultation process. Any amendments to the DCP will need to be undertaken by the individual Councils in accordance with the process stipulated by the EP&A Act and Regulation . The consultation process would be guided by the respective Councils Community Participation Plan. It is noted the key stakeholder groups to be consulted include the Department of Planning and Environment- Water - Hunter Valley Flood Mitigation Authority.

It is recognised that the formatting and presentation of the recommended planning controls and any associated mapping may vary between each Council DCP but the substantive intent and metrics within the controls should remain consistent. Ideally the amendment processes of each of the Councils, in particular the timing for public consultation and adoption/commencement of the DCP controls, should occur in tandem. Where variations are sought as a consequence of the public participation process, those amendments should be discussed between the individual Councils in the aim of maintaining consistency.

5.2.7 Coordination between Councils and State Agencies

To ensure that a consistent basis for the assessment of flood impacts across the Lower Hunter Floodplain it would be desirable to establish a flood risk management user group comprising technical staff (development and strategic planners and engineers) from each of the Councils and DPE (EHG Group) to discuss matters such as:

- Any issues with the implementation of the DCP controls and possible amendments
- Variations sought and provided to the DCP controls for individual DAs on the basis of satisfying performance criteria.
- Additional information or refinement of the Technical Guidelines that could assist in the DA assessment process.

The user group could also be responsible for monitoring the extent to which development is progressing relative to the parameters adopted for the purposes of Stage 2 modelling and initiate when a review process would be appropriate.

6 Conclusion

There is presently about 41,000 lots of varying size within the floodplain the subject of this Study, of which over 33,000 (80%) are zoned for urban development. Most (93%) of these urban zoned lots are occupied. The initial iterations of flood modelling in Stage 2 determined that the filling of all urban land to the FPL applicable to the relevant LGA would result in unacceptable flood impacts. All newly planned areas are already limited to areas above the currently applicable FPL and it is evident that the issues associated with allowing (or not allowing) filling of land to achieve flood immunity to the same level is a consequence of legacy decisions.

The primary aim of this study is to develop consistent DCP controls for the study area Councils to manage cumulative filling of the Lower Hunter River floodplain. Cumulative impacts are an extension to the consideration of flood impacts that development could have on properties external to the development site, and is best undertaken at a strategic level for the whole of the floodplain.

Cumulative impacts relate to the impacts that all potential development in the floodplain, considered together, could have as opposed to the impacts that relate to individual developments. The modelling undertaken in Stage 2 determined the extent of development that could cumulatively occur before unacceptable impacts arose. The stage 2 modelling also considered where localised effects of development could have unacceptable impacts because of proximity to other development or structures. This established thresholds, which if not exceeded, are not expected to result in unacceptable off site impacts.

The planning controls proposed by this Study have been developed to accommodate development to the extent found acceptable, on the basis of existing development and land use zoning. The alternate solution is to progressively pursue the rezoning of urban land to non-urban land that would not have the same expectation for development and filling. This would need to focus on urban land located within floodways and then critical flood storage areas. Consideration of such an alternative approach is beyond the scope of this study and should commence at a regional planning level to determine firstly the social and economic impacts that such an approach would have and how the needs of the community could continue to be met through alternate planning strategies. This would need to be a collaborative approach involving the 3 local Councils and key government agencies such as the DPE and NSW Reconstruction Authority.

7 Glossary

Abbreviation	
1% AEP flood or 1 in 100 per year chance flood	A flood that has a 1 in 100 chance of being reached or exceeded within any 12 month period and occurs on average once every 100 years. Also known as a 1% flood or described as the 1 in 100 per year chance flood. See Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI).
Annual Exceedance Probability (AEP)	AEP (measured as a percentage) is a term used to describe flood size. It is the preferred means of describing how likely a flood is to occur in a given year. For example, a 1% AEP flood is a flood that has a 1% chance of occurring, or being exceeded, in any one year. It is also referred to as the '100 year flood' or 1 in 100 year flood'. The terms 100 year flood, 50 year flood, 20 year flood etc., have been used in this study. See also Average Recurrence Interval (ARI).
Australian Height Datum (AHD)	A common national plane of level approximately equivalent to the height above sea level. All flood levels, floor levels and ground levels in this study have been provided in metres AHD.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood equal to or larger in size than the selected event. ARI is the historical way of describing a flood event. AEP is generally the preferred terminology, for example, a 100-year ARI flood that has 1 in 100 chance of being reached or exceeded in any given year. It is equivalent to a 1% AEP flood See also Annual Exceedance Probability (AEP).
BCA	Building Code of Australia is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. The BCA is produced and maintained by the Australian Building Codes Board (ABCB), and given legal effect through the Building Act 1975.
CDC	Complying Development Certificate
CC	Construction Certificate
Councils	Maitland City, Port Stephens and Newcastle City Councils
DA	Development Application
DCP	Development Control Plan
DPE	The NSW Department of Planning & Environment (DPE) (formerly NSW Department of Planning Industry and Environment - DPIE, Department of Planning and Environment – DPE, Department of Planning and Infrastructure – DPI and Department of Planning – DoP).
DA	Development Application
Development Control Plan (DCP)	A DCP is a plan prepared in accordance with the *Environmental Planning and Assessment Act, 1979* that provides detailed guidelines for the assessment of development applications.
emergency management	A comprehensive approach to dealing with risks to the community arising from hazards. It is a systematic method for identifying, analysing, evaluating and managing these risks.

Abbreviation	
EP&A Act	*Environmental Planning and Assessment Act, 1979*
EPA Regulation	*Environmental Planning and Assessment Regulation 2000*
flood	A natural phenomenon that occurs when water covers land that is normally dry. It may result from coastal inundation (excluding tsunamis) or catchment flooding, or a combination of both..
Flood function	The flood related functions of floodways, flood storage and flood fringe within the floodplain. Flood function is equivalent to hydraulic categorisation.
flood hazard	The potential for damage to property or risk to persons during a flood. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.
Flood impact assessment (FIA)	Refers to a site specific study prepared to assess the impacts on flood behaviour that are likely to occur as a consequence a particular development.
Flood impact and risk assessment (FIRA)	A study to assess flood behaviour, constraints and risk, understand offsite flood impacts on property and the community resulting from the development, and flood risk to the development and its users. A site specific flood impact assessment would be a subset of a FIRA.
flood level	The height of the flood described either as a depth of water above a particular location (e.g. 1m above a floor, yard or road) or as a depth of water related to a standard level such as Australian Height Datum.
flood liable land	Equivalent to flood prone land.
The Manual	The Flood Risk Management Manual (FRMM) published by the DPE Environment and Heritage Group in June 2023.
Flood Planning Levels (FPLs)	The combination of flood levels and freeboards selected for planning purposes..
flood prone land	Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood liable land in the FRMM.
FRM	Flood Risk Management
Flood storage areas	Areas of the floodplain that are outside floodways which generally provide for temporary storage of floodwaters during the passage of a flood and where flood behaviour is sensitive to changes that impact on temporary storage of water during a flood
Flood Study	A study that investigates flood behaviour, including identification of flood extents, flood levels and flood velocities for a range of flood sizes. A flood study is undertaken in accordance with the FRM process outlined in the Manual to support the understanding and management of flood risk. It is different from a flood impact and risk assessment (FIRA)
floodplain	Equivalent to flood prone land.

Abbreviation	
Floodplain Risk Management Plan (FRM Plan)	A management plan developed in accordance with the principles in the Manual and its supporting guidelines.
Floodplain Risk Management Study (FRM Study)	A management study developed in accordance with the principles in the Manual and its supporting guidelines. The outcome of a Floodplain Risk Management Study is a Floodplain Risk Management Plan.
Floodway areas	Areas of the floodplain which generally convey a significant discharge of water during floods and are sensitive to changes that impact flow conveyance. They often align with naturally defined channels or form elsewhere in the floodplain.
freeboard	A factor of safety typically used in relation to the setting of minimum floor levels or levee crest levels.
Local Environmental Plan (LEP)	A Local Environmental Plan is a plan prepared in accordance with the Environmental Planning and Assessment Act, 1979, that defines zones, permissible uses within those zones and specifies development standards and other special matters for consideration with regard to the use or development of land.
LGA	Local Government Area
merit approach	Weighs social, economic, ecological and cultural impacts of land-use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and wellbeing of the state's rivers and floodplains.
EHG	The Environment and Heritage Group of the DPE (formerly the Office of Environment and Heritage and the Department of Environment, Climate Change and Water, and DECCW).
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation (PMP), and where applicable, snow melt, coupled with the worst flood-producing catchment conditions.
risk	The effect of uncertainty on objectives' (ISO 2018). Note 4 of the definition in ISO31000:2018 also states that 'risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood.' For example, the potential inundation of an aged person's facility presents a greater flood risk than the potential inundation of a sports ground amenities block (if both buildings were to experience the same type and probability of flooding). Reducing the probability of flooding reduces the risk, increasing the consequences increases risk..
SEPPs	State Environmental Planning Policies
SWC	Subdivision Works Certificate

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APPENDIX A: PEER REVIEW OF DR LIAROS

APPENDIX B: BRIEF FOR STAGE 2 OF STUDY

Project brief for

Stage 2- Lower Hunter Floodplain Cumulative Development Impact Study and Plan

December 2022

PORT STEPHENS COUNCIL

Contents

1. INTRODUCTION

Preface

Port Stephens Council, in conjunction with Maitland City Council and the City of Newcastle (**the Councils**) are seeking proposals from suitably qualified consultants for Stage 2 of the Lower Hunter Floodplain Cumulative Development Management Study and Plan.

The Councils have received financial support from the State Floodplain Management Program, managed by the NSW Department of Planning and Environment (**DPE**), to undertake a cumulative development impact study (**the Study**) for the Lower Hunter floodplain.

The primary objective of the New South Wales (**NSW**) Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through DPE, the NSW Government provides specialist technical assistance to local government on all flooding, flood risk management, land-use planning matters and flood emergency management.

The *Floodplain Development Manual* (NSW Government 2005) is provided to assist councils to meet their obligations through the preparation and implementation of floodplain risk management plans, through a staged process.

The *Floodplain Development Manual* is consistent with Australian Institute of Disaster Resilience Handbook 7: *Managing the floodplain: best practice in flood risk management in Australia* (AIDR Handbook 7) (AIDR 2017).

Background

There is significant development pressure in the Hunter Valley with the Hunter Regional Plan forecasting a population increase of 130,000 people over the next 20 years, many of whom are anticipated to want to live on the Hunter River floodplain.

Development on the floodplain often includes the importation of fill to raise ground levels above the flood planning level (**FPL**) in association with development permissible under current planning instruments. Planned future growth could increase the extent of development that involves further filling within the floodplain. Such development of the floodplain has the potential to result in a cumulative loss of significant flood volume and conveyance, and if not carefully managed, this could considerably increase the risk to life and property.

Currently, development applications are assessed by individual Councils on a lot-by-lot basis. The planning approval process, from the point of view of flood assessment, is somewhat complicated by the Hunter River channel forming the boundary between Port Stephens, Maitland and Newcastle Local Government Areas (**LGA**s). This development approval process has allowed numerous developments to import considerable volumes of fill onto the floodplain.

The Councils have collectively recognised that the cumulative fill volume from all permissible development (under the current planning controls) could potentially have an adverse impact on flood levels (through a reduction of floodplain volume and conveyance) and potentially result in a redistribution of floodwaters within the floodplain. These impacts would worsen with any changes to the planning controls that allowed for further development in the floodplain unless properly understood and managed.

Managing cumulative impacts is a shared responsibility for all consent authorities within the Lower Hunter floodplain. An analysis of planning controls for the three Councils of the Lower Hunter floodplain, indicates that while there is commonality for flood planning in Local Environmental Plans (**LEP**s) including a commitment to the principles of the NSW Government Flood Prone Land Policy and the NSW Government Floodplain Development Manual, the detailed approach to floodplain development controls varies considerably and inequitably between Councils.

Study Objective

The objective of this project is to deliver a regional strategy to guide sustainable and equitable development of the Lower Hunter Floodplain.

2. THE PROJECT OVERVIEW

The Study is being undertaken in three stages:

Stage 1 was completed by Water Research Laboratory (**WRL**) of the School of Civil and Environmental Engineering at UNSW Sydney. This stage was a scoping study that collated available information, identified and determined the needs of the stakeholders and recommend a methodology for the subsequent stages of the project. The Stage 1 study is included as **Appendix 1** to this brief.

Stage 2 (this stage) will use models to assess the sensitivity of the floodplain to filling. The assessment will analyse the cumulative impact of future development (including any significant public infrastructure upgrades) on flood characteristics. The impact assessments will examine a range of floods and climate change considerations to determine acceptable levels of fill in specific areas and the design considerations for fill works. Stage 2 will inform the planning recommendations required from Stage 3.

Stage 3 will provide recommendations for catchment-wide consistent strategies, policies and development controls to manage the cumulative filling of the Lower Hunter floodplain. The Study and Plan will:

- Assist Councils in managing future development and reduce the impacts of flooding and flood liability on communities and to reduce private and public losses resulting from floods, and
- Assist the Councils, the Regional Planning Panel, and the State Government and Planning Assessment Commission in making informed decisions on managing flood risk for future development and to reduce flood damages arising from development decisions.

GLN planning (**GLN**) has been engaged to undertake Stage 3, and will lead the procurement and management of the consultant undertaking Stage 2.

3. THE STUDY AREA

The study area comprises the floodplain of the Hunter River and its tributary rivers and creeks in the Port Stephens, Maitland and Newcastle LGAs. The extent of the floodplain is shown in **Figure 1**.

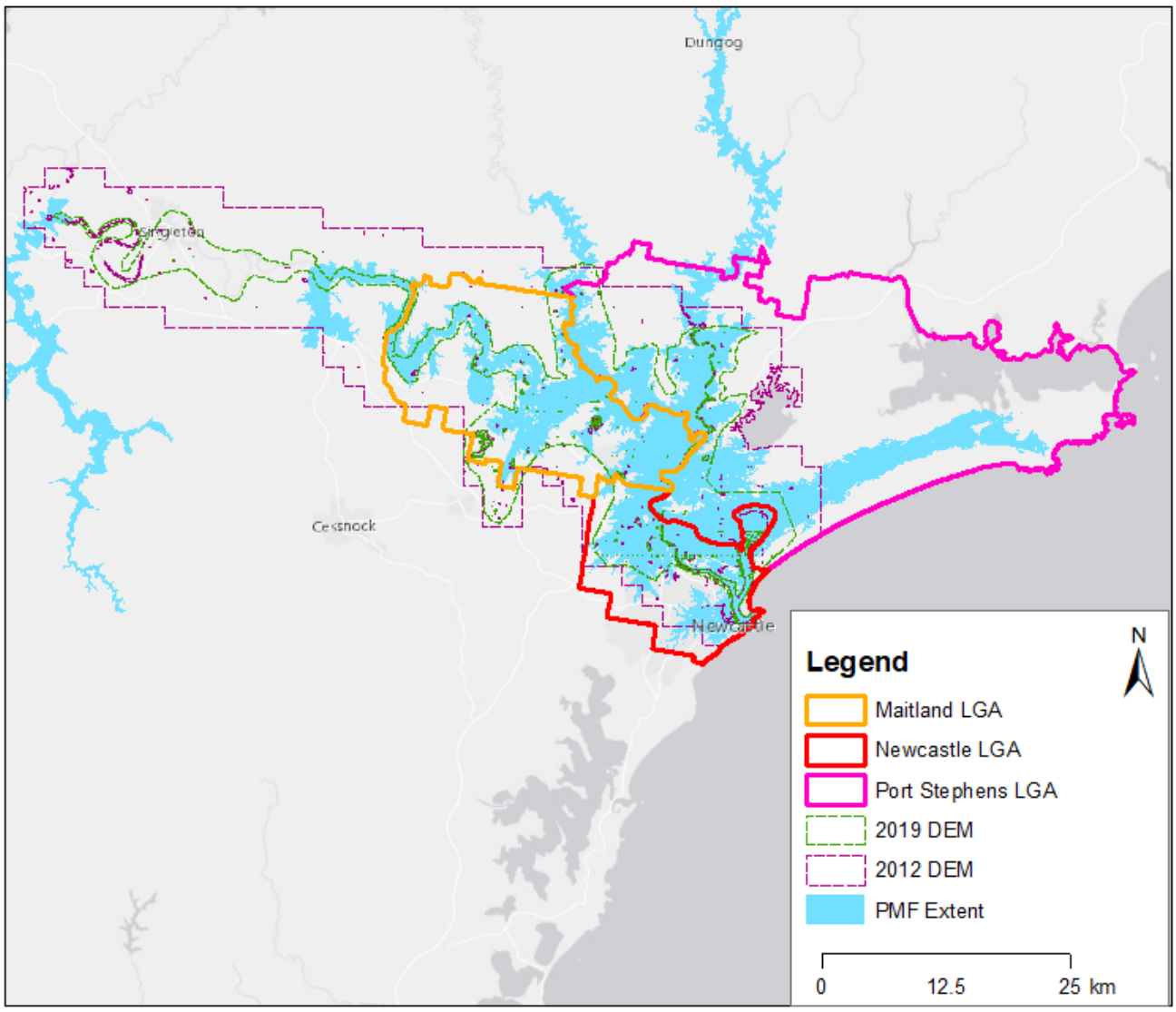

***Figure 1** - Study area for the Lower Hunter River Cumulative Floodplain Development Management Study and Plan*

4. SCOPE OF WORKS

Overview

The tenderer's proposal is to outline a methodology that will achieve the objectives of the study. The proposed methodology is to be developed to meet the scope of work and to produce the required deliverables.

