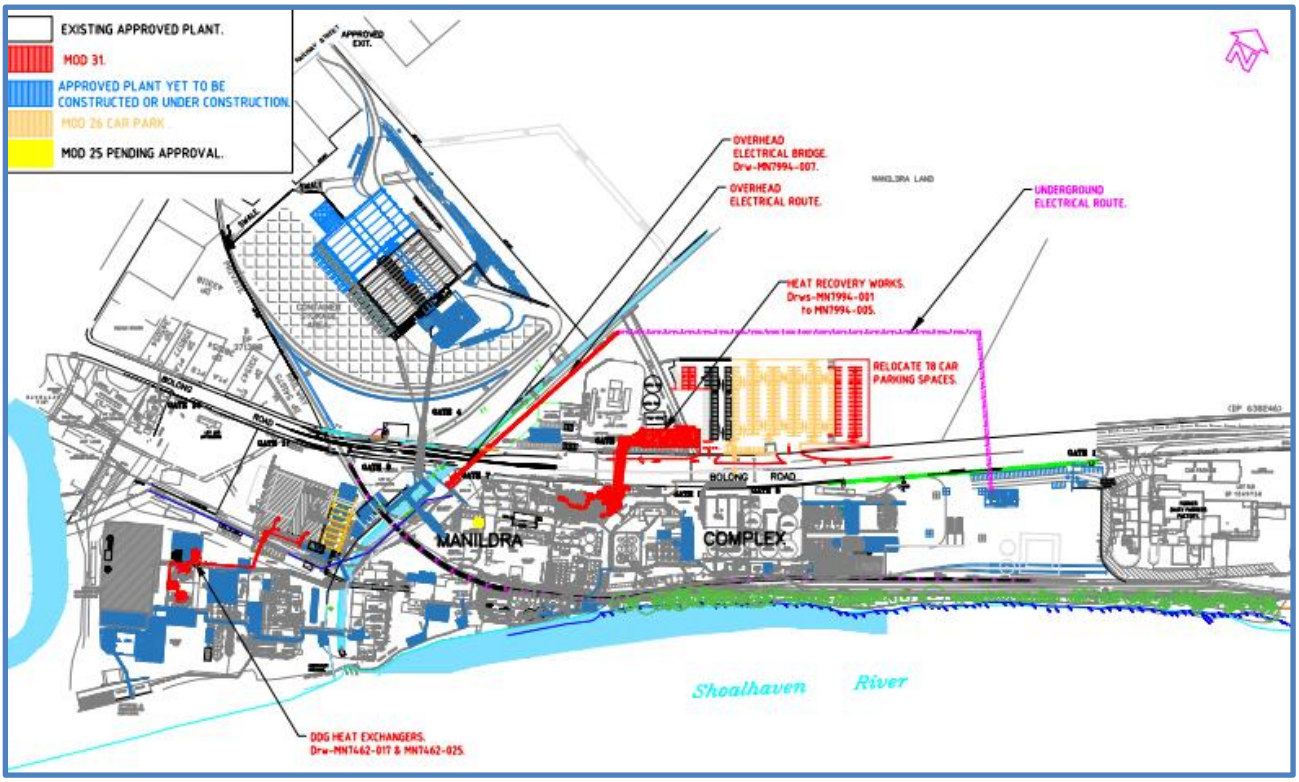
Proposed Ethanol Distillery Heat Recovery Project Mod31
220 Bolong Road, Bomaderry Flood Compliance Report



wma water

August 2025

Level 2, 160 Clarence Street
Sydney, NSW, 2000

Tel: 9299 2855
Fax: 9262 6208
Email: wma@wmawater.com.au
Web: www.wmawater.com.au

PROPOSED ETHANOL DISTILLERY HEAT RECOVERY PROJECT MOD31
220 BOLONG ROAD, BOMADERRY FLOOD COMPLIANCE REPORT

AUGUST 2025

Project **Proposed Ethanol Distillery Heat Recovery Project Mod3** **220 Bolong Road, Bomaderry Flood Compliance Report**	**Project Number** **114044 - 39**
Client Shoalhaven Starches	**Client's Representative** John Studdert Sebastien Tauni
Authors Richard Dewar Fabien Joly	**Prepared by** 
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TABLE OF CONTENTS

PAGE

LIST OF APPENDICES

LIST OF TABLES

LIST OF IMAGES

LIST OF FIGURES

APPENDIX C: Climate Change Results

EXECUTIVE SUMMARY

Background: The Shoalhaven Starches plant is located on the northern bank of the Shoalhaven River at Bomaderry (Figure 1).

Shoalhaven Starches is seeking approval to modify their Project Approval for the Shoalhaven Starches Expansion Project to deploy a suite of heat recovery upgrades and enabling infrastructure that will deliver a transformative, immediate, and ongoing reduction in its Scope 1 carbon dioxide emissions.

The Manildra Group has recently been awarded a $44.5M grant by the Federal Government, under the “Powering the Regions Fund”, for this suite of heat recovery projects at the Shoalhaven Starches site at Nowra. The “Powering the Regions Fund” is delivering $330M to nine projects to keep Australian industry not just surviving but thriving, as demand for low emissions products grows around the world. The Mod31 Proposal will include the following aspects.

- Beverage Grade Ethanol Distillery Heat Recovery.
- Fuel Grade Ethanol Reconfiguration and Heat Recovery.
- Dried Distillers Grain Heat Recovery.

These upgrades will capture and transform waste heat into usable energy to drive the ethanol, starch and gluten manufacturing processes. This will ultimately reduce the amount of virgin steam that is required by displacing the need to burn natural gas at the plant's onsite co-generation plant and other gas-fired boilers. Plans of the proposed works are shown on Figure 2 and included in Appendix B.

Flooding: The proposed works are on land inundated in the 1% Annual Exceedance Probability (AEP) flood event by floodwaters from the Shoalhaven River (as determined in the November 2022 Shoalhaven River Flood Study – Reference 1). The construction of any works on the floodplain will cause a loss of temporary floodplain storage and a loss of hydraulic conveyance. The resulting increase in flood levels will depend upon the magnitude of these losses.

Prior to construction of the Shoalhaven Starches plant at Bomaderry there would have been significant flow through the site and adjoining land during a flood, as there is across any riverbank. Since approximately 1970 the ongoing construction of the plant has reduced the flow path through a large part of Shoalhaven Starches lands on the northern bank. Floodwaters are therefore diverted to other parts of the floodplain and this may increase flood levels on these lands.

It should be noted that other works on the Shoalhaven River floodplain (e.g. completed new bridge at Nowra and upgrading of the Terara levee) will also have contributed to changes in flood level in parts of the floodplain over time. The impacts of these works have not been determined as part of this report.

Past Studies: Several previous flood studies have been undertaken for Shoalhaven City Council and Shoalhaven Starches. The key ones are listed below.

1. Lower Shoalhaven River Flood Study, November 2022 (for Council, Reference 1).
2. Shoalhaven River Flood Study, March 2013 (for Shoalhaven Starches, Reference 2).
3. Lower Shoalhaven River Flood Study, April 1990 (for Council, Reference 3).

WMAwater has also undertaken many (> 10) flood impact assessment / compliance reports for Shoalhaven Starches in the last 15+ years. These past flood impact assessments by WMAwater were undertaken using hydraulic models prepared initially in Reference 3 and subsequently in Reference 2. With completion of the November 2022 Lower Shoalhaven River Flood Study (Reference 1), the hydrologic and hydraulic models established in that study have been adopted for use in this report by WMAwater for Shoalhaven Starches.

These flood impact assessment reports determined the incremental changes in peak flood levels due to ongoing proposed works by Shoalhaven Starches. It is only since 2023/2024, with the adoption of the computer models provided in Reference 1, that the cumulative effects of all works by Shoalhaven Starches have been quantified.

A comparison between the peak 1% AEP flood levels from the March 2013 (Reference 2) flood study and the November 2022 (Reference 1) flood study indicates a significance reduction in flood levels, as shown Figure 3. This has occurred due to many factors including the adoption of the 2019 Australian Rainfall and Runoff (ARR, Reference 4) guidelines in Reference 1, whilst Reference 2 and Reference 3 adopted the prior 1987 edition of ARR (Reference 5).