The brief is purposely prescriptive where possible to limit the variability between tenders and to ensure the objectives of the study are fulfilled as intended. However, refinements will be considered where they will provide greater efficiencies or improved deliverables, having regard to the objectives of the study.

The proposal should include a section on limitations to specifically indicate the ability to comply with the full requirements of the brief or to specifically identify any recommended variations or limitations with the proposed approach in meeting the full requirements of this brief, including the defined deliverables for all end users.

The consultant is required to complete the following tasks:

1. Prepare hydraulic modelling required to inform:
    a. An analysis of the potential cumulative impacts associated with filling within the floodplain in association with:
        i. development permitted by existing planning controls
        ii. development that could be permitted by future planning controls in fulfilment of current local and regional planning strategies.
    b. The preparation of appropriate of planning controls in Stage 3 of the Study that addresses:
        i. the quantum of fill associated with individual developments that could be acceptably allowed in the floodplain, or parts of the floodplain, with or without compensatory excavation
        ii. design parameters to guide the manner any fill is placed in the floodplain to mitigate against unacceptable localised impacts due to potential changes in flood behaviour.
    c. Complementary planning recommendations such as the refinement of future urban release areas to avoid the necessity for filling within the floodplain or matters to address in the consideration of major public infrastructure projects.
2. Attend project meetings as required.

The Stage 2 Study will be managed by GLN with overriding direction provided by Port Stephens Council (**PSC**) as required. GLN will be the day-to-day contact for the study. Project meetings will be attended by representatives from each of the three councils as well as DPE representatives.

Study Familiarisation

Prior to the inception meeting, the project team should review and familiarise themselves with the Stage 1 report “Scoping Study for the Lower Hunter River Cumulative Development Impact Study and Plan”, prepared by WRL in June 2021, and the range of flood model resources and data inputs to be provided by GLN, as outlined below.

No site inspection is required as part of the Study.

Available Data

Land Survey Information

Best available and suitable land survey information will be provided by GLN to the Stage 2 consultant. This data is to be used to generate the DEM to be used for undertaking the required hydraulic modelling. This will comprise:

- 2021 LiDAR for the Newcastle and Maitland LGAs
- Latest available Elevation and Depth – Foundation Spatial Data (ELVIS) from NSW Spatial Services

- Updates to the above LiDAR information obtained by GLN from Council records of recent developments and major public infrastructure works (to be provided as a Digital Elevation Model - .dem or GIS Shapefile - .shp dependant on the quality of available data).

All LiDAR is to be provided at the commencement of the study. Acquiring of any additional data outside of what is provided is not considered to be a part of this scope.

Previous Hydraulic Models

As identified within the Stage 1 report, several hydraulic models have been developed within the Lower Hunter region. Table 2-2 of the Stage 1 report summarises each of these models. As demonstrated within the Stage 1 report, none of these models provide a catchment wide understanding of the Lower Hunter floodplain across the three partner councils. Each of the models tabulated below will be available for Stage 2.

Table 2-2 Flood studies combined to create merged flood models (Smith and Simpson, 2019)

Flood Study	Year	Flood Study Owner	Hydrological catchment model	Hydraulic flood model
Williams River Flood Study	2009	Port Stephens Council and Dungog Shire Council	XP-RAFTS	TUFLOW
Hunter River Flood Study – Branxton to Green Rocks	2010	Maitland City Council	FFA/WBNM	TUFLOW
Singleton Floodplain Risk Management Study	2011	Singleton Council		TUFLOW
Upgrading of Lower Hunter Flood Model at Hexham	2008	Newcastle City Council	FFA	Mike Flood
Aberdeen Flood Study	2013	Upper Hunter Shire Council	WBNM	TUFLOW
Wollombi Brook Flood Study	2016	Singleton Council	XP-RAFTS	TUFLOW
Paterson River Flood Study - Vacy to Hinton	2017	Maitland City Council, Port Stephens City Council, Dungog Council	WBNM	TUFLOW
Williamtown-Salt Ash Floodplain Risk Management Study and Plan	2017	Port Stephens Council	XP-RAFTS	TUFLOW

- Flood Frequency Analysis (FFA)

Future Development Areas

The Stage 2 consultant will be provided with the following information to be used to model the potential cumulative flood impacts associated with existing zonings and possible future zonings that permit additional development in fulfilment of current local and regional planning strategies.

General

GLN will provide the Stage 2 consultant with a GIS layer (i.e. Shapefile) comprising relevant base data and various layers of information compiled specifically for this study. The base data will include:

- Existing modelled flood extents (1% AEP and PMF) (Only PMF provided from Port Stephens and Newcastle)
- Existing land zoning shapefile
- Cadastre shapefiles

- 2021 1M DEM LiDAR for Maitland & Newcastle (produced by Metromap)
- ELVIS 1M DEM for Maitland, Newcastle and Port Stephens
- Shapefiles for unoccupied & occupied properties (Port Stephens data clipped to PMF extent)
- Flood Studies for Maitland (Hunter River Flood Study, Wallis Swamp Fishery 2019)
- Newcastle Buildings layer shapefile
- Floor level surveys for Newcastle, Port Stephens, Williamtown and Williams River

Locations of assumed existing fill mounds to support gaps in LiDAR data:

- Geocoded list of approvals (mounds) by Hunter Valley Flood Mitigation Scheme (2001 – 2022)
- Port Stephens Geocoded list of approved DA mounds (1996 – 2022)
- Maitland Geocoded list of approved DA mounds (2020-2022)

Future locations of Urban Release Areas.

- Various georeferenced strategic plans provide by each Council. A consolidated shapefile of urban release areas can be prepared if required.

Committed Development

The Stage 2 consultant will be provided with the following to be used to determine the location and extent of potential fill associated with committed development:

- The identification of currently vacant lots within the study area upon which a fill pad or pads could be constructed under existing planning controls
- Assumptions to be applied to determine the size and height of fill pads and associated works such as raised lead in access roads.
- The identification of where filling could be expected within existing urban release areas to bring levels in compliance with the relevant Flood Planning Level (**FPL**)
- The identification of established urban areas within the floodplain where infill development could occur and assumptions to be applied to determine the potential for filling.
- The identification of planned major public infrastructure projects in the floodplain (including the Newcastle Low Lying Suburbs Sea Level Rise Levee).

Examples for the Assessment of Localised Flood Impacts

The Stage 2 consultant will be provided with the following to be used to determine the potential for localised flood impacts associated with the construction of fill pads and associated works:

- Up to six examples described in writing and/or in PDF plans depicting the size and shape of fill pads and associated works relative to similar existing or potential future developments.
- The general location with the floodplain to assume the location of the example. Note, the same example may be required to be tested in different floodplain locations.
- Assumptions as to the scale and form of such development, and associated parameters such as fence type, to be applied when undertaking hydraulic modelling.

Possible Future Development

The Stage 2 consultant will be provided with the following to be used to determine the location and extent of potential fill associated with future development:

- The delineation of planned future urban release areas that are located within the floodplain will be provided by GLN as a consolidated GIS layer.
- Other possible redevelopment within established urban areas that could result in the need for filling within the floodplain.
- Possible future major public infrastructure projects within the floodplain.
- GLN will specify assumptions to be applied in modelling the above potential developments such as the treatment of building footprints and fencing and representation of major public infrastructure projects.

Baseline Hydraulic Modelling

No single suitable hydraulic model covers the entirety of the Lower Hunter floodplain region. However, as outlined within Stage 1, extensive modelling has been undertaken of specific areas within the catchment.

To assess the cumulative impact assessment of filling in the Lower Hunter floodplain, the consultant is to update the two largest of the existing models as follows:

- Hunter River Branxton to Green Rocks Flood Study (WMA Water, 2010)
- Williamtown-Salt Ash Floodplain Risk Management Study and Plan (BMT, 2017)

These models are to be updated to incorporate the latest LiDAR data to be provided to the consultant by GLN Planning. No provision for recalibration, validation or update to ARR 2019 is required for this assessment on the basis that it is required for a relative impact assessment. Consequently, these models are to be updated for the purpose for a relative impact assessment and not for revising planning levels and planning areas.

Design event modelling is to be undertaken using the updated model for the 1% AEP, 1% AEP with Climate Change and PMF events. The approach to the consideration of climate change is to be consistent with previous modelling.

Tenderers are asked to provide a separate cost for additional model runs, if for example preliminary results indicates that it would assist the study to investigate more frequent events (eg 1 in 10 year event or around the levee level) and less frequent events (eg a 1 in 500 year event). This should be clearly shown as an optional additional costs in the tender response.

Analysis of Cumulative Flood Impacts

To assess the cumulative impacts of development within the floodplain, several scenarios are to be simulated. Each of these scenarios are listed within Table 1 and reflect various stages and extent of development within the Lower Hunter region.

The outcomes of the hydraulic modelling analysis is to be undertaken and presented in a manner that will inform Councils' floodplain management and the development of planning controls, as outlined below.

***Table 1** – Impact Scenarios to be Analysed as a part of Stage*

Scenario	Development	Events
Cumulative Impacts of Committed Development	All approved developments and infills within the study area.	1%, 1% with Climate Change, PMF
Localised Impacts of Committed Development	Three example flood impact assessments on specific developments.	
Possible Future Development	All potential rezoning (to be advised by GLN), committed rezoning and approved DAs within the study area.	

Note, the events may be extended to include additional optional floods as specified above.

Cumulative Impacts of Committed Development

The Stage 2 consultant is to simulate the Committed Development scenario for the design flood events defined in Table 1.

The scope of this assessment is to determine the:

- Scale of cumulative filling by quantifying the potential for fill pads to impact flood conveyance in key locations.
- Spatial variability of the sensitivity of flood behaviour to filling.
- Sensitivity of flood behaviour on fill scenarios (volume).
- Sensitivity of flood behaviour on fill scenarios over time, taking into account climate change.
- Impact on flood behaviour of a fully developed floodplain (i.e. unmitigated filling of all permissible flood storage areas). Fully developed scenario assumptions will be provided by GLN and will represent all future development that are anticipated or are reasonably foreseeable within the study area.
- Extent, configuration and location of future filling that is possible without causing unacceptable cumulative impacts on flood risk locally and to upstream and downstream property/ communities. Unacceptable impacts will be defined by the project working group. GLN will chair a meeting for this discussion, which will include the stage 2 consultants as well as representatives from the Councils and DPE.

The modelling results will need to be sufficient to inform the preparation of DCP planning controls for each of the Councils. It is intended that the controls will establish a range of parameters for future development on land currently zoned to permit development within the floodplain, including:

- The maximum size and design level of fill pads in rural areas. It is envisaged that the DCP amendments will allow moderate importation of fill without requiring hydraulic modelling in support of the DA, under certain circumstances. This could be achieved by setting limits on the area, volume and configuration of fill which may be used without the requirement for hydraulic modelling in support of individual development applications in particular parts of the floodplain.
- The necessity for compensatory excavation. The guidance may need to consider that cut and fill are not always equitable. Cut typically comes from lower in the floodplain and fill in higher

sections. This changes flood behaviour as lower areas are flooded first and provide little benefit when water reaches higher levels where fill has been placed.

- The DCP will need to define acceptable impacts (depth, velocity, time of inundation, and flood hazard). Limits may need to vary spatially across the floodplain to represent the sensitivity of each area to filling. Such areas may have been identified within existing Floodplain Risk Management Plans.

Localised Impacts of Committed Development

The Stage 2 consultant is to simulate up to six examples for the Assessment of Localised Flood Impacts scenario for the design flood events defined in Table 1.

The scope of this assessment is to determine the:

- Potential for fill works to impact flood conveyance and result in localised impacts drawing from the results of modelling of the (up to) six examples required to be assessed.
- Spatial variability of the sensitivity of flood behaviour to filling.
- Sensitivity of flood behaviour on fill scenarios (configuration).
- Sensitivity of flood behaviour on fill scenarios over time, taking into account climate change.

The modelling results will need to be sufficient to inform the preparation of DCP planning controls for each of the Councils. It is intended that the controls will establish a range of parameters for future development on land currently zoned to permit development within the floodplain, including:

- The maximum size and design level of fill pads in rural areas.
- Separation distances from buildings and fill pads on adjacent land.
- The extent and design level of associated works and recommended performance criteria for any engineering mitigation measures (e.g. culvert capacity for access roads).
- Necessity for variations to the controls depending on location within the floodplain.

Possible Future Development

The Stage 2 consultant is to simulate the Possible Future Development scenario for the design flood events defined in Table 1.

The scope of this assessment is to determine the:

- The potential for filling associated with possible future development, in addition to committed zoned development potential to have unacceptable cumulative impacts.
- Spatial variability of the sensitivity of flood behaviour to such filling.
- Sensitivity of flood behaviour on fill scenarios over time, taking into account climate change

The modelling results will inform the future review of local and regional planning strategies prepared by the Councils and DPE. It is intended that the outcome will provide recommendations to guide relevant strategic planning having regard to:

- The potential for unacceptable cumulative impacts associated with the development of planned urban release areas or the redevelopment of established areas.
- If required, criteria for reviewing the extent and/or nature of these areas to avoid unacceptable impacts such as reduction in the planned urban footprint and/or compensatory measures.

Guidelines for Assessing the Incremental Impacts of Filling

The Stage 2 works will also need to contribute to the preparation of assessment guidelines for the cumulative impact of imported fill onto the floodplain, to be undertaken in Stage 3. The assessment guidelines are intended to provide proponents with a prescriptive, cost effective methodology to investigate cumulative impacts of an individual flood mound at the DA stage. The intent is for the Guidelines to be used by development proponents to undertake site specific assessments where deemed to comply limits are exceeded. It is anticipated that this methodology will establish how to:

- define the study area
- define the flood behaviour for the base case
- assess the incremental impacts of the proposed filling
- assess the cumulative impacts of unmitigated development
- assess the cumulative impacts of mitigated development

For clarity, the Stage 2 consultant is not required to undertake the cumulative impact assessment for a defined site. Rather the consultant will support the development of a guideline to undertake cumulative impact assessments moving forward. The below sections summarise the individual sections of this guideline.

The guidelines will be prepared to build off the work undertaken in Stage 2 adopting the same models to ensure consistency across the assessments.

Define the study area

The consultant is to develop a methodology to define the study area for the cumulative impact assessment. The study area will be based on the area of influence of the project. It is anticipated that the area of influence will depend on:

- the location, volume and configuration of filling
- the expected future growth in that location
- the sensitivity of the floodplain to filling
- the proximity to local drainage lines/ overland flow paths
- the hydraulic categorisation e.g. storage, floodway, fringe
- sensitivity of receiving environments.

Define the flood behaviour for the base case

The consultant is to develop a methodology to define the flood behaviour of the floodplain based on the base case modelling within the Stage 2 works. It is anticipated that this would involve modelling the flooding behaviour (levels, velocities, storage and flowpaths) for the range of design events, using the same model(s) adopted for the Stage 2 assessment. Simulated events will be the same as those undertaken for the Stage 2 works to ensure consistency in modelling approach across assessments.

Assess the incremental impacts of the proposed filling

The consultant is to develop a methodology to assess the incremental impacts of the proposed filling (the incremental case). It is anticipated that this would involve:

- Develop a DEM based on the adopted base case within the Stage 2 modelling with the addition of proposed fill.
- Assess the incremental impacts from the proposed filling to flooding behaviour (levels, velocities, and time of cut-off of major transport corridors) for the range of design events.

Assess the cumulative impacts of the proposed filling without mitigation

- Develop a DEM for the based on the adopted cumulative impacts scenario within the Stage 2 modelling with the addition of proposed infill.
- Assess the impacts of unmitigated filling to flooding behaviour (levels, velocities, and time of cut-off of major transport corridors) for the range of design events.
- Compare the unmitigated cumulative scenario against the base case.
- Determine if the unmitigated cumulative impacts exceed acceptable limits. If so, then the proponent is to proceed to the mitigated cumulative case. Acceptable limits are to be defined by the participating councils and provided to the consultant.

Assess the cumulative impacts of the proposed filling with mitigation

- Modify the DEM from the "proposed filling without mitigation" scenario to mitigate the impacts associated with potential future filling as outlined above. Mitigation options for testing may include:
    - Reducing the allowable fill per lot
    - Changing the configuration of fill
    - Not filling to the lot boundaries
    - Reducing the slopes of the fill pads
    - No filling of flow paths.
- Assess if the mitigated cumulative impacts exceed acceptable limits. If so, then the proponent must further mitigate cumulative impacts or justify the impacts.