Development on the Floodplain: Each development on the floodplain has the potential to cause an impact upon flood levels. The impacts of works within the floodplain on hydraulic characteristics are twofold, firstly, a loss of temporary floodplain storage volume and secondly a loss / restriction of flow area or conveyance. It is the loss of flow area which produces the greatest impact, as the area of floodplain storage lost due to all works by Shoalhaven Starches since 1990, represents less than 1% of the total available floodplain storage area of the northern floodplain of the Shoalhaven River.

Scope of Work: The scope of work was to use up to date hydraulic modelling taken from Reference 1 to assess the impacts on flooding of the proposed works by Shoalhaven Starches. This report provides an assessment of the implications of the proposed works (termed Mod31) on surrounding flood levels and considers both the incremental effect (i.e. the change compared to that previously approved up to July 2025 that includes built and not yet built), as well as the cumulative effects of all past approved works (built and not yet built) by or for Shoalhaven Starches since 1990.

It should be noted that the design events (5% AEP, 1% AEP and the PMF) adopted to assess the impacts on flooding of the proposed works do not include anthropomorphic climate change (i.e rainfall increase and sea level rise). However, climate change has been considered in

Appendix C.

The hydraulic modelling assumes the same topography (taken from Reference 1) for 1990 and July 2025 conditions outside the lands owned by Shoalhaven Starches. However, within the Shoalhaven Starches lands, including the Supagas facility, the Reference 1 TUFLOW model has been revised to create the following three model scenarios.

1. The works as present in 1990 (termed the 1990 Existing model).
2. Those approved (built and not yet built) as of July 2025 (termed the July 2025 Existing model).
3. Those approved (built and not yet built) as of July 2025 plus including the Mod31 proposed works as shown on Figure 2 (termed the Mod31Design or Proposed model).

Thus, for example, the constructed new bridge over the Shoalhaven River at Nowra is included in all three scenarios as are all works on the Riverview Road / Terara levee. This approach therefore only determines the cumulative effects of the works by or for Shoalhaven Starches since 1990 and has not assessed the impacts of other works on the floodplain in that time.

Assessment of Impacts of Proposed Development: The impacts of the proposed development on flooding have been evaluated for the following two scenarios.

- Comparison of the Proposed with the July 2025 Existing model. This determines the incremental impact of the proposed Mod31 development application.
- Comparison of the Proposed with the 1990 Existing model. This provides the cumulative effects of the proposed Mod31 development plus all approved (built and not yet built) works by or for Shoalhaven Starches since 1990.

Results of Assessment: The proposed Mod31 works have increased flood levels as shown on Figure 4 to Figure 15. Figure 16 and Figure 17 show the land use zones in the local area with the maximum flood level increases on each property shown on Figure 18 to Figure 23.

In summary the maximum cumulative increases in flood level since 1990 are shown below. However, in all three events most areas only experience a maximum increase of up to 0.1m.

- 5% AEP – up to 0.1m (Figure 4),
- 1% AEP – up to 0.2m (Figure 8),
- PMF – up to 0.3m (Figure 12).

The maximum incremental increases in flood level since July 2025 are shown below. However, the increases are predominantly within land owned by Shoalhaven Starches.

- 5% AEP – less than 0.01m (Figure 6),
- 1% AEP – less than 0.1m (Figure 10),
- PMF – less than 0.1m (Figure 14).

Possible Mitigation Measures: There are no viable means of reducing the increase in peak flood levels resulting from these works. One of the most beneficial and practical means of reducing flood damages to existing buildings and risk to life is to improve the awareness and preparedness of the occupants or employees. There are several ways of undertaking such a scheme and these are outlined in Table 3 and most require involvement by Council and / or the SES. Funding a scheme would assist in improving the community's flood awareness and consequently reducing flood damages for all floodplain occupiers.

Climate Change: The August 2024 ARR Version 4.2 has provided a methodology for determining the effects of anthropomorphic rainfall increase and sea level rise and this has been discussed in Appendix C. Figure 3 to Figure 23 do not take into account anthropomorphic climate change but figures in Appendix C do include the impacts of climate change.

1. INTRODUCTION

1.1. Background

The Shoalhaven Starches plant is located on the northern bank of the Shoalhaven River at Bomaderry (Figure 1).

Shoalhaven Starches is seeking approval to modify their Project Approval for the Shoalhaven Starches Expansion Project to deploy a suite of heat recovery upgrades and enabling infrastructure that will deliver a transformative, immediate, and ongoing reduction in its Scope 1 carbon dioxide emissions.

The Manildra Group has recently been awarded a $44.5M grant by the Federal Government, under the “Powering the Regions Fund”, for this suite of heat recovery projects at the Shoalhaven Starches site at Nowra. The “Powering the Regions Fund” is delivering $330M to nine projects to keep Australian industry not just surviving but thriving, as demand for low emissions products grows around the world. The Mod31 Proposal will include the following aspects.

- Beverage Grade Ethanol Distillery Heat Recovery.
- Fuel Grade Ethanol Reconfiguration and Heat Recovery.
- Dried Distillers Grain Heat Recovery.

These upgrades will capture and transform waste heat into usable energy to drive the ethanol, starch and gluten manufacturing processes. This will ultimately reduce the amount of virgin steam that is required by displacing the need to burn natural gas at the plant's onsite co-generation plant and other gas-fired boilers. Plans of the proposed works are shown on Figure 2 and included in Appendix B.

The proposed works are on land (Image 1) inundated in the 1% Annual Exceedance Probability (AEP) flood event by floodwaters from the Shoalhaven River (taken from the November 2022 Shoalhaven River Flood Study – Reference 1). The construction of any works on the floodplain (i.e. the works are inundated in the PMF) will cause a loss of temporary floodplain storage and a loss of hydraulic conveyance. The resulting increases in flood levels will depend upon the magnitude of these losses.