The Stage 2 consultant shall provide recommendations in regard to the establishment of the above methodology, in sufficient detail to allow for the guidelines to be prepared in Stage 3 of the study.

Peer review

The consultant is to undertake a comprehensive internal peer review of the study including hydrologic and hydraulic modelling, reporting and outcomes. The peer review is to be documented and considered in finalising the outcomes of the report..

Reporting

The draft and final report is to cover the issues identified in the scope of work in sufficient detail to be fit for the intended purpose. As a minimum it is to contain the following information:

Executive Summary

- Outlining the purpose of the study as well as its methodology, results and conclusions

Introduction

- Outlining the purpose of the study, the intended end users and the client

Background

- Study Area – description of the study area and its catchment(s) that have been analysed.
- Previous Studies – a summary of the Stage 1 scoping study and other studies used.
- Outline parameters established by the brief to be adopted for flood modelling purposes.

- Flood Behaviour – Written description of design and historical flood behaviour for a range of events for locations across the study area

Available Data

Provided and collected – description of all data collected (data and survey) and used for the study and their limitations and final ownership. This includes:

- Historic Data – including summary of historic events and available data
- Guidelines used
- Data collection
- Topographic and Aerial Survey and imagery
- Other information provided by GLN (including vacant lot information, other areas of potential development under existing controls, possible future development areas, planned significant public infrastructure projects and examples of past filling works)

Hydrological analysis

Summary of the basis of hydrology, noting it is not within the scope of this project to redefine the hydrologic basis.

Hydraulic Analysis

Summary of the adopted hydraulic modelling and any key revisions included within the assessment. The development of the DEMs for each scenarios should be documented within this section including listing the available datasets with respective resolution and accuracy.

Model Validation

Description of model validation against previously undertaken modelling.

Base Case

Reporting on the revised base case including any notable changes from previous model results.

Cumulative Impact of Committed Development

Reporting on the cumulative impacts of committed development scenario.

Localised Impacts of Committed Development

Reporting on the localised impacts of committed development scenario.

Possible Future Development

Reporting on the possible future development scenario.

Guidelines for Assessing the Incremental Impacts of Filling

Detail inputs into the development of Guidelines for Assessing the Incremental Impacts of Filling.

Peer Review

Conclusions

Figures

Acknowledgements

References

Appendices

Data Handover

(a) The report is to summarise the intellectual property of all study material (including outputs, models and input data), in consideration of the requirements of the brief.

(b) The final Report shall be provided as a single MS Word/ PDF as a fully compiled document.

(c) The consultant will submit a copy of all processed modelling results in a format ready for use by the Councils.

(d) All other materials used in the engagement will be delivered at the end of the engagement in the format specified in the latest national generic brief for flood investigations to develop project-specific specifications (NSW DPIE-EES).

(e) An outline of the file structure and directory and file naming convention will be provided along with the data files, including the types of data and file formats, explanations of any acronyms used, the folder organisation and the document version format.

Printing of the final report(s) shall not proceed without the written direction of the Council. The cost of all work associated with preparing the approved final report shall be included in the consultant's fee estimate.

Budget and timeline

The consultant is to prepare and submit a project timeline and costs for each major component of the study. The due date for the tender is 20.01.2023.

It is envisaged that the successful tenderer will be appointed early February 2023 and an inception meeting will be held in the third week in February. Based on this commencement timing it is anticipated that a draft report would be provided by the end of March 2023. A meeting to discuss acceptable impact will occur between these times.

Meetings

The consultant shall attend three meetings. The meetings will be attended by representatives from each of the three councils as well as GLN and DPE representatives. The meetings will be scheduled for the project inception, to discuss criteria for determining acceptable impact levels during the analysis phase, and when draft report and results are delivered.

Stage 2 – Fee Proposal

In addition to the information requested in this Project Consultancy Brief, consultants are requested to provide:

(i) A clear and concise methodology addressing the objectives and scope of work. Consultants are encouraged to outline innovative approaches to addressing the objectives of the project.

(ii) Demonstrated technical skill, knowledge, experience and qualifications of key project personnel relevant to the engagement along with:

a. resumes and reporting managers, and

b. experience in projects of a similar nature to this one

(iii) An itemised fee quote for all scope of work tasks inclusive of all disbursements.

(iv) An indicative project programme, including required milestones, meetings and proposed payment schedule.

(v) A table of hourly rates for all senior personnel.

(vi) A lump sum rate for the three proposed face-to-face project meetings

(vii) A lump sum amount of "savings" for converting a proposed face-to-face meeting to an online/zoom meeting

(viii) Confirmation that the consultant has the required insurances. Note the quantum of professional indemnity insurance required is $10 million (AS4122 clause 30.4).

Note the need to complete the returnable Tender Schedule A, Schedule D, Schedule L, Schedule M and Schedule Q.

Client's representative (AS4122 clause 6)

For day to day matters:

Paul Grech
Director
GLN Planning
t: 02 9249 4100
m: 0411 876 521
e: paul@glnplanning.com.au

For overall direction and payment matters:

Michael Osborne
Senior Drainage & Flooding Engineer
Port Stephens Council
t: 02 4988 0274
m: 0439 442 984
e: michael.osborne@portstephens.nsw.gov.au

5. STAGE 2 – CONSULTANCY AGREEMENT

AS4122-2010 *General Conditions of Contract for Consultants* will apply with:

- This brief
- The additional Copyright and Intellectual Property Clause (see below)
- The Special Conditions of Contract SC1, SC2, SC3, SC4, SC5 and SC7
- Port Stephens Council - Purchase Order Terms and Conditions

6. ADDITIONAL COPYRIGHT AND INTELLECTUAL PROPERTY CLAUSE (SEE CLAUSE 7)

The Consultancy Agreement will contain the following additional clauses:

Intellectual property

1.1 *In this clause, Intellectual Property includes all statutory, legal, equitable and other proprietary rights and interests, including without limit, in copyright, patents, registered and unregistered trademarks, registered designs, circuit layouts, trade secrets, semiconductor or circuit layout rights, trade, business or company names, or other proprietary rights, or any rights to registration of such rights existing in Australia, whether created before or after this agreement.*

1.2 *The consultant indemnifies Council, the NSW Department of Planning and Environment (DPIE-EES) and their employees and agents against any action, costs, expenses, losses or damages suffered or incurred by all, or any more of them, arising out of, or in any way in connection with:*

(a) any breach by the consultant or its employees or its agents of the consultant's obligations under clause 1.2, and

(b) any infringement by council or DPIE-EES of third party Intellectual Property rights in its use of the Project Materials.

1.3 *The consultant warrants that:*

- *in carrying out the Project, it will not infringe any Intellectual Property rights, and*
- *any report by the Recipient will not contain anything that, to its knowledge, is libellous or defamatory.*

1.4 *Subject to clause 1.5:*

- *The consultant grants to the council and the State, at no cost, a perpetual, irrevocable, worldwide, royalty-free non-exclusive licence, including the right to sub-license, to use, reproduce, modify, adapt, publish and communicate to the public, the Project Materials (to avoid doubt, including for the purpose of making the Project Materials freely available to the public or any section of it, whether in hard copy or on-line and including use and modification of any models and copying photographs), and*
- *To ensure compliance by the consultant with clause 1.4(a), if the consultant engages a third party to create the Project Materials the consultant must ensure that the terms of its engagement provide that the third party:*
  - *assigns Intellectual Property in such materials to the council immediately on creation of the materials; and*
  - *warrants that it has the legal authority to comply with the obligation referred to in this clause.*

1.5 *To the extent that the consultant cannot take ownership of Intellectual Property in any Incorporated Existing Materials:*

(a) the consultant must ensure that relevant third parties grant to the council and State, at no cost, a perpetual, irrevocable, worldwide, royalty-free, non-exclusive licence, including the right to sub-licence, to use, reproduce, modify, adapt, publish and communicate to the public, the Incorporated Existing Materials for any Non-Commercial Purpose (to avoid doubt, including for the purpose of making the Incorporated Existing Materials freely available to the public or to any section of it, whether in hard copy or on-line and including use and modification of any models and copying of photographs); and

(b) if any of the Incorporated Existing Materials are included in the materials referred to in clause 1.7, the Recipient must ensure that relevant third parties make those Incorporated Existing Materials available to the public under a Creative Commons Attribution 4.0 licence.

1.6 *This clause 1 survives termination or expiry of this agreement.*

1.7 *To make the required information available under a Creative Commons Attribution 4.0 licence the Consultant must insert a copyright notice into the deliverables indicated below in accordance with the form and instructions in Schedule A. The Consultant must particularise New Contract Material and Existing Contract Material, as specified in the instructions in Schedule A. The deliverables this refers to are as follows:*

(i) project report(s) and associated figures (excluding any sections highlighted as confidential by the council);

(ii) *spatial flood extent layers for key events; and*
(iii) *any other data and tools noted as IP Case 1 in Column 4 of Table 14 or otherwise advised by council to the consultant*

SCHEDULE A

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APPENDIX 1 – STAGE 1 SCOPING STUDY

UNSW SYDNEY | Australia's Global University

School of Civil and Environmental Engineering
Water Research Laboratory

Scoping Study for the Lower Hunter River Cumulative Development Impact Study and Plan

WRL TR 2020/27 | June 2021

By G P Smith, L Montano and P F Rahman

UNSW SYDNEY
Water Research Laboratory
School of Civil and Environmental Engineering

Scoping Study for the Lower Hunter River Cumulative Development Impact Study and Plan

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Project details

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Client	Port Stephens Council
Client address	PO Box 42 Raymond Terrace NSW 2324
Client contact	Michael Osborne Email: michael.osborne@portstephens.nsw.gov.au
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UNSW SYDNEY | Water Research Laboratory
School of Civil and Environmental Engineering

www.wrl.unsw.edu.au

110 King St, Manly Vale, NSW, 2093, Australia

Tel +61 (2) 8071 9800 | ABN 57 195 873 179

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1 Introduction

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney was commissioned by Port Stephens Council on behalf of a consortium of government stakeholders to undertake Stage 1 of the Lower Hunter Floodplain Cumulative Development Impact Study and Plan.

Key government stakeholders steering the study include:

- Port Stephens Council
- Maitland City Council
- Newcastle City Council
- NSW Department of Planning Industry and Environment (DPIE) Hunter Valley Flood Mitigation Scheme (HVFMS) Manager
- NSW DPIE Environment Energy and Science (EES) Flood group
- Hunter Joint Organisation

The three planned stages of the Lower Hunter Floodplain Cumulative Development Impact Study and Plan are as follows:

Stage 1 (this report) is the preparation of a scoping study. The aim of the scoping study is to collate the available information, identify and determine the needs of the stakeholders, and recommend a methodology for the subsequent stages of the project.

Stage 2 will use flood models to assess the sensitivity of the floodplain to filling. The assessment will analyse the cumulative impact of future development (including significant infrastructure upgrades such as road and rail) on flood characteristics. The impact assessments will examine a range of floods and climate change considerations and determine acceptable levels of fill in specific areas.

Stage 3 will provide recommendations for catchment-wide consistent strategies, policies and development controls to manage the cumulative filling of the Lower Hunter floodplain. The Lower Hunter Floodplain Cumulative Development Impact Study and Plan will:

- Assist Councils in managing future development and reduce the impacts of flooding and flood liability on communities and to reduce private and public losses resulting from floods, and

- Assist the Councils, and the State Government and Planning Assessment Commission in making informed decisions on managing flood risk for future development, and reduce flood damages arising from development decisions.

This report addresses the findings of **Stage 1**. The following tasks were completed as part of this Stage 1 scoping study:

1. Review existing data and flood models and recommend what additional data and changes to the existing models are required to meet the needs of this Study.

2. Recommend a methodology for Stages 2 and 3 in accordance with the NSW Floodplain Development Manual and industry best practice.

3. Identify stakeholders who should be consulted and the process for consultation during the preparation of the Study and Plan.

4. Assess the current extent of floodplain filling, including, but not limited to:
   - areas where floodplain filling is occurring or where there is development pressure to occur;
   - the nature of the filling, which may include filling that has the potential to redirect flow paths (e.g. concentration of homes on raised pads along a river that acts like a levee); and
   - areas likely to be adversely impacted by filling.

5. Identify and outline the key issues that will need to be addressed in subsequent study stages.

1.1 Background

There is significant development pressure in the Hunter Valley with the Hunter Regional Plan forecasting a population increase of 130,000 people over the next 20 years, many of whom are anticipated to want to live on the Hunter River floodplain. Development on the floodplain often includes the importation of fill to form a mound (or pad) raised above the flood planning level. Such development of the floodplain has the potential to result in a cumulative loss of significant flood volume and conveyance, and if not carefully managed, considerably increase the risk to life and property.

On a floodplain site inspection by WRL in November 2019, our staff noted numerous new peri-rural developments along the Hunter, Paterson and Williams River banks with homes and sheds

constructed on large fill pads. These fill pads, which were in some instances butted up against the HVFMS levee banks, were often raised to a flood planning level higher than the levee's crest. The HVFMS manager has been contacted on numerous occasions by local residents concerned about the impact new developments of this type might have on flooding.

Currently, development applications are assessed by individual Councils on a lot-by-lot basis. The planning approval process, from the point of view of flood assessment, is somewhat complicated by the Hunter River channel forming the boundary between Port Stephens, Maitland and Newcastle Local Government Areas (LGAs). This development approval process has allowed numerous developments to import considerable volumes of fill onto the floodplain. The Councils have collectively recognised that the cumulative fill volume from all permissible development (under the current planning controls) could potentially have an adverse impact on flood levels (through reduction of floodplain volume and conveyance) and potentially result in a redistribution of floodwaters across the floodplain.

1.2 Study Area

The study area comprises the floodplain of the Hunter River and its tributary rivers and creeks in the Port Stephens, Maitland and Newcastle LGAs. The floodplain was defined in the study by the Probable Maximum Flood (PMF) extent polygon. The PMF extent was derived by merging readily available design flood model results as part of the data analysis for the *Hydraulic and cost benefit assessment of the impact of climate change on the Hunter Valley Flood Mitigation Scheme* (Smith et al., 2020). The extent of the PMF floodplain compared to the LGAs and the extent of available digital elevation models (DEMs) is shown in Figure 1-1.

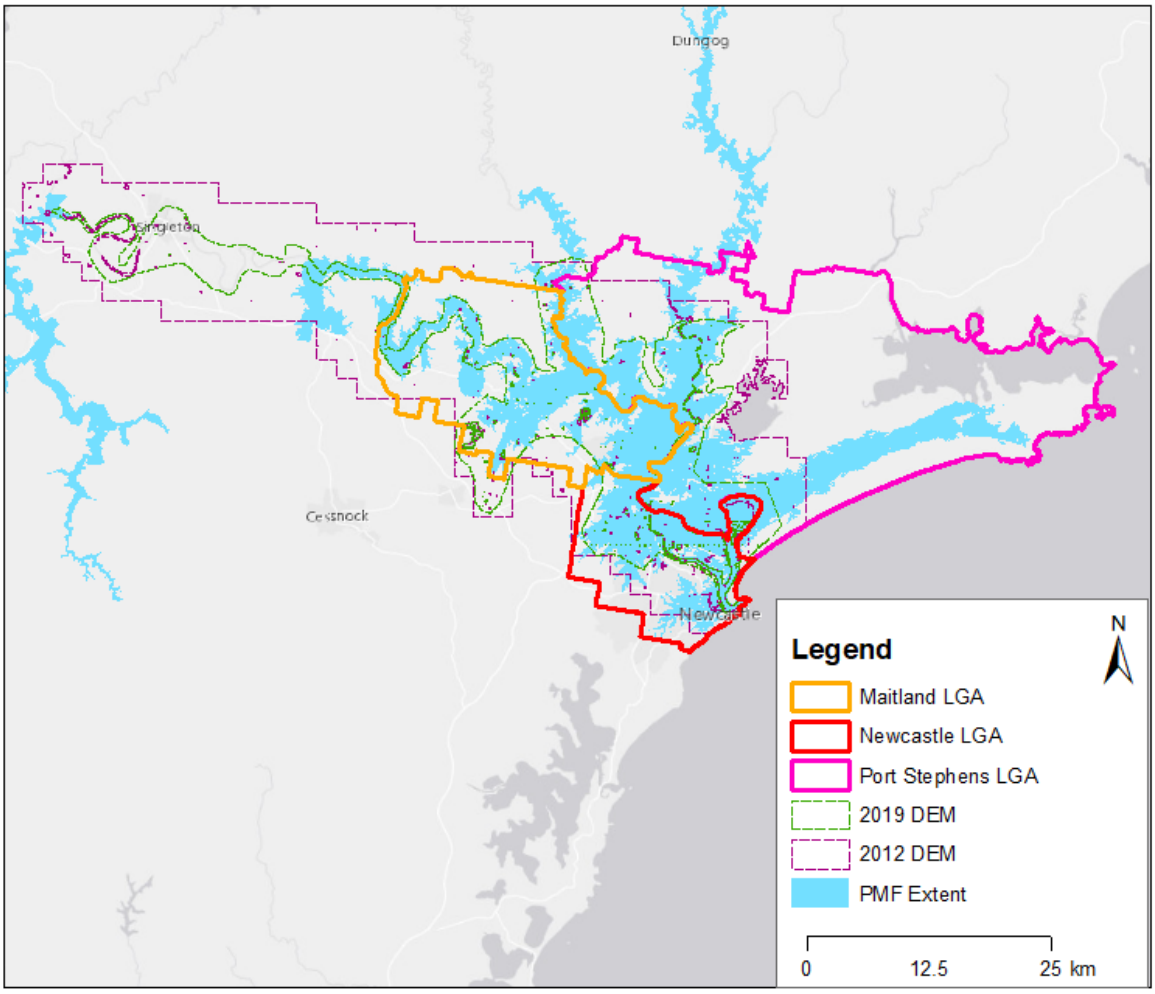


Figure 1-1 Study area for the Lower Hunter River Cumulative Development Study

2 Floodplain Data Analysis

2.1 Preamble

The first task completed for the study was a review and analysis of key floodplain data sets. Topographic and flood behaviour datasets were collated and compared to quantify the volume of fill that has been imported onto the floodplain.