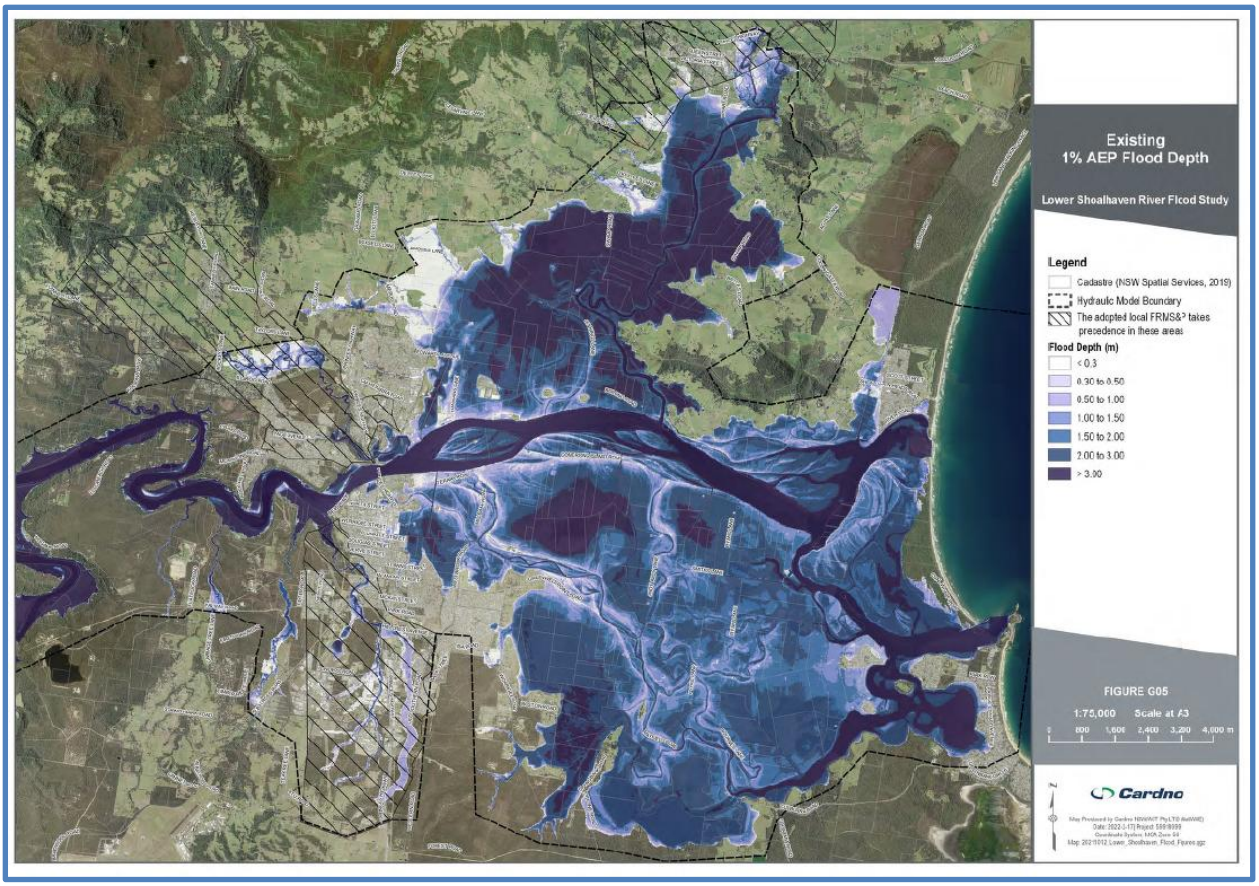


Image 1 - 1% AEP flood extent (Reference 1)

Prior to construction of the Shoalhaven Starches plant at Bomaderry there would have been significant flow through the site and adjoining land during a flood, as there is across any riverbank. Since approximately 1970, the ongoing construction of the plant has reduced the flow path through a large part of Shoalhaven Starches lands. Floodwaters are therefore diverted to other parts of the floodplain and this may increase flood levels on these lands.