The ARCGIS Geographical Information System (GIS) software package was used to process and analyse floodplain terrain and design flood water level data sets.

Analysis of DEM data sets provided a spatial description of the location, level and estimated volume of fill on the floodplain. The mapped fill areas were then compared to available design flood water level mapping to enable a desktop assessment of the possible influence of the imported fill on flood behaviour.

2.2 Available Data

2.2.1 LiDAR

Readily available DEMs of the floodplain were provided by Hunter Local Land Services (HLLS). Both DEMs were developed by Griffith University on a project delivered for HLLS *Digital Elevation Model of Difference for HVFM Assets and lower reaches of Hunter, Paterson and Williams Rivers* (Pietsch, 2020). The DEMs used for this study were based on available LiDAR data as specified in Table 2-1.

Table 2-1 LiDAR available information

Source	File type	Collection Dates	Resolution	Data collection
LiDAR	DEM	2012-2014	1 m	Publicly available information from ELVIS
LiDAR	DEM	2019	0.5 m	AAMGroup

Attempts were made to source additional DEM datasets from prior to 2012. While DEM data was used to support modelling studies prior to 2012, data of suitable spatial coverage and resolution was not available.

2.2.2 Design Flood Water Levels

Design flood water level data sets were made available to the study by DPIE EES from the study *Hydraulic and cost benefit assessment of the impact of climate change on the Hunter Valley Flood Mitigation Scheme (HVFMS)* (Smith et al., 2020). GIS based, gridded flood level surfaces were sourced for the following design flood events:

- 1% Annual Exceedance Probability (AEP) flood risk map: represents the flood level and extent map used by Councils to define the flood planning level (FPL) for development control;
- 0.5% AEP flood risk map: a proxy adopted in the HVFMS assessment a representative of the future 1% AEP flood risk accounting for climate change impacts;
- PMF flood risk map: Defines the full extent of the floodplain and is used by emergency managers to determine the full population at risk of flooding.

The design flood maps sourced for this study were derived from a suite of flood models produced for various sections of the floodplain. These flood model datasets were prioritised and as part of the HVFMS study. The derivation of the merged flood level maps is described in Smith and Simpson (2019). The merged flood maps used model results from the Council lead flood studies listed in Table 2-2.

Table 2-2 Flood studies combined to create merged flood models (Smith and Simpson, 2019)

Flood Study	Year	Flood Study Owner	Hydrological catchment model	Hydraulic flood model
Williams River Flood Study	2009	Port Stephens Council and Dungog Shire Council	XP-RAFTS	TUFLOW
Hunter River Flood Study – Branxton to Green Rocks	2010	Maitland City Council	FFA/WBNM	TUFLOW
Singleton Floodplain Risk Management Study	2011	Singleton Council		TUFLOW
Upgrading of Lower Hunter Flood Model at Hexham	2008	Newcastle City Council	FFA	Mike Flood
Aberdeen Flood Study	2013	Upper Hunter Shire Council	WBNM	TUFLOW
Wollombi Brook Flood Study	2016	Singleton Council	XP-RAFTS	TUFLOW
Paterson River Flood Study - Vacy to Hinton	2017	Maitland City Council, Port Stephens City Council, Dungog Council	WBNM	TUFLOW
Williamtown-Salt Ash Floodplain Risk Management Study and Plan	2017	Port Stephens Council	XP-RAFTS	TUFLOW

- Flood Frequency Analysis (FFA)

An example of the merged model results for the 1% AEP flood is presented in Figure 2-1. Areas where maps were interpolated between flood models to develop a continuous and consistent flood surface are identified in Figure 2-2.

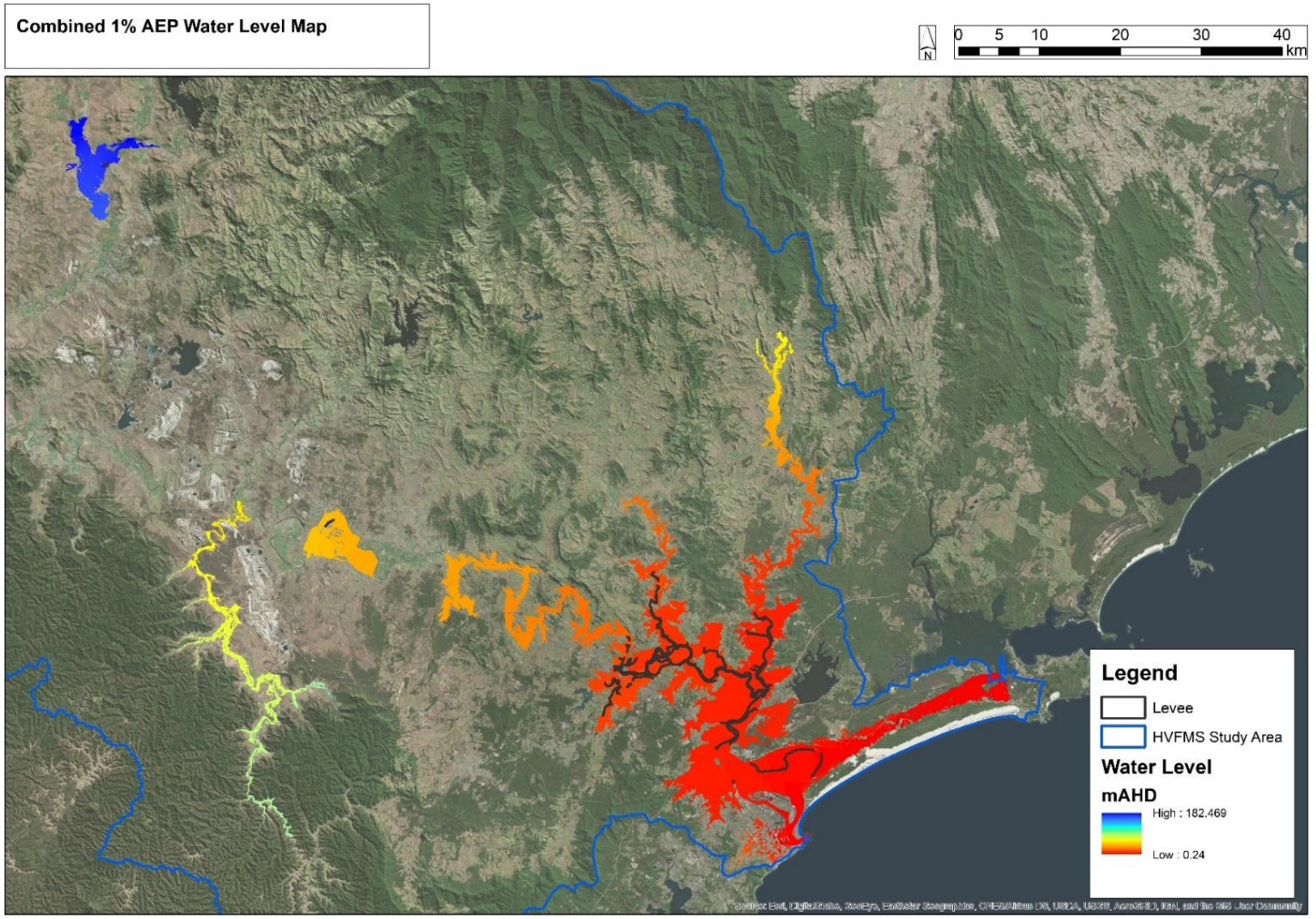
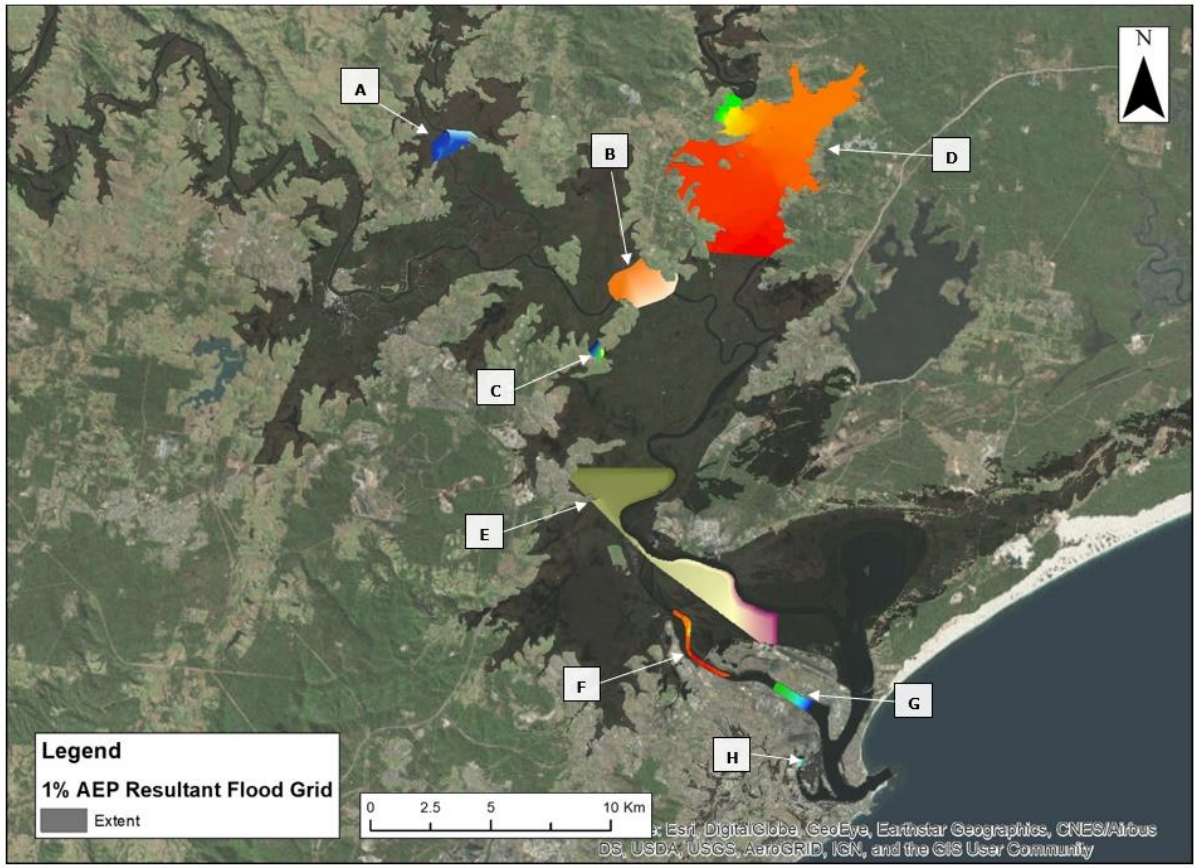


Figure 2-1 Present day 1% AEP water level map (Smith and Simpson, 2019)



Grid	Combined flood model
A	Paterson River Model and Hunter River Model
B	Hunter River Model and Williamtown model
C	Hunter River Model and Williamtown model
D	Williams River model and Williamtown model
E	Hexham model and Williamtown model
F	1D Hexham model and 2D Hexham model
G	Hexham model and Williamtown model
H	Throsby model and Williamtown model

Figure 2-2 Summary of interpolations undertaken to create the 1%AEP grid (Smith and Simpson, 2019)

2.3 Floodplain Fill Data Analysis

2.3.1 Imported fill 2012 - 2019

An estimate of the volume of fill imported onto the floodplain between 2012 and 2019 was determined by subtracting the 2012 DEM from the 2019 DEM on a 1 m grid resolution. The resulting difference grid highlighted changes in the LiDAR sourced ground surfaces. The difference grid was overlaid over aerial photography of the floodplain and an assessment of difference grid highlighted numerous locations where the analysis identified filling of the floodplain.

While LiDAR is generally a reliable method for measuring high accuracy ground surface data over large spatial extents, it is well understood that the method does not penetrate water, meaning that the data is void over water bodies (rivers, lakes, ponds etc.) and that accuracy is also compromised in areas that are heavily vegetated since the airborne laser is less likely to penetrate through dense vegetation to measure the underlying ground surface. Identified areas of difference between the DEMs that were clearly due to changes in vegetation between the 2012 and 2019 datasets were manually removed from the difference map. Beyond those two issues, the vertical accuracy of the LiDAR data is in the order of ± 0.1 m to ± 0.2 m. Since it was anticipated that significant fill on the floodplain was likely to be greater than a 0.2 m change in land elevation, the difference map was automatically 'cleaned' to filter out that any differences of 0.2 m or smaller. Each fill area was then identified by an individual perimeter polygon and manually checked against 2020 aerial imagery sourced from Nearmaps ©. By observing the aerial photography, fill areas were identified as being one of:

- Residential;
- Industrial;
- Road/driveway; or
- Miscellaneous.

Residential fill was further classified using 2020 Nearmaps © aerial photography identifying whether or not there was a building constructed on the fill. Examples of various types of fill are provided in Figure 2-3 to Figure 2-6.

Maitland City LGA

Thornton (Circa 2012)

Thornton (Circa 2019)

Port Stephens LGA

Hinton (Circa 2012)

Hinton (Circa 2019)

Figure 2-3 Examples of residential fill (Image source: Nearmap ©)

Maitland City LGA

Millers Forest (Circa 2012)

Millers Forest (Circa 2019)

Port Stephens LGA

Eagleton (Circa 2012)

Eagleton (Circa 2019)

Figure 2-4 Examples of driveway upgrades (Image source: Nearmap ©)

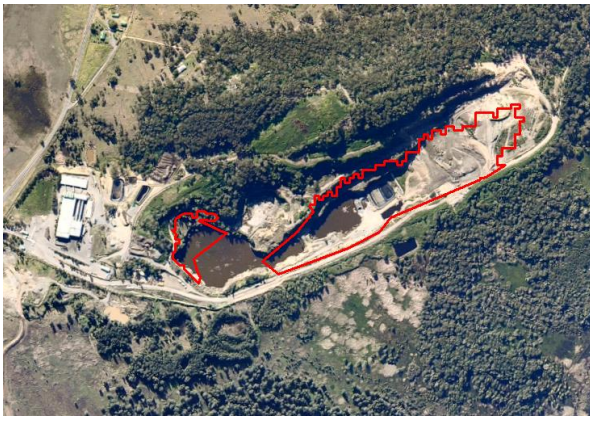
Maitland City LGA

Pitnacree (Circa 2012)

Pitnacree (Circa 2019)

Port Stephens LGA

Irrawang (Newline Rd landfill) (Circa 2012)



Irrawang (Newline Rd landfill) (Circa 2019)

Figure 2-5 Examples of industrial fill (Image source: Nearmap ©)

Maitland City LGA

Woodberry Road (circa 2012)

Woodberry Road (circa 2019)

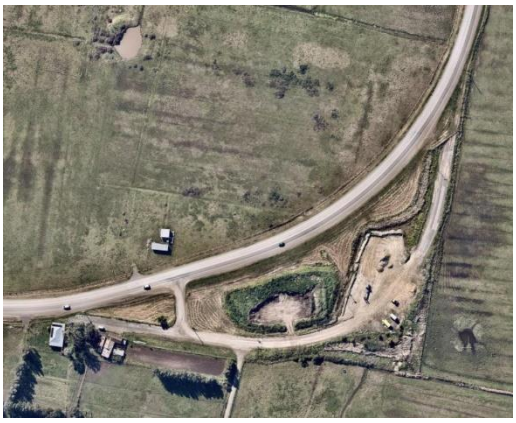


Figure 2-6 Example of miscellaneous fill (Image source: Nearmap ©)

Table 2-3 Imported fill volume (m^3) (difference 2012 – 2019)

	Local government area (LGA)			Total
Fill Area	**Newcastle**	**Port Stephens**	**Maitland**	
Residential/rural	-	591,851	1,043,372	1,635,223
Industry	-	1,043,602	122,207	1,165,810
Other	61,508	52,863	185,208	299,579
Road	9,161	17,198	64,042	90,401
All	70,669	1,705,514	1,414,829	3,191,012

Table 2-4 Imported fill area (ha) (difference 2012 – 2019)

	Local government area (LGA)			Total
Fill Area	**Newcastle**	**Port Stephens**	**Maitland**	
Residential/rural	-	36.5	86.3	122.7
Industry	-	12.7	9.6	22.3
Other	15.1	4.8	14.9	34.9
Road	5.7	4.7	17.8	28.2
All	20.8	58.7	128.6	208.1

Table 2-3 shows that there was in the order of 3.2 million cubic metres of fill placed on the floodplain between 2012 and 2019. The fill was predominantly in the Port Stephens (1.7 million m^3) and Maitland (1.4 million m^3) LGAs. Analysis shows that the fill in Port Stephens LGA was dominated by an increase of 934,000 m^3 fill at the Newline Road landfill. Residential fill pads accounted for more than 50% of the total fill volume.