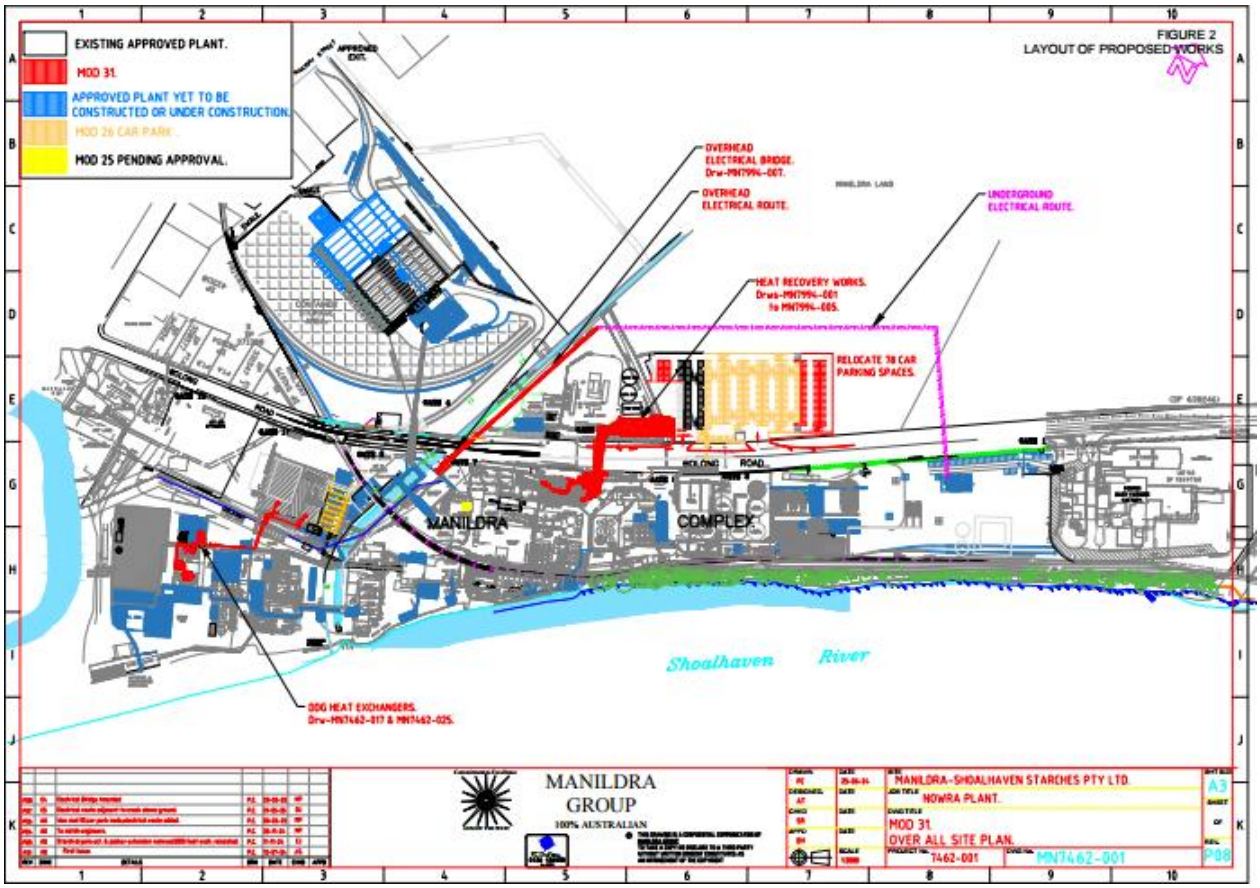


Image 2 - Mod31 Proposed Works

WMAwater Pty Ltd (formerly Webb McKeown & Associates) was commissioned by Shoalhaven Starches to provide this flood compliance report for the proposed Mod31 works (Image 2). A glossary of flood related terms is provided in Appendix A.

1.2. Scope of Work

The flood assessment undertaken included the following:

- Assessment of existing flood conditions at the site.
- Assessment of hydraulic impacts (increases in the 5% AEP, 1% AEP and PMF flood levels) of the proposed Mod31 works. This was considered in comparison to the "July 2025 Existing" floodplain conditions as well as the cumulative impact assessment of the Mod31 proposed development (plus all built and approved but not yet built works by Shoalhaven Starches) since 1990 (1990 Existing).
- Mapping to show where the increases in flood levels have occurred across the floodplain and within individual properties.
- Discussion of results.
- Discussion on possible flood mitigation measures.
- Assess compliance with Shoalhaven City Council's DCP Chapter G9.
- Provide comment on Section 5.21 from Council's LEP.
- Possible approaches for increased management of the flood risk.

- Discuss the possible climate change issues (refer Appendix C), including the August 2024 ARR Version 4.2 climate change update (Reference 4).

1.3. Study Area

Shoalhaven Starches plant is located on the northern bank of the Shoalhaven River approximately 1.5 kilometres downstream of Nowra Bridge. The plant has been on this site since approximately 1970 and has expanded considerably since that time. The proposed developments are located within the Shoalhaven River catchment (Figure 1) which is part of the Shoalhaven City Council LGA.

There is a well-documented history of flooding on the Shoalhaven River since European settlement commenced around 1800. Most notable are the floods of 1860 and 1870 which devastated the then urban and commercial centre at Terara on the southern bank. The flood of April 1870 was probably greater than a 1% AEP event. It inundated the Terara township by over a metre and swept away approximately one third of the village land. Five lives were lost in rural areas along the Shoalhaven River. According to some accounts, the earlier 1860 flood was even more devastating and carried away over 50 buildings. Several lives were lost as well as some 79 acres (32 hectares) of land. Following these floods most of the population moved to high ground in the west and formed the town of Nowra with Terara declining to a small village.

Since 1970 major flooding has occurred in 1974, 1975 and 1978 with smaller events in 1976 and 1988. More recently the lower Shoalhaven River catchment was flooded in June 2013, August 2015, June 2016, February 2020, August 2020, March 2021 and May 2021. The March 1978 flood is the largest flood in the last 50 years reaching 5.3m AHD at Nowra Bridge, the next largest was August 2020 which reached 4.2m AHD at Nowra Bridge with the other post 1988 floods not exceeding 4m AHD at Nowra Bridge.

1.4. History of Floodplain Modelling - Lower Shoalhaven River

Best practice flood modelling typically involves the setting up and calibration of two computer models. A hydrologic model that converts the rainfall to runoff and a hydraulic model that includes inflows from the hydrologic model, as well as ocean boundaries, and determines peak flood levels and velocities based on hydraulic formulae. Both models are calibrated to historical data (where possible), including historical flood levels and river flow gaugings, to ensure that they can replicate the historical events and are then used to determine design flood events. Design events are those that have a known probability of occurrence, such as the 1% AEP event (i.e. the flood has a 1% chance of being equalled or exceeded in any year).