2.3.2 Pre-2012 imported fill

The study proposal indicated that an attempt would be made to source further DEMs measured prior to 2012 so that an assessment could be made as to whether the rate of fill importation to the floodplain had increased in recent years. Unfortunately, a pre-2012 DEM of similar extent, resolution and accuracy to the 2012 and 2019 DEMs could not be sourced.

In lieu of a third, earlier DEM, a method was devised to estimate the amount of fill present in the 2012 DEM. The method involved five steps:

i) Slope analysis was undertaken in ARCGIS to get an impression of the steepness of the terrain. DEM cells with a slope above and below 15 degrees (as shown in red in Figure 2-7) were identified;
ii) 2020 Nearmaps © aerial photography was used in conjunction with the reclassified slope layer to locate areas of fill;
iii) The Google street maps layer was used to classify fill using the same categories as the 2012 – 2019 assessment (e.g. residential, road etc.);
iv) Fill layers were identified with polygons;
v) The area of each polygon was multiplied by an assumed depth of fill of 2 m to estimate the volume of fill.

While this method of estimating fill is somewhat approximate because of the assumed (conservative) depth of fill of 2 m, it does provide a point of comparison with more recent fill volumes. A summary of estimated pre-2012 fill is provided in Table 2-5**.** The method has identified all fill placed on the floodplain prior to 2012. The fill could have been placed on the floodplain any time prior to 2012.

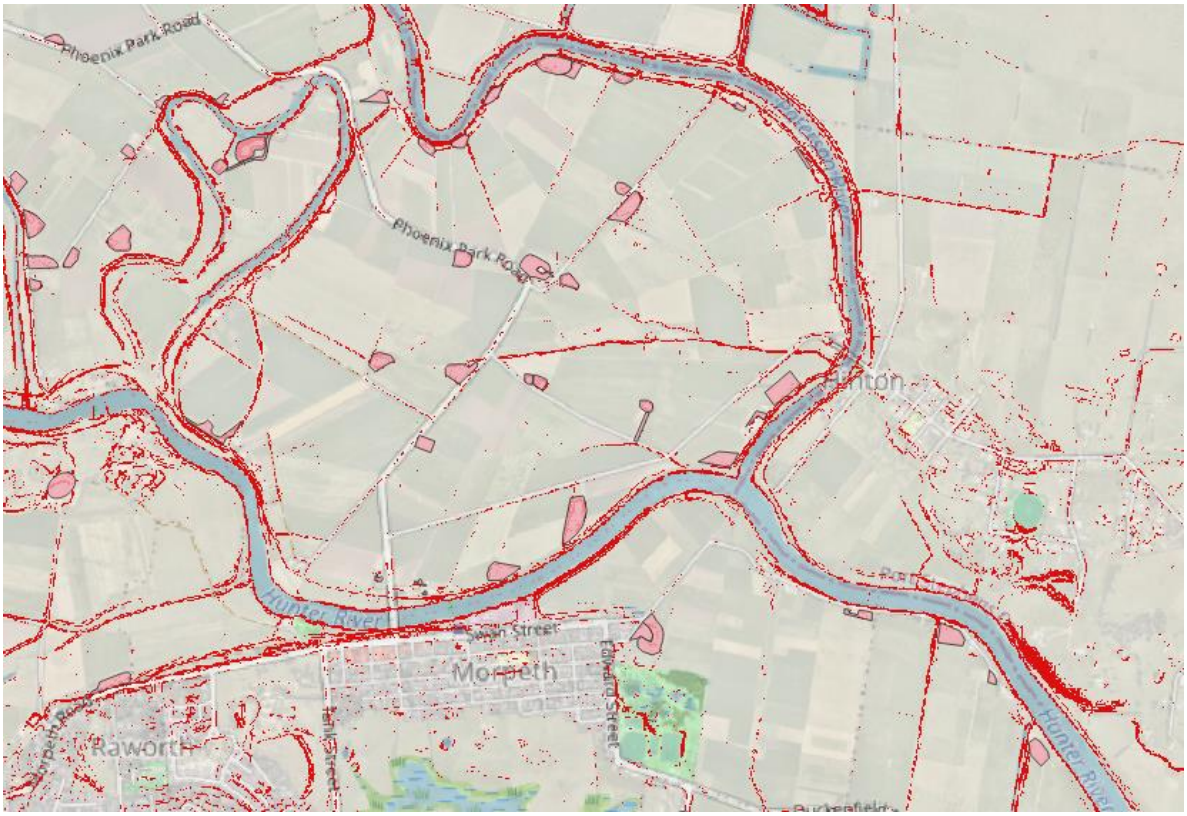


Figure 2-7 DEM cells (red) with a slope above and below 15 degrees a Phoenix Park

Table 2-5 Pre-2012 floodplain fill volume (m^3)

	Local government area (LGA)			Total
Fill Area	**Newcastle**	**Port Stephens**	**Maitland**	
Residential/rural	-	203,659	888,700	1,092,359
Industry	-	193,684	78,151	271,836
Other	233,389	43,756	117,825	394,969
Road	98,725	66,472	274,952	440,149
All	332,114	507,570	1,359,628	2,199,312

Table 2-5 shows that there was approximately 2.2 million cubic metres of fill placed on the floodplain prior to 2012. The fill was predominantly located within the Maitland LGA (1.4 million m^3), with more fill than in the Port Stephens (508,000 m^3) and Newcastle (332,000 m^3) LGA's combined.

A comparison of Table 2-3 and Table 2-5 notes that, excluding HVFMS levee banks, there has been more fill placed on the floodplain between 2012 and 2019 than estimated to have been imported in the extended period prior to 2012. The accelerated fill importation rate is believed to be linked to the ready availability of low cost fill forthcoming from tunnelling projects in Sydney. Since these major tunnelling projects (e.g. WestConnex) are ongoing and there are others planned

(e.g. second Harbour crossing, Northern Beaches link etc.) there is likely to be an ongoing supply of low cost fill. However, it is also the Councils' experience that some low cost fill has been imported onto the floodplain illegally and in some cases this contains asbestos containing material (ACM).

2.4 Impact of Fill on Flooding

The importation of fill onto the floodplain can potentially affect flood behaviour by two mechanisms:

i) Volume displacement: The volume of fill on the floodplain effectively reduces the flood volume capacity causing an equivalent increase in flood level; and

ii) Reduction of floodplain flow path conveyance capacity: The NSW Floodplain Development Manual defines floodways as *"those areas of the floodplain where a significant discharge of water occurs during floods. ... Floodways are the areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood level".* The placement of fill in floodways can inhibit flood flows causing floodwaters to back up behind the fill and change direction. While the redirection of flows may only affect the flood behaviour (levels, flow speed, flow direction) locally to the fill, depending on the relative proportion of the flow deflected and the location on the floodplain, the flow redirection may cause a broader impact on floodplain flow behaviour, sometimes affecting flood levels many kilometres away.

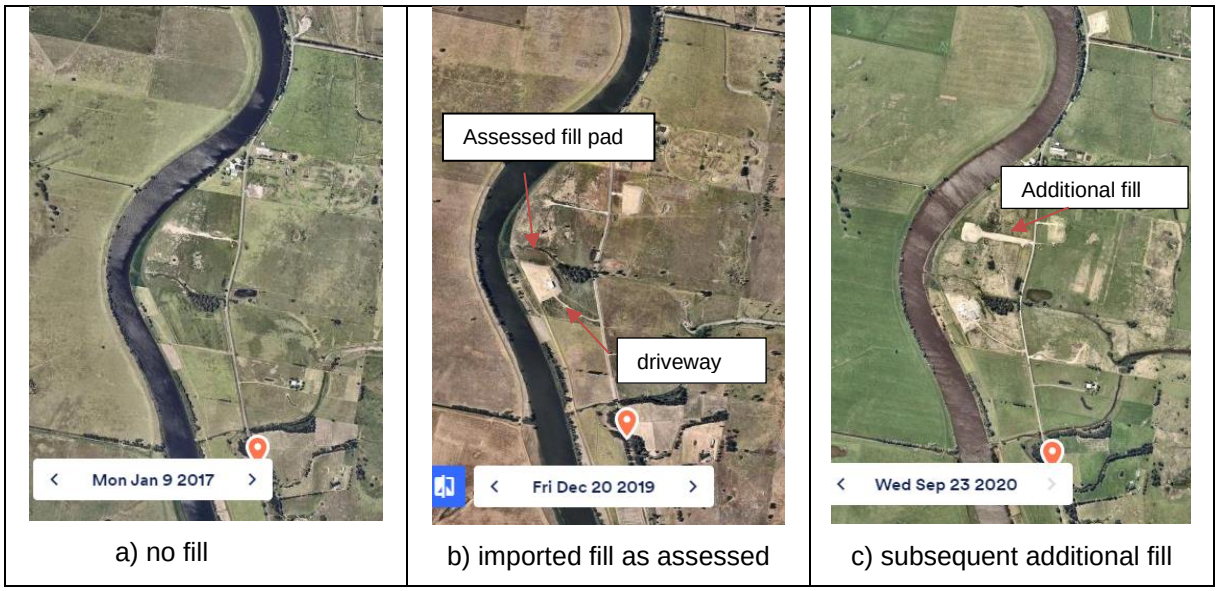
2.4.1 Volume displacement assessment

The flooded volume of the floodplain in the study area can be estimated using the available design flood inundation maps and the floodplain DEM. Using ARCGIS tools, the flooded volume of the floodplain at the peak 1% AEP flood level was estimated to be 1,154 million cubic metres. By comparison, the total amount of fill on the floodplain was estimated as 5.4 million cubic metres or 0.47% of the 1% AEP flooded volume. On this basis, the volume displacement of the fill might be anticipated to be very small overall at the flood planning level. However, this is somewhat dependent on the amount and distribution of fill in any one local area.

2.4.2 First-pass flood conveyance assessment

If fill is placed in overbank flood pathways, then depending on the shape and size of the fill compared to the width of the flowpath, relatively small amounts of fill can have a significant impact on the flow level, direction and distribution of flow across the floodplain. In a worst case scenario, the fill could deflect the flood flows proportionally into a different part of the floodplain, causing incremental increases in flood impacts compared to the existing flood exposure.

Figure 2-8 provides an example of a typical fill pad being constructed on the floodplain and the evolution of fill, both on individual properties and on adjacent properties, in one locality. Figure 2-8 a) shows no fill on the site in January 2017. Figure 2-8 b) shows that between January 2017 and December 2019 the fill pad placed on site as investigated in the local flood model assessment has appeared. Figure 2-8 c) shows a substantial amount of further fill placed on an adjacent property in the period between December 2019 and September 2020 indicating the accelerated rate that fill is currently being imported to some parts of the floodplain.



a) no fill

b) imported fill as assessed

c) subsequent additional fill

Figure 2-8 Evolution of fill, Newline Road Eagleton

Flood modelling of the site completed by BMT for DPIE (HVFMS Manager) for the 10% AEP flood risk level shows that the fill pad significantly deflects flood flows (Figure 2-9). Not only do flood flows change direction, they also accelerate significantly, particularly around the corners of the fill pad.

At face value, the fill pad assessed in the model analysis presented in Figure 2-9 has been included in the model by adjusting the model topography grid. Many contemporary flood studies of rural and peri-urban floodplains adopt a model grid resolution in the order of 10 m to 40 m. At this grid resolution, fill features such as the driveway to the fill pad are not able to be accurately represented by the model grid and need to be included in the model using sub-grid scale model adjustments.

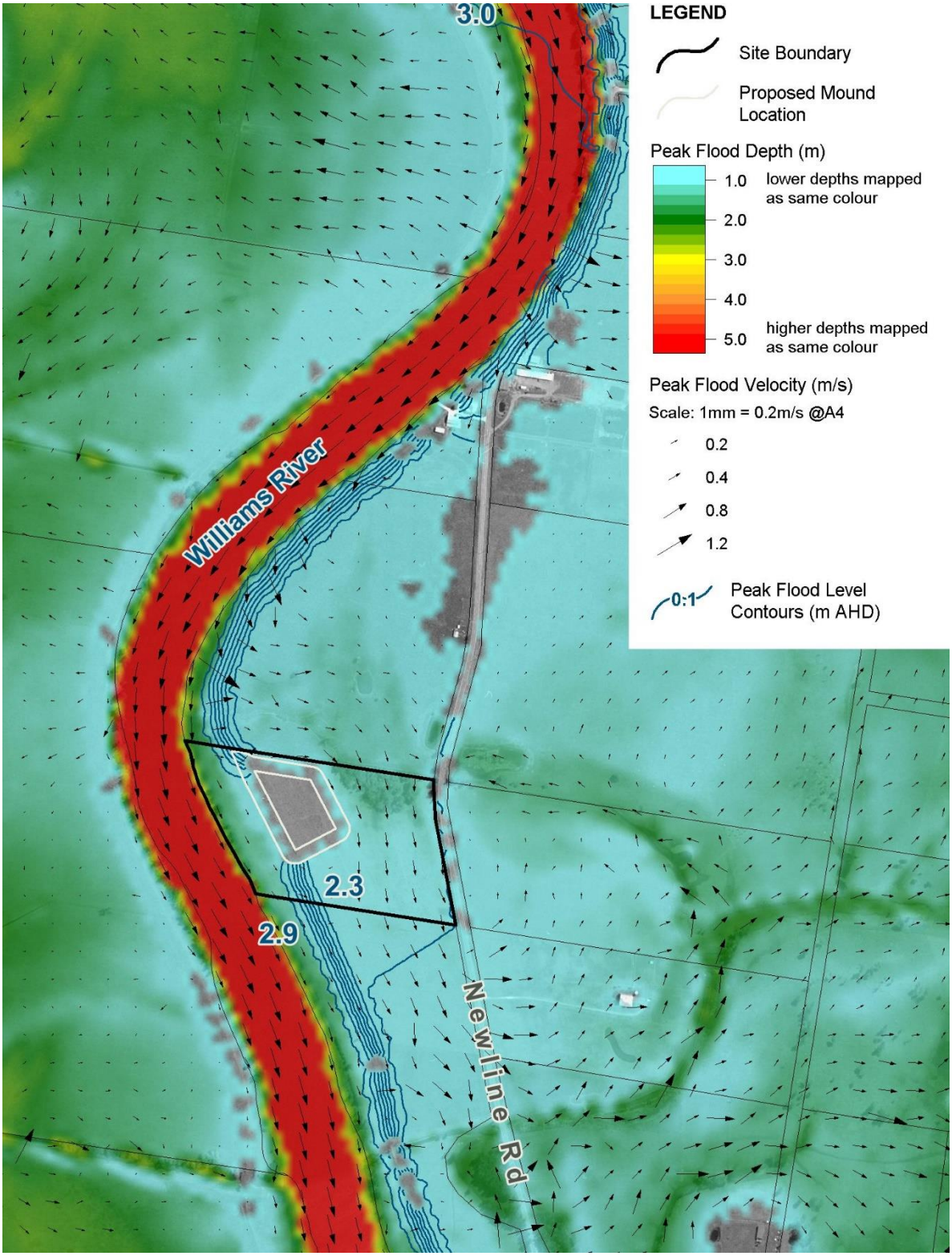


Figure 2-9 Flood impact at 10% AEP (after BMT, 2019)

In isolation, the local influence of a fill pad on flood flow behaviour may not extend far from the immediate vicinity of the fill. However, when there are clusters of fill pads, such as those identified in Figure 2-10 showing an area near the junction of the Hunter and Williams Rivers, there is a high likelihood that flood behaviour in the area will be more significantly influenced as the flows deflected by individual fill pads interact with each other. In some areas where fill pads on adjacent properties are particularly close to one another, the fill pads constitute what amounts to a de-facto 'second levee' with a significant influence on flow levels and flow distributions both locally and potentially on the broader floodplain. By way of example, flood modelling completed for the strategic assessment of the HVFMS (Smith et al., 2020) noted that tested changes to segments of the levee near Phoenix Park could influence flood levels as far downstream as Hexham Swamp.

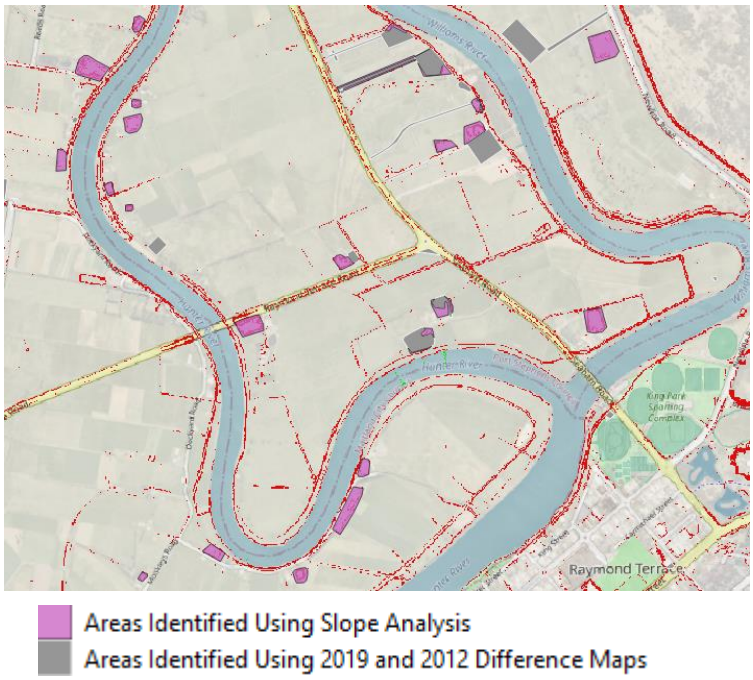


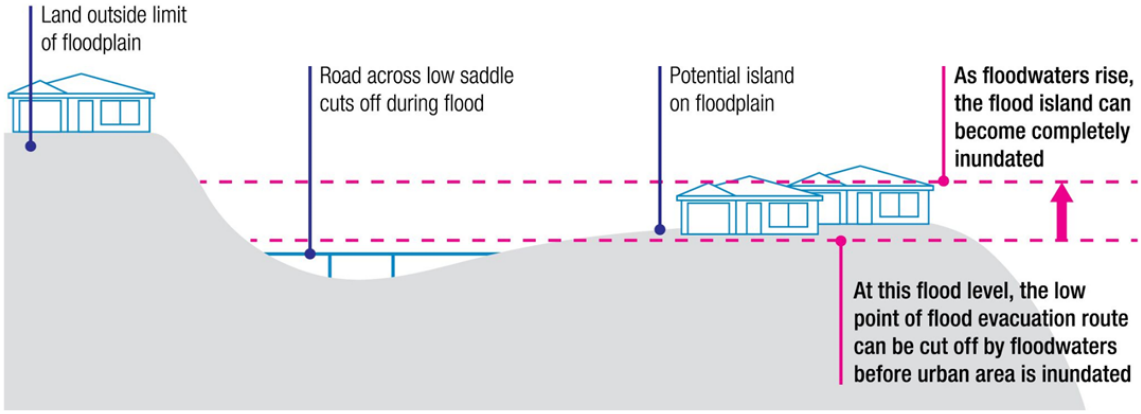
Figure 2-10 Fill pads identified near the Hunter / Williams River junction

2.5 Flood Safety Issues

While the fill pad identified in Figure 2-8 and Figure 2-9 does not presently have a building constructed on it, the presented flood analysis illustrates how a fill pad can be completely isolated in a flood. There are numerous safety issues associated with being isolated in a flood, particularly if the flood duration is in the order of days rather than hours. These safety issues are discussed in detail in reports such as the NSW Floodplain Risk Management Guideline Flood Emergency Response Planning, Classification of Communities (DECC, 2007) and Australian Disaster

Resilience Handbook 7, A Guide to Best Practice in Flood Risk Management in Australia (AIDR, 2017).

In flood emergency management parlance, fill pads on the open floodplain constitute “Low Flood Islands”. Figure 2-11 illustrates the concept of a low flood island. The flood analysis presented in Figure 2-9 shows that the fill pad will be completely surrounded by water in a 10% AEP flood. Anyone residing on such a fill pad would need to evacuate before the flood arrived as all trafficable routes to high ground from the fill pad are cut off by low level flooding.



Schematic of a cross-section of a floodplain showing how, as floodwaters rise, some areas (known as flood islands) can become isolated as lower-level access roads are flooded. As floodwaters continue to rise, these flood islands can become fully submerged. (Infrastructure NSW)

Figure 2-11 Schematic of a Low Flood Island (NSW SES, 2020)

Should flood levels continue to rise, anyone trapped on the fill pad would need to shelter in place until the flood recedes. Fill pad levels should typically be constructed to above the Flood Planning Level (FPL) which is most commonly defined as the 1% AEP flood plus a freeboard of 0.5 m. Should flood levels continue to rise above the FPL, people trapped on fill pads would need to move to the highest point on the fill pad. If there is a habitable building on the fill pad, then current development controls require the second storey of the building to be constructed above the Probable Maximum Flood (PMF) level and the building should also be capable of structurally withstanding the forces exerted on it during the PMF event.

A cross check of fill pad levels against 1% AEP flood levels was completed as part of this study. The analysis compared the highest ground level on the fill pad with:

- The 1% AEP flood level for present day conditions;
- The 0.5% AEP flood level which is a proxy estimate of the future 1% AEP flood level with an allowance for climate change; and
- The PMF flood level.

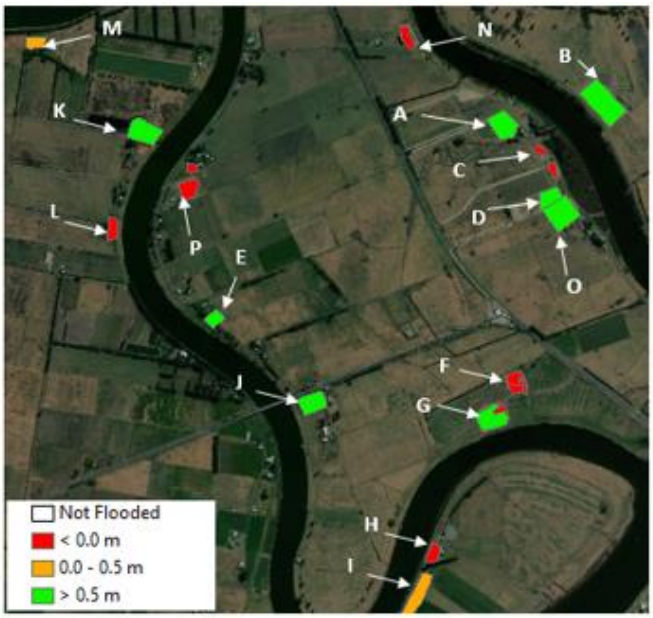
An example of the GIS based comparison of fill levels and flood levels is presented in Figure 2-12, with fill pads coloured:

- Green are above the FPL;
- Orange are above the 1% AEP flood level but below the FPL; and
- Red are below (i.e. overtopped by) the 1% AEP flood level.

A summary of fill pad levels compared to flood levels by LGA is provided in Table 2-6 for Maitland, Table 2-7 for Port Stephens, and Table 2-8 for Newcastle. The analysis showed that there are 186 fill pads that would be overtopped (inundated) by a 1% AEP flood. Of these 186 fill pads, 86 of them have buildings constructed on them. Note that the current study has not distinguished between various building types. Buildings may or may not be habitable residences. Numerous sheds storing agricultural equipment and stock feed are known to be on the floodplain. Some fill pads may have been provided for stock refuge.

Study stakeholders have suggested that there might be several reasons why a fill pad with a building on it has not been constructed at or above the FPL. Reasons might include that the development approval was made through deliberation by Council, concessions may have been made during the approval process which lowered the FPL, or perhaps historical approval at a certain level has been superseded by a more recent Flood Study which has since revised the FPL upward.

The fill pads that are at risk of overtopping in the 1% AEP event are predominantly situated in the Maitland and Port Stephens LGA's. A first pass assessment of the future risk of fill pads on the floodplain indicates that the risk of fill pads being overtopped will increase with future climate change. The total number of fill pads that are exposed to overtopping for a future (2100) 1% AEP flood increases to 225 fill pads (a 21% increase) with 120 of these fill pads currently having a building constructed on them. The PMF will overtop 343 of the total 411 identified fill pads.



Fill Pad	Fill pad elevation above 1% AEP (m)	Imagery © Nearmap	Fill Pad	Fill pad elevation above 1% AEP (m)	Imagery © Nearmap
A	0.98		I	0.33	
B	2.39		J	2.62	
C	-1.03		K	1.10	
D	2.20		L	-1.17	
E	0.51		M	0.312	
F	-0.63		N	-0.09	
G	0.83		O	1.31	
H	-0.21		P	-0.34	

Figure 2-12 Fill pad levels compared to existing 1% AEP flood levels – Hunter / Williams River junction

Table 2-6 Summary of fill pad levels versus flood levels in Maitland LGA

Maitland fill pads compared to flood levels								
	Fill pads with buildings				Fill pads without buildings			
	Not flooded	Above FPL	Below FPL but above flood level	Flooded	Not flooded	Above FPL	Below FPL but above flood level	Flooded
Existing 1% AEP	11	73	33	52	22	39	10	67
Future 1% AEP	8	54	25	79	15	38	8	70
PMF	4	17	3	138	3	23	4	89

Table 2-7 Summary of fill pad levels versus flood levels in Port Stephens LGA

Port Stephens Fill pads below/above flood level								
	Fill pads with buildings				Fill pads without buildings			
	Not flooded	Above FPL	Below FPL but above flood level	Flooded	Not flooded	Above FPL	Below FPL but above flood level	Flooded
Existing 1% AEP	1	29	6	31	5	20	5	32
Future 1% AEP	2	23	5	38	5	18	4	35
PMF	0	5	1	60	3	4	0	53

Table 2-8 Summary of fill pad levels versus flood levels in Newcastle LGA

Newcastle Fill pads below/above flood level								
	Fill pads with buildings				Fill pads without buildings			
	Not flooded	Above FPL	Below FPL but above flood level	Flooded	Not flooded	Above FPL	Below FPL but above flood level	Flooded
Existing 1% AEP	0	0	0	3	1	0	0	1
Future 1% AEP	1	0	0	3	0	1	0	0
PMF	0	0	0	3	0	0	1	0

Note in the tables above that 'FPL' is the existing FPL which has been assumed as the existing 1% AEP flood level plus 500 mm of freeboard. For the purposes of comparison, the existing 0.5% AEP flood level has been adopted as a proxy for the future 1% AEP flood level with climate change.

If we assume two people occupy each of the 227 fill pads with buildings isolated by flooding at the 1% AEP risk level there would be up to 454 people that might need to be rescued in a 1% AEP flood.

Beyond the people safety issues, there are also potential environmental impacts from ACM in flood mounds. Should the flood mounds become unstable during a flood due to erosion of the mound then there is the potential for ACM to be spread across the floodplain. Councils do not support the placement of ACM in flood mounds.

3 Planning Controls Summary

3.1 Preamble

Currently, applications for floodplain development are assessed by individual Councils on a lot-by-lot basis. The development approval process across the three Councils has allowed numerous developments to import considerable volumes of fill onto the floodplain in areas that convey significant flood flow volumes.

Councils are required to assess rezoning requests in accordance with planning directions issued under Section 9.1 of the Environmental Planning & Assessment Act. Direction 4.3 provides the framework for assessment of rezoning proposals on flood prone land. The Direction requires assessment of impacts, including impacts on other properties.

The NSW Government Flood Prone Land Policy (in DIPNR, 2005) provides mechanisms for Councils to limit developments in areas that would impede floodwater storage capacity and thereby adversely impact other downstream areas.

Controls on floodplain development, aligned with the principles of the Flood Prone Land Policy, are set out for each Council LGA under each Council's local environment plans (LEPs) and development control plans (DCPs). Approved house pads are recorded in each Councils' development application tracking system, though this information appears to not be readily accessible by all Councils. New house pads do not appear to be systematically included in geodatabases for studies of flood behaviour, though the outputs of this study would assist in that regard.

Note that some flood mounds have been constructed as stock refuges. It seems that stock refuges are not well understood or controlled from a planning perspective. These types of mounds may also be a target for illegal dumping.

Where house pads/flood mounds are constructed on, or adjacent to, any part of a levee, floodgate, spillway, control bank, drain or bank protection forming part of the HVFMS, or within a declared floodway, the landowner is required to obtain the scheme manager's consent under section 256 of the Water Management Act. This consent is required to ensure protection of the scheme's structural function and operations. This consent is separate from Council planning requirements and development control consent processes. It is unknown how many mounds have been constructed

without the HVFMS manager's consent, though it is clear from the assessment conducted by this study that this has occurred.

3.2 Review of Planning controls

Each Council's LEP and DCP is publicly available on the individual Council webpages. A brief review of each Council's planning implements found:

- The majority of councils in NSW have adopted a standard model local clause in their local environmental plan for earthworks which applies to require the cumulative impacts of fill, including on any future development in the locality;
- Each LEP acknowledges flooding as a planning constraint for flood affected property;
- Each Council's planning documents refer to the NSW Floodplain Development Manual as a key guide to floodplain management practice;
- Each Council's DCP has specific controls for flood affected properties, but these are focussed on constraints for individual properties. Each DCP has been developed individually to suit the needs of the individual Council. As a result, the DCPs are each quite unique and have little by way of consistency/commonality in approach;
- Each Council DCP acknowledges that cumulative impacts may manifest through approval of multiple individual developments;
- None of the Council documents mandates assessment of cumulative impacts. Acknowledgement of the need to assess cumulative impacts is however found in each Council's documents.
    - Maitland City Council's DCP Part B Environmental Guidelines, Section B.3 Hunter River Floodplain, Section 2.1 Risks to Property: notes the need to assess cumulative impacts - "*the potential for the development to increase the flood affectation and likely damages for existing and future development on the floodplain, including consideration of cumulative development of an area.*"
    - Newcastle City Council's DCP Section 4.01 Flood Management: acknowledges the need to assess cumulative impacts as the third of four aims of flood management - "*3. To ensure development, when considered both individually and as an instance of cumulative development trends, will not cause unreasonable adverse flooding impacts in other locations.*"
    - Port Stephens Council DCP accessed for the study has only a passing reference to cumulative impacts. This is found in a glossary of terms in Appendix E of the DCP where one of the roles of a flood study is noted as: "*Assess cumulative flood storage impacts, flood levels, velocity (including direction), hazard and hydraulic categories*". As part of the

study review process, Council highlighted that Port Stephens Council's recently adopted a revised Flooding DCP (Chapter B5) which includes a performance based solution (B5.19) requirement which states: "*The proposed development will not increase the potential individual or cumulative flood impact.*"

Newcastle Council (DHI, 2008) and Maitland Council (WMAWater, 2015) have undertaken model assessments of the cumulative impacts of fill on the floodplain fringe (edge) at the existing 1% AEP flood level. No assessment of the potential impact of isolated individual flood mounds has been attempted to date.

3.2.1 Requested and supplied planning data

The following Table 3-1 summarises the additional floodplain planning data requested of Councils and delivered for this study. Table 3-1 demonstrates the lack of consistency of approach and data availability across Councils.

Table 3-1 Summary of supplied planning datasets

Item	Port Stephens	Maitland	Newcastle
GIS land use zoning map	✓	✓	
Database of DA approved fill pads / flood mounds		✓	
Database of properties that could potentially have a future flood mound			
Rural houses GIS layer		✓	

4 Conclusions and recommendations

There is significant development pressure in the Hunter Valley with the Hunter Regional Plan forecasting a population increase of 130,000 people in the next 20 years, many of whom are anticipated to want to live on the Hunter River floodplain. Development on the floodplain often includes the importation of fill to form a mound (or pad) raised above the flood planning level. Such development of the floodplain has the potential to result in a loss of flood volume and conveyance, and if not carefully managed, considerably increase the risk to life and property. The potential cumulative impact of filling is of concern and currently unquantified.

This scoping study reviewed available topographic data to determine the rate and volume of fill imported to the Hunter River floodplain. Imported fill volumes were estimated using available digital elevation model data for the period prior to 2012 and the period 2012 – 2019. The imported fill pad levels were also compared with available design flood levels. A detailed summary of the floodplain data analysis is provided below. Recommendations for further analysis are also provided.

The Lower Hunter River floodplain straddles Maitland, Port Stephens and Newcastle local government areas (LGAs) whose Councils are responsible for land use planning and development control on the floodplain with their respective jurisdictions. A review of Council LEPs and DCPs found that while Councils acknowledge that importation of fill onto the floodplain might have cumulative impacts on floodplain, all Councils continue to consider development applications on a case-by-case basis. In most cases, record keeping of development applications that have had fill approved are inconsistent across Councils, and unconsolidated both internally within each Council and externally across the three LGAs. As a result the data is not in a form that is easily assessed for cumulative impacts. Further detailed findings of the review of planning documentation is provided below.