The 1990 Lower Shoalhaven River Flood Study (Reference 3) was commissioned by the then NSW Government Public Works. It established the CELLS hydraulic computer model and determined design flood levels along the river and adjoining floodplain. From approximately the year 2000 to 2013 the same CELLS hydraulic computer model was used by WMAwater, on behalf of Shoalhaven Starches, to evaluate the potential incremental increases in flood level due to

further works by Shoalhaven Starches on the northern floodplain.

In 2013 Shoalhaven Starches commissioned WMAwater to update the Shoalhaven River Flood Study hydraulic modelling to current best practice (Reference 2) and adopted a TUFLOW hydraulic computer model with the hydrologic inputs taken from the 1990 Shoalhaven Council funded Flood Study (Reference 3). This hydraulic model has been used by WMAwater in every subsequent flood impact assessment undertaken for Shoalhaven Starches up until publication of the November 2022 Lower Shoalhaven River Flood Study (Reference 1).

It should be noted that the design flood levels from the 1990 Shoalhaven Council funded Flood Study (Reference 3) are very similar to the results from the Shoalhaven Starches funded 2013 Flood Study (Reference 2) as they both adopt the same hydrologic modelling inputs and were each calibrated to the same historical flood levels.

In February 2023 Shoalhaven Council approved the November 2022 Lower Shoalhaven River Flood Study undertaken by Stantec / Cardno (Reference 1). This study reviewed all available flood information and determined updated best practice design flood levels across the study area. The study compared the November 2022 Lower Shoalhaven River Flood Study (Reference 1) design peak water levels to the previous Shoalhaven City Council funded 1990 Shoalhaven River Flood Study (Reference 3) results and indicated as follows.

- *Water levels are 0.3m to 0.5m lower at Nowra Bridge for the 20% AEP and 5% AEP events.*
- *Water levels are generally significantly lower by 0.9m at Nowra Bridge in the 1% AEP event.*
- *The PMF event produces design peak water levels that are very close (0.05m lower) to the Extreme event peak water levels at Nowra Bridge from the 1990 Flood Study (Reference 3).*

The changes in design flood levels at Nowra and immediately downstream are largely because of (there are other reasons) the following.

- Adoption of updated hydrologic methodologies detailed in the 2019 version of ARR (not including the 2024 climate change advice) (Reference 4) compared to the 1987 version of ARR (Reference 5) that was used in the two prior Flood Studies.
- Changed design ocean water levels.

It is not possible to create a rigorous digital flood map of the results from the 1990 Flood Study (Reference 3) but the comparison of 1% AEP flood levels from the March 2013 Shoalhaven River Flood Study (Reference 2) and the November 2022 Lower Shoalhaven River Flood Study (Reference 1) are shown on Figure 3. This shows the significant lowering of the 1% AEP flood levels at Nowra Bridge, as noted above (note the 1990 and 2013 Flood Studies produce similar peak levels).

The hydrologic and hydraulic models established in the November 2022 Lower Shoalhaven River Flood Study (Reference 1) have been adopted for use in this flood impact assessment. A Flood Certificate dated 10 August 2023 from Shoalhaven City Council is provided in Appendix D.

1.5. Inclusion of August 2024 ARR Version 4.2 Climate Change

In August 2024 Engineers Australia released ARR Version 4.2. The most significant change was inclusion of an updated anthropomorphic climate change approach which provided a methodology to include increases in design rainfall intensities from those adopted in the original version of ARR 2019. Shoalhaven City Council advised that this updated climate change approach should be included in this flood compliance report and this is documented in Appendix C.

The outcome of the above is that design flood contours and depths figures for the 5% AEP, 1% AEP and PMF events, including rainfall increase and sea level increase, are provided in Appendix C. These figures should be used to determine design flood levels for all works that are required to satisfy a given flood planning level.

1.6. The Proposed Works

The proposed Mod31 works are shown in Image 2 and documented on plans in Appendix B. The works indicate several structures, a pipe gantry over Bolong Road, underground and above ground electric cables and extension of the car parking.

The hydraulic modelling has assumed that the structures are “solid” preventing the inflow of floodwaters (apart from the gantry) and will restrict the flow of floodwaters from the Shoalhaven River to the northern floodplain. However, the impact of the proposed works will be mitigated to some extent as the Stage 1 works contain existing structures which already partially restrict flow paths.