4.1 Summary Findings: Floodplain Data Analysis

1) The volume of fill imported to the floodplain between 2012 and 2019 is more than double the fill volume imported prior to 2012.
2) The accelerated rate of fill onto the floodplain is understood to be associated with disposal of tunnelled rock spoil from projects in Sydney. These projects are ongoing and there are more tunnelling projects planned, so there is likely to be an ongoing supply of clean, cheap fill available over the next decade.

3) The volume of fill on the floodplain, while large at 5.4 million cubic metres, is a small percentage (0.47%) of the flooded volume of the floodplain at the 1% AEP flood risk level (which was estimated at 1,154 million cubic metres).
4) While the volume of floodwater displaced by the imported fill is relatively small, the impact of emergent fill pads on flowing floodwaters has been demonstrated using fine grid scale models (BMT, 2019) as significant in terms of deflecting and accelerating flows. Where fill pads are close to one another, there is the potential for flows deflected by adjacent fill pads to interact with one another. The cumulative impacts of adjacent fill pads on the flow are potentially significant with floodwaters building up behind the fill pads and being redirected and potentially redistributed across the floodplain. Where there are clusters of fill pads in key flow conveyance areas of the floodplain, there is the potential for significant redistribution of flows across the floodplain with impacts felt for significant distances both upstream and downstream of the fill.
5) Cumulative impacts of clusters of fill pads on flood behaviour have not been assessed, nor has a limit been set on the amount of fill the floodplain might assimilate without significant impacts on existing flooding.
6) Many of the fill pads identified in the assessment will be isolated from high ground during small overbank floods (e.g. the 10% AEP flood) with road access and evacuation routes closed by floodwaters.
7) More than half of the fill pads identified have a building constructed on them.
8) A significant number of flood pads have no freeboard at the 1% AEP flood risk level and will be overtopped by floods of this size. Almost all flood pads identified in this assessment will be overtopped by the PMF. The risk to life could be further refined by the classification of habitable versus non-habitable buildings, noting that non-habitable buildings are not required to provide freeboard.
9) Most fill pads identified in this assessment would be isolated for days at a time in a flood of the order of the 1% AEP flood, with significant risks to life and health for any persons trapped on the fill pads.
10) Key flood models of the subject floodplain were developed prior to 2012 so do not account for the increased fill placed on the floodplain between 2012 and the present day.
11) No flood model results, including from the most recent floods, specifically included the fill pads that existed when the models were developed because they were built on grid resolutions that were too coarse to satisfactorily resolve the fill pad volumes. There is no evidence in the model results of the influence of fill pads on flood behaviour.
12) The model results do not include the impact of elevated driveways or other 'narrow' embankments as the model grid resolutions are generally too coarse to resolve driveways which are in the order of 3 m in width, while the model grids are in the order of 10 m to 40 m.

13) Existing models established to set flood planning levels have been developed independently by the three Councils. While all of the models have been developed using methods following best practice guidelines, there are inconsistencies in flood behaviour data where they overlap, predominantly due to the adopted boundary conditions which focus on the assessment of risk on the local floodplain in each LGA. There are also other variations in the models including adopted topographic datasets and applied modelling techniques and parameters.

Beyond the shortcomings of the existing flood model results with regards to their representation of floodplain filling, there is no current assessment of cumulative fill impacts either holistically or on an LGA basis, and no attempt has been made to set a limit on the amount of fill that might ultimately be permitted on the Hunter River floodplain.

4.2 Summary of Planning Controls

A review of planning controls across the three Councils indicates that while there is some commonality for flood planning in LEPs, including a commitment to the principles of the NSW Government Flood Prone Land Policy and the NSW Government Floodplain Development Manual, the detailed approach to floodplain development controls varies considerably between Councils.

While cumulative impacts of fill on flood behaviour are acknowledged as an issue in all Council DCPs, the investigation of cumulative impact is not mandated and it is understood that there has been no meaningful attempt to assess the cumulative impact of imported fill onto the floodplain.

There has likely been no meaningful assessment of the cumulative impact of imported fill onto the floodplain because of the cost and scale of the investigation required, proportionate to the assessment of individual DAs for flood mounds.

A data request to Councils for records on DA approvals demonstrated that record keeping for floodplain fill approved developments is inconsistent across Councils in content and quality. Generally, the level of record keeping is poor. While Maitland Council has provided a list of approved DAs with flood fill, this does not cover the full extent of fill discovered in the data analysis. Port Stephens and Newcastle Councils were not able to provide any useful DA approval data for this study. This is not necessarily an indication that data does not exist, but data was not able to be readily provided in the timeframes required for this study. The lack of any data describing the issue of floodplain fill DA's is a concern.

Given the potential for cumulative filling of the floodplain to significantly impact flood flow behaviour, with the associated increased risk to life and property, there is a need to understand the potential for future fill importation so that appropriate controls and limits on fill importation can be applied to manage potential changes.

Where house pads/flood mounds are constructed on, or adjacent to, any part of a levee, floodgate, spillway, control bank, drain or bank protection forming part of the HVFMS, or within a declared floodplain, the landowner is required to obtain the scheme manager's consent under section 256 of the Water Management Act. This consent is separate from Council planning requirements and development control consent processes. The HVFMS management is concerned that many development applications have not been referred to them for assessment.

Beyond these land use planning issues, there are also emergency management considerations due to the increased population at risk of isolation on fill pads during large flood.

4.3 Recommendations

The study scope for this Stage 1 Scoping Study calls for recommendations for two following stages of the Lower Hunter Floodplain Cumulative Development Impact Study and Plan:

- Stage 2 - Assessment of cumulative flood impacts; and
- Stage 3 - floodplain-wide strategies, policies and development controls to manage the cumulative filling.

4.3.1 Stage 2 - Assessment of cumulative flood Impacts

A model assessment of the sensitivity of flood behaviour to cumulative filling is recommended as Stage 2. Future filling of the floodplain is associated with numerous potential sources including:

- Broader scale urban residential subdivisions;
- Peri-urban residential fill pads and flood mounds;
- Major commercial/industrial development precincts; and
- Road/rail infrastructure upgrades.

There are numerous issues to discuss and resolve on the modelling scope for this assessment. Key recommendations are:

1) A single model should be developed for the Lower Hunter floodplain with consistent boundary conditions. There are presently multiple numerical models of the Lower Hunter River floodplain. This is a legacy of the existing modelling being the responsibility of local government.

2) The model needs to be able to represent the influence of fill by property by property development. Representation of individual fill mounds will require a model resolution of 5 m or less.
3) The model should also have the capability to model local features that have a footprint less than the model grid resolution, but at a height that would influence flood behaviour. Peri-urban fill pads with elevated driveway access require special consideration.
4) The model needs to have consistent boundary conditions that are representative of design flood conditions on the floodplain. The boundary conditions should also consider future climate change.

While model technology is continuously improving, a model domain encompassing the required floodplain extent over the three LGAs at 5 m (or less) grid resolution will provide a substantial modelling challenge at significant expense. A staged approach to the modelling assessment is recommended.

In the first instance (Stage 2A) a first pass analysis is recommended to establish the sensitivity of flood behaviour to the importation of fill, particularly fill pads. This assessment could be conducted relatively quickly and affordably, and would establish:

i. The scale of the issue of cumulative fill by quantifying the potential for fill pads to impact flood conveyance in key locations;
ii. Given the considerable coordination and budget required across Councils to comprehensively address the issue, a sense of the urgency/timing required to constrain future development.

The recommendations for Stage 2A are:

5) Use of an existing model covering a key area of the floodplain to assess the cumulative impacts of fill. The existing Williamtown/Salt Ash model is recommended and the recommended focus area is the floodplain adjacent to the confluence of the Hunter and Williams Rivers. Fill pads in the Phoenix Park area might also be assessed.
6) Resample the model grid or nest a fine-grid model of the focus area at a resolution that adequately resolves the existing fill pads.
7) Simulate the model using the 1% AEP flood for the following cases:
    a. 2012 LiDAR topography;
    b. 2019 LiDAR topography;
    c. A representative ultimate future case with all other properties in the focus area with a land use zoning that allows fill pad development.

8) Compare the model results from 7) to determine the scales of potential impact of development on flood behaviour in both the local area and beyond.

This first pass model assessment would provide indicative impacts of cumulative fill only. Assuming that these impacts are significant, a more comprehensive floodplain wide assessment of flood behaviour would be required to assess cumulative fill impacts and provide the necessary information to underpin planning constraints on future development. This modelling exercise would take significant time and budget to deliver. Similar studies have taken several years to deliver. If it is clear from the first pass assessment that fill pads are having a profound impact on flood behaviour, then an interim set of planning constraints might need to be considered. This is discussed further in Section 4.3.2.

There are a range of issues regarding the validity and consistency of flood datasets across local government jurisdictions. These have been highlighted in detail in the flood assessment conducted for the HVFMS strategic review (Smith et al., 2020) which recommends a single, consistent model covering the entire floodplain be developed. A key reason for this recommendation is so that the impact of changes to the floodplain through development can be assessed across LGA boundaries. Prior to a floodplain model being developed, consistent model boundaries would be required. A recommendation of the HVFMS review is that a best practice, catchment wide hydrological model be developed to enable consistent design flow estimates for the full range of catchment flood conditions (peak flow, volume, and timing) to be developed. Any commitment to upgrading the floodplain model to a single model across all three LGAs would require this hydrological study as a prerequisite. This hydrological model would also enable the comprehensive assessment of future, climate change impacted flooding.

Assuming the hydrological model data set is available, the following steps are recommended for Stage 2B:

9) Source updated topography data.
10) Develop a floodplain wide model across all three LGAs.
11) Simulate the model for the full range of design flood risk levels using appropriate flood flow boundaries from the catchment wide hydrological model for both existing and future climate to develop consistent design flood behaviour information across the floodplain. Note that this information would supersede flood behaviour datasets from existing flood studies in all three LGAs.
12) Assess the limits for cumulative fill in key locations across the floodplain. Note that these may vary depending on the location of the floodplain and the designated landuse.

4.3.2 Stage 3 - floodplain-wide strategies, policies and development controls to manage the cumulative filling

The following steps are recommended to be delivered by a suitably qualified planning consultant for Stage 3:

1. Make data and the model available to Councils for use during rezoning assessments and DA assessments (note there likely no need for statutory amendments required for a Council to bring cumulative impact assessments in as a relevant matter to an assessment of a DA under s.4.15).
2. Request the NSW Department of Planning, Industry & Environment amend Ministerial direction 4.3 to refer to the data and model for development in the Hunter Floodplain.
3. Request the NSW Department of Planning, Industry & Environment include in the Hunter Regional Plan actions to and directions in relation to the data and the model and proposed guidelines (note the plan is currently under review and is supposed to be finalised Oct 2021).
4. Develop guidelines for assessing development (DAs and rezonings) likely to require filling. Include guidance from the NSW SES addressing emergency management requirements. Request Department of Planning, Industry & Environment endorse the guidelines and adopt them for State significant development in the Hunter floodplain as well.

Note that steps 1) – 3) could be completed independently of Stage 2 tasks.

Given that Stage 2B may take several years to deliver, an interim set of guidelines might be delivered based on the outcomes of Stage 2A. Depending on the severity of potential flood impacts, the interim guidelines might range from a moratorium of further development with imported fill, to a 'no regrets' policy based on only approving fill on properties a specific distance from existing fill pads or other topographical flow constraints.

5 References

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DECC (2007) *NSW Floodplain Risk Management Guideline Flood Emergency Response Planning, Classification of Communities*. Department of Environment and Climate Change. October 2007.

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WMA Water (2015). Hunter River – Floodplain Risk Management Study and Plan. Report prepared for the Maitland City Council, Final Report, November 2015.

APPENDIX C: DEVELOPMENT SCENARIOS MODELLED TO ASSESS LOCALISED IMPACTS

Appendix C

Assessment of Localised Impacts – Examples Modelled

Disclaimer

Note, these scenarios are hypothetical and have been formulated to test the potential localised flood impacts associated with individual filling activities. A range of parameters have been specified having regard to past development applications and current planning controls, but the scenarios have sought to identify worst case possible scenarios in order to provide a robust basis for preparing planning controls to manage potential impacts. Given the purpose for the modelling assessments, the examples modelled are not intended to represent any actual developments or specific sites.

Scenarios 1 and 2: Non-Urban Fill Pads (2 Examples)

This scenario will examine potential localised flood impacts associated with the construction of fill pads for a dwelling house and curtilage uses, including an elevated access road. It is to be assumed that the top level of the fill pad is the applicable residential floor level FPL. As fill pads are also permitted to be constructed for livestock refuges in some cases, the maximum likely fill pad for dwelling house purposes plus livestock refuges will be considered for one of the scenarios.

This example is to be modelled in two separate locations in the lower and upper end of floodplain to examine the potential for different impacts:

- Scenario 1 – Upper end of the floodplain within the Maitland LGA
- Scenario 2 – Lower end of the floodplain within the Port Stephens LGA.

For each scenario adopt 3 typical non-urbans lot that are currently vacant or do not have existing fill pads. The location is chosen such that it as typical as possible for the purposes of the flood modelling. That is, the lots should have at least an obvious building area near to the road that is lower than the minimum FPL for residential floor levels, and have with minimal site specific qualities that would differ from other candidate sites. This is to ensure the results of the modelling reflect, as far as possible, the results that would be expected if applied to other sites in the same part of the catchment.

Consequently these scenarios represent 2 of the 6 scenarios to be considered.

<u>Scenario 1</u>

Based on the Maitland DCP, the following development parameters applied to each of the 3 lots should be modelled:

a. Filling volume - 7,000m^3 for a fill pad and access driveway.
b. The fill pad will accommodate a dwelling house (assume a 400m^2 footprint), rural shed (assume a 2,000m^2 footprint) connected to a public road with an access driveway.
c. A separate fill pad with a volume of 3,500m^3 for stock refuge.
d. Assume a 10m separation between the toe of each fill pad, on the basis that would be the minimum practical separation to provide internal site access.

e. Adopt a 20m setback from the top of the fill pad to the public road unless the lot has an area of less than 5,000m^2 in which case adopt 10m, to accord with minimum DCP requirements for buildings.

f. Adopt either of the following setbacks from the top of the fill pad to side or rear boundaries to accord with minimum DCP requirements for buildings. Assume the worst case, that is, that at least 2 lots adopt the minimum setbacks from the same common boundary and the third lot is sited the minimum setback distance from the closest boundary.

- 10m if lots zoned RU1
- 6m if the lot is zoned C4 or zoned R5 with an area of more than 5,000m^2
- 4m if the lot is zoned R5 with an area of less than 5,000m^2.

Scenario 2

Based on the Port Stephens DCP, the following development parameters are applied to each of the 3 lots are to be modelled:

a. Fill pad size is 20m by 20m.

b. Assume a 180m separation between the toe of each fill pad and all other property boundaries.

c. Include an access driveway connecting the pad to a public road.

d. Filling volume - 7,000m^3 for a fill pad and access driveway.

e. The fill pad will accommodate a dwelling house (assume this will occupy the whole of the fill pad).

Scenarios 3: Residential Urban Infill

This scenario involves the filling of 3 existing urban residential lots in an established older low density residential area to provide for medium density housing. It is assumed that the area is currently below the minimum residential floor flood planning level and will progressively be filled as redevelopment occurs. Consequently, in the interim, the properties adjoining the scenario site will remain at a lower level than the scenario site.

A location within the established low lying inner area of R3 Medium Density Residential zoned land at Beresfield near the train station around Addison St, Kendall St and Landor St in the Newcastle LGA is to be modelled.

Scenarios 4: Industrial Urban Infill

This scenario involves the redevelopment of existing industrial premises in an established industrial area. The development scenario involves demolition of an existing industrial building that occupies 50% or less of the site that is below the current FPL. The site is filled to the FPL and new industrial building is constructed that occupies 90% of the site.

A location in the industrial zoned E4 General Industrial land at Sandgate on the northern side of the highway, around Ferry Road, River Road and Mangrove Road is to be modelled.

Scenario 5: Filling of an industrial lot for Large Scale Industrial Development

This scenario involves filling and development of large format industrial development on large lots in the outskirts of the Newcastle LGA. Adopt a lot with an area of 1 hectare to align with the controls in the Codes SEPP that allow filling in certain circumstances as complying development. Assume 100% of the site is filled to the FPL.

A location in the industrial zoned E5 Heavy Industrial land at Hexham in the Maitland Road/ Old Maitland Road is to be modelled.

Scenario 6: Filling on the edge of Greenfield urban Release Areas

This scenario involves filling and development at the edges of new greenfield urban release areas to provide development platforms that are wholly above the current FPL. This scenario was intended to investigate the consequences arising from situations where release areas may have been defined based on superseded FPLs or have assumed that filling in some areas, to provide larger or more rationally shaped development parcels, would be acceptable based on site specific flood impact assessments.

As possible situations based on the current planning context and which fitted within the parameters of the flood models were not available, a hypothetical option was devised. It is to be assumed that the western side of the Chisholm release area within the Maitland LGA (Thornton Stage 2 Urban Release Area) from Harvest Boulevarde in the south up to and including the knob of land north of the Billabong Parade and Arrowtail Street intersection is filled to the FPL to facilitate urban development. This represents a narrow corridor of Rural zoned as opposed to E2 Environmental Conservation and E3 Environmental Management zoned land. .

APPENDIX D: DRAFT DCP CONTROLS

PRELIMINARY DRAFT

Appendix D

Draft DCP Controls

Preface - Implementation

These controls have been prepared for incorporation in the DCPs of each of the 3 study area Councils. The process of amending the DCPs is to be undertaken by the individual Councils, in accordance with process specified by the EP& A Act and Regulation.

It is recognised that the formatting and presentation of the controls and any associated mapping may vary between each Council DCP but the substantive intent and metrics within the controls should remain consistent. Ideally the amendment processes of each of the Councils, in particular the timing for public consultation and adoption/commencement of the DCP controls, should occur in tandem. Where variations are sought as a consequence of the public participation process, those amendments should be discussed between the individual Councils in the aim of maintaining consistency.

The Prescriptive Controls specify measures that if complied with, are expected to ensure the Performance Criteria are satisfied. Where alternative solutions to the Prescriptive Controls are proposed, the proponent should justify how the development will still satisfy the Performance Criteria and remain consistent with the objectives of the control and the objects of the Act.

The base principles which have guided the preparation of these controls are:

- The assessment of flood impacts should be based on consideration of the effects of development across the whole of the floodplain, irrespective of administrative boundaries.
- Any change to the natural or built conditions in the floodplain should not have a material economic, environmental or safety impact on other properties or users in the floodplain.
- When determining whether a change will have a material impact, an allowance should be made for tolerances in the accuracy of flood modelling and in consideration of the relative vulnerability of different properties and users that may be potentially impacted. (eg residential dwellings should be afforded lower tolerances than parks or rural land).
- The criteria for assessing the acceptability of impacts from an individual development should be less than the criteria for assessing cumulative impact. This takes into account that there could always be further development in the floodplain that should be allowed for when assessing acceptability.

These base principles should be maintained with any refinements that may occur during the implementation stage.

The following DCP controls were required to relate specifically to addressing potential cumulative flood impacts that development could have on properties external to the development site. The controls will necessarily also refer to potential external flood impacts in general. The provisions of the existing DCPs that relate to external mainstream flood impacts (ie not overland flow flood impacts) should be superseded by the draft provisions below. The following controls should have no effect on all other provisions of the Councils' DCPs that relate to flood risk management.

Area of Application

The following controls are to apply to land subject to mainstream flooding within the LGA, within the Hunter Valley Catchment. [Note Councils may wish to describe an area of application for the whole of the FRM DCP controls that would be inclusive of the Study Area, such as "all flood liable land within the LGA" and include a map or reference/hyperlink to Council's online mapping system.]

General Note

The Councils should add a note generally to the flood risk management provision of the DCP to the effect of *Where the proposed development is located in a Dedicated Floodplain or near an asset of the Hunter Valley Flood Mitigation Scheme, additional approvals may be required under S256 of the Water Management Act 2000.*

Definitions

Reference should be made to the adoption of the definitions contained within the *Flood Risk Management Manual* published by the Department of Planning in 2023, unless an alternative definition is provided by the DCP. The following specific definitions apply to the recommended DCP provisions.

Compensatory excavation *means the excavation of material to offset the placement of fill, so that there is no net reduction in the flood storage capacity in a hydraulically linked part of the floodplain defined by a specified flood event. Note: this means that the area of compensatory excavation must be available to accommodate flood waters during a specified flood event and for example cannot therefore be prematurely filled with ground water or local overland flows.*

Cumulative impact assessment *refers to the practice of investigating the collective impacts, both positive and negative, that can result from a clustering of all foreseeable works within the floodplain. Note: An assessment of the cumulative impact of potential future development in the floodplain of the Hunter River is detailed in the Lower Hunter Floodplain Cumulative Development & Impact Study & Plan (Stages 1, 2 and 3: 2021; 2023 & 2023).*

Fill pad *is a raised mound that is constructed from imported fill or material excavated from the development site, to accommodate a dwelling, rural building or agricultural activity (such as a stock refuge or storage of agricultural equipment) in a non-urban zone, to provide increased flood immunity for those uses.*

Flood Impact Technical Guidelines *are the guidelines that outline the methodology to be applied when required to undertake a site specific flood impact assessment.*

Hunter River floodway and flood storage areas *are those shown on the maps referred to as [Council to insert preferred name of maps or on line maps]*

Material impact *means the potential environmental, financial or safety impact on a property that is external to the development site that is projected to occur as a consequence of flooding, after allowing for the tolerances in modelling capabilities, the pre-existing flood liability of the property and the sensitivity of the property and its use to flooding.*

Medium density housing *means all forms of residential accommodation other than dwelling houses*

Minor development *means development, not otherwise defined, that is not located within floodway or flood storage areas, involves work that affects less than 20% of the 1% AEP floodplain within the boundaries of the development site and does not involve the net filling of land, or building a structure that increases the floor area of a building by more than 10% or 30m^2 (whichever is the greater).*

Principal floor area *means:*

a) in a residential situation, a living or working area, such as a living room, kitchen, bedroom or study, and excluding non-habitable floor areas for uses such as car parking, laundries and secondary bathrooms that are located at ground level that is predominantly open and within undercroft spaces; and

b) in other situations such as industrial or commercial premises, an area used for offices, the principal operating floor area of a business or an area where valuable possessions susceptible to flood damage in the event of a flood are stored.

Objectives

The following objectives should be added to the general FRM objectives within the DCPs.

- Ensure the sustainable and equitable development of the floodplain such that long term filling across the Lower Hunter floodplain does not result in material adverse impacts.
- Ensure that development is not unacceptably intensified in identified floodways and flood storage areas resulting in material impacts.

Performance Criteria

1. Conveyance and storage of floodwaters through the floodplain is not materially impacted by the development in isolation and when considered together with a cumulative impact assessment.

2. Development has no material impact on the natural or built environment as a consequence of flooding.

Prescriptive Controls

1. The controls will apply in the following way:

   1.1 If the cumulative flood impact threshold criteria are not exceeded then no further assessment of cumulative flood impacts is required.

   1.2 If the cumulative flood impact threshold criteria are exceeded then:

   a. Any additional fill in flood storage areas above that allowed for by the threshold criteria must be addressed by compensatory excavation and/or the floors of a proposed building is to be elevated in a manner that maintains flood storage capacity in the 1% AEP floodplain (see Note B) if required to achieve a minimum flood planning level.

   b. No additional fill, than otherwise allowed for by the cumulative flood impact threshold criteria, is permitted in the floodway.

   c. Any proposed changes to ground levels and the height of a building must also be acceptable having regard to all other applicable requirements of the DCP and Local Environmental Plan.

   Note: Cumulative impact assessments are undertaken at a strategic planning level by Council and are not required to be provided with individual development applications.

2. A site specific flood impact assessment will be required to be prepared and submitted with the development application where the local siting criteria in Table 1 are not satisfied, to demonstrate compliance with the controls specified in Table 1.

3. A site specific flood impact assessment shall be prepared in accordance with the *Flood Impact Technical Guidelines.* Note Council may also require overland flow flooding impacts or other potential localised flood impacts to be addressed.

4. The site specific flood impact assessment should be incorporated into a broader *flood impact and risk assessment* (FIRA) where required to address other floodplain risk management considerations such as emergency management.

5. The assessment of a proposal to fill land will be based on ground levels as existing at [*Council to insert date that DCP amendments to commence*]. Where land has been filled to the maximum permitted by the DCP, no further filling will be permitted.

Table 1: Prescriptive Controls for Flood Impact Assessment

Proposed Development	Cumulative Flood Impact Assessment Threshold Criteria (A & C)	Local Siting Criteria (C) (If exceeded - a site specific flood impact assessment is required)	Controls for site specific flood impact assessments (B & C)		
			Off-site Flood Levels	Off-site Flood Flow Velocities	Other
Fill pad to support a dwelling house	A maximum fill pad volume in the 1% AEP floodplain of 7,000m^3 per lot.	FIA is required where: • the fill pad or other works are located within 30m of another fill pad or solid structure within the 1% AEP floodplain or 15m from the property boundary, measured from the toe of the pad, or • located closer than 40m from the top bank of the Hunter River of major tributary, or • abutting and existing levee or between an existing levee and the River, or • where considered necessary in the opinion of Council.	1, 2	2	
Fill pad – other (D)	A maximum fill pad volume in the 1% AEP floodplain of 3,500m^3 per lot		1, 2	2	
Other development on non-urban zoned land	Any development located in a floodway or flood storage area, other than minor development.		1, 2, 3	1,3	1
Dwelling house on urban zoned land	The maximum site coverage of the dwelling house and any ancillary buildings within the 1% AEP floodplain is 50%; and the existing ground level is raised to a maximum level equal to the x% AEP flood level or by no more than 300mm, whichever is the lesser.	FIA is required where an overland flow path would be affected or where considered necessary in the opinion of Council.	1, 2, 3	1,3	
Medium density housing	The maximum site coverage of all buildings within the 1% AEP floodplain is 70%; and the existing ground level is raised to a maximum level equal to the x% AEP flood level or by no more than 300mm, whichever is the lesser.	FIA is required where located within a floodway, where an overland flow path would be affected or as considered necessary in the opinion of Council.	1, 2, 3	1,3	1
Industrial development	The maximum site coverage of all buildings and outdoor	FIA is required where located within a floodway, where an overland flow path would be affected or as considered	1, 2, 3	1,3	1

Proposed Development	Cumulative Flood Impact Assessment Threshold Criteria (A & C)	Local Siting Criteria (C) (If exceeded - a site specific flood impact assessment is required)	Controls for site specific flood impact assessments (B & C)		
			Off-site Flood Levels	Off-site Flood Flow Velocities	Other
	storage areas within the 1% AEP floodplain is 70%; and the existing ground level is raised to a maximum level equal to the x% AEP flood level or by no more than 300mm, whichever is the lesser.	necessary in the opinion of Council.			
All other development other than minor development	For all other development located in a floodway or flood storage area, other than minor development, the maximum site coverage of all buildings within the 1% AEP floodplain is 70%; and the existing ground level is raised to a maximum level equal to the x% AEP flood level or by no more than 300mm, whichever is the lesser.	FIA is required where located within a floodway, where an overland flow path would be affected or as considered necessary in the opinion of Council.	1, 2, 3	1,3	1
Minor development		FIA is required if located in a floodway or where an overland flow path would be affected.	1, 2	1,3	
Subdivision (D)	The threshold criteria are exceeded by any subdivision that involves the creation of a new lot within a floodway or flood storage area, other than a lot that is not intended to be permanently occupied such as a lot to be used only for agricultural purposes or a public reserve; and where the combined allowable fill for all proposed lots is exceeded by the allowable fill for the original lot. (E)	FIA is required where considered necessary in the opinion of Council.	1, 2, 3, 4	2	1, 2

Notes:

No criteria or control applies.

A. The cumulative flood impact threshold criteria were determined as part of the *Lower Hunter Floodplain Cumulative Development & Impact Study & Plan* (Stages 1, 2 and 3: 2021; 2023 & 2023) and is broadly based on the cumulative impact of potential development in the floodplain into the foreseeable future, as opposed to the impact of an individual development.

B. The controls relate to the 1% AEP flood with climate change related rainfall and sea level adjustments forecast for the year 2100, unless otherwise stated.

C. All assessments are to be based on flood conditions as predicted for the year 2100 based on best available climate change flood risk data and ground levels as existing as at [*Council to insert date that DCP amendments to commence*].

D. Includes fill pads for any other purpose such a stock refuge, shed, or any ancillary works such as access driveways.

E. When considering the acceptability of subdivision, this is to take into consideration all works and buildings that would be anticipated to facilitate future development permitted in the zoning of the land such as the creation of a fill pad and access road on rural zoned land or the construction of an industrial building on land zoned for employment purposes. All filling assessed as necessary and acceptable shall be undertaken prior to the issue of a subdivision certificate or identified as a restriction on the title of the lot. The wording of the restriction is to be approved by Council, and Council shall be assigned as the authority to amend or rescind the restriction.

Controls

Off-site Flood Levels

1. A maximum increase of 10mm at the footprint of buildings that are not associated with the development, where floor levels are currently inundated in a 1% AEP flood.

2. A maximum increase of 20mm in inundation of land zoned for urban residential, industrial or commercial purposes.

3. A maximum increase of 30mm in inundation of land zoned for rural, primary production, environment conservation or public recreation purposes.

4. A maximum increase of 30mm in inundation, during floods up to a 2%, 5% or 0.05% AEP event of land zoned for urban residential, industrial or commercial purposes.

Off-site Flood Flow Velocities

1. Flood flow velocities are not increased at the property boundary for any flood up to a 1% AEP flood:
   a) by any amount where the existing condition flow velocity is greater than 1.5 m/s, or
   b) by more than 20% where the existing flow velocity is less than 1.5 m/s.

2. Maximum relative increase in velocity of 10%, where the resulting velocity is greater than 1.0 m/s, unless adequate scour protection measures are implemented and/or the velocity increases do not exacerbate erosion as demonstrated through site-specific risk of scour, or geomorphological assessments.

3. No increase in velocity beyond 1.0 m/s, unless adequate scour protection measures are implemented in accordance with the recommendations of a suitably qualified professional engineer.

Other

1. No increase in the flood hazard category of adjoining land defined according to the general hazard vulnerability curves shown in Figure 6 of the *'Australian Disaster Resilience Handbook 7 - Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia'* (2017).

2. Any new lot created by the subdivision of land must have a defined building area, outside of the floodway or flood storage area, that is capable of accommodating development envisaged by the zoning of the land. The building area is to be shown as a restriction on the title of the property, where the property is located within a non-urban land use zone in the applicable local environmental plan.

APPENDIX E: TECHNICAL GUIDELINES

NOT ISSUED WITH THIS DRAFT REPORT

APPENDIX F: DWELLING DEMOLITION DATA

Dwelling Demolition Data

Year/Qtr	Maitland		Port Stephens		Newcastle		NSW	
	Demoltions	dwgs demolished	Demoltions	dwgs demolished	Demoltions	dwgs demolished	Demoltions	dwgs demolish
2017/1	2		2		58		1590	
2017/2	1		1		50		1812	
2017/3	5		5		58		1682	
2017/4	0		1		64		1650	
Subtotal	**8**	**0.026%**	**9**	**0.03%**	**230**	**0.33%**	**6734**	**0.23%**
2018/1	0		4		59		1,816	
2018/2	2		2		63		1,673	
2018/3	3		4		52		1,793	
2018/4	3		2		50		1,492	
Subtotal	**8**	**0.026%**	**12**	**0.04%**	**224**	**0.33%**	**6774**	**0.23%**
2019/1	5		4		34		1,315	
2019/2	0		3		87		1,562	
2019/3	2		3		47		1,499	
2019/4	3		2		43		1,658	
Subtotal	**10**	**0.028%**	**12**	**0.03%**	**211**	**0.28%**	**6034**	**0.19%**
2020/1	7		2		43		1,274	
2020/2	3		1		53		1,639	
2020/3	3		4		65		1,699	
2020/4	3		5		52		2,012	
	16	**0.045%**	**12**	**0.03%**	**213**	**0.29%**	**6624**	**0.21%**
Total dwgs at 2021 Census	35413		35649		74342		3199992	
Avg no of Dwgs Demolished PA	10.5		11.25		219.5		6541.5	
Projected Dwg Demolition in 50 Years	525		562.5		10975		327075	
Projected % of total Dwg Stock demolished in 50 years based on 2017-2020 data	**1%**		**2%**		**15%**		**10%**	
Years it would take for 10% of dwellings to be demolished	318		306		33		46	

Notes

1. Percentage of total dwelling stock demolished is based on total dwellings at the 2016 Census for 2017 and 2018 and 2021 Census for 2019 and 2020

2. Dwelling demolishment data obtained from ABS Preliminary data on the number of dwellings approved to be demolished from the September 2016 quarter to the June 2021 quarter, released 8/10/2021.

3. Apparent differences in last 2 rows of projections are due to rounding

GLN Planning Pty Ltd Trading as GLN Planning
ABN 39 585 269 237

A Level 10, 70 Pitt Street Sydney NSW 2000
P GPO Box 5013, Sydney NSW 2001
E info@glnplanning.com.au
T (02) 9249 4109 F (02) 9249 4111

glnplanning.com.au

gln.

planning
consulting
strategy