2. APPROACH

2.1. Background

Each development on the floodplain has the potential to cause an impact upon flood levels. The impacts of works within the floodplain on hydraulic characteristics are twofold - firstly a loss of temporary floodplain storage volume and secondly a loss / restriction of flow area or conveyance. It is the loss of flow area which produces the greatest impact, as the area of floodplain storage lost due to all works by Shoalhaven Starches since 1990, represents less than 1% of the total available temporary floodplain storage area of the northern floodplain of the Shoalhaven River.

Whilst the individual impacts (construction of a building) may be small the cumulative increases from several developments over time may be significant. Therefore, the proposed Mod31 works (Appendix B) need to be assessed in the context of the total cumulative impacts of all development by Shoalhaven Starches in the northern floodplain as well as the incremental impacts.

For the purposes of this report the nominal starting date for the assessment of cumulative impacts is 1990. This date corresponds to the floodplain development status at the time when the previous design flood level information adopted by Shoalhaven City Council was established in the1990 Lower Shoalhaven River Flood Study (Reference 3).

2.2. Works on the Floodplain Since 1990

It is not possible to itemise all developments on the Shoalhaven River floodplain that have occurred since 1990. Many of them are small (building a house) and have minimal effect on flood levels and there is no accurate record of each development. The most well-known large-scale developments since 1990 in the local area of the Shoalhaven Starches complex are:

- those by or for Shoalhaven Starches,
- those by the prior Dairy Farmers on their site to the east of Shoalhaven Starches,
- the upgrading of the southern river levee from Riverview Road to Terara and
- construction of the new Nowra bridge over the Shoalhaven River.

All these large developments that have occurred since 1990 have had some form of flood impact assessment undertaken for them. For example, it is noted that the 2022 Shoalhaven Flood Study (Reference 1) states "*Transport for NSW (TfNSW) (formerly RMS) prepared an REF for of a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra. A flooding and hydrologic assessment was prepared by Arup Pty Ltd. The assessment concluded that the proposed bridge design and intersection upgrade at Bridge Road and Illaroo Road achieves flood immunity for the up to 1% AEP flood event. However, the proposed design increases peak flood levels at a limited number of properties near Moorhouse Park by about 0.2 m for the 2% and 1% AEP event*".

The adopted 2022 Lower Shoalhaven River Flood Study (Reference 1) is based on the land and building topographies as they existed at the time these were surveyed and collected as part of the study (circa 2019 / 2020). For example, the Shoalhaven Starches large storage ponds on the

northern floodplain are included and Reference 1 notes that the approved design for the new bridge over the Shoalhaven River at Nowra has been included in the modelling. Thus, the design flood levels adopted by Shoalhaven City Council in February 2023, and to be used for future flood related development control purposes (i.e. setting house floor levels), include all the increases in flood levels that have occurred by all developments on floodplain up to approximately 2019 / 2020. Though the topography does not include the approved and yet to be built developments on the floodplain (the modelling can only include what is on the ground at the time, plus the Nowra bridge design) by or for Shoalhaven Starches or the current Mod31 proposed works.

All modelling undertaken in this report assumes the same topography for 1990 and July 2025 conditions outside the lands owned by Shoalhaven Starches. Thus, for example the new bridge over the river at Nowra is included in both the 1990 and July 2025 conditions. This approach therefore only determines the cumulative effects of the works by or for Shoalhaven Starches since 1990 and has not assessed the impacts of works by others on the floodplain.

2.3. Hydraulic Modelling Approach Adopted in this Study

The loss of hydraulic conveyance depends on the extent of the restriction to a flow path caused by the works. Prior to construction of the Shoalhaven Starches plant at Bomaderry there would have been significant flow through the site during a flood, as there is across any riverbank. However, since approximately 1970 the ongoing construction of the plant has already significantly reduced the flow path through the site. This issue has been investigated in WMAwater's October 2000 report titled "*Further Development within the Manildra Starches Plant off Bolong Road, Bomaderry - Hydraulic Assessment*". In summary an agreement was reached that any future development within the intensively built-up area of the plant, as indicated on Image 3 below (taken from that report) would not further decrease the flow path and therefore hydraulic modelling to quantify their hydraulic impacts would not be required.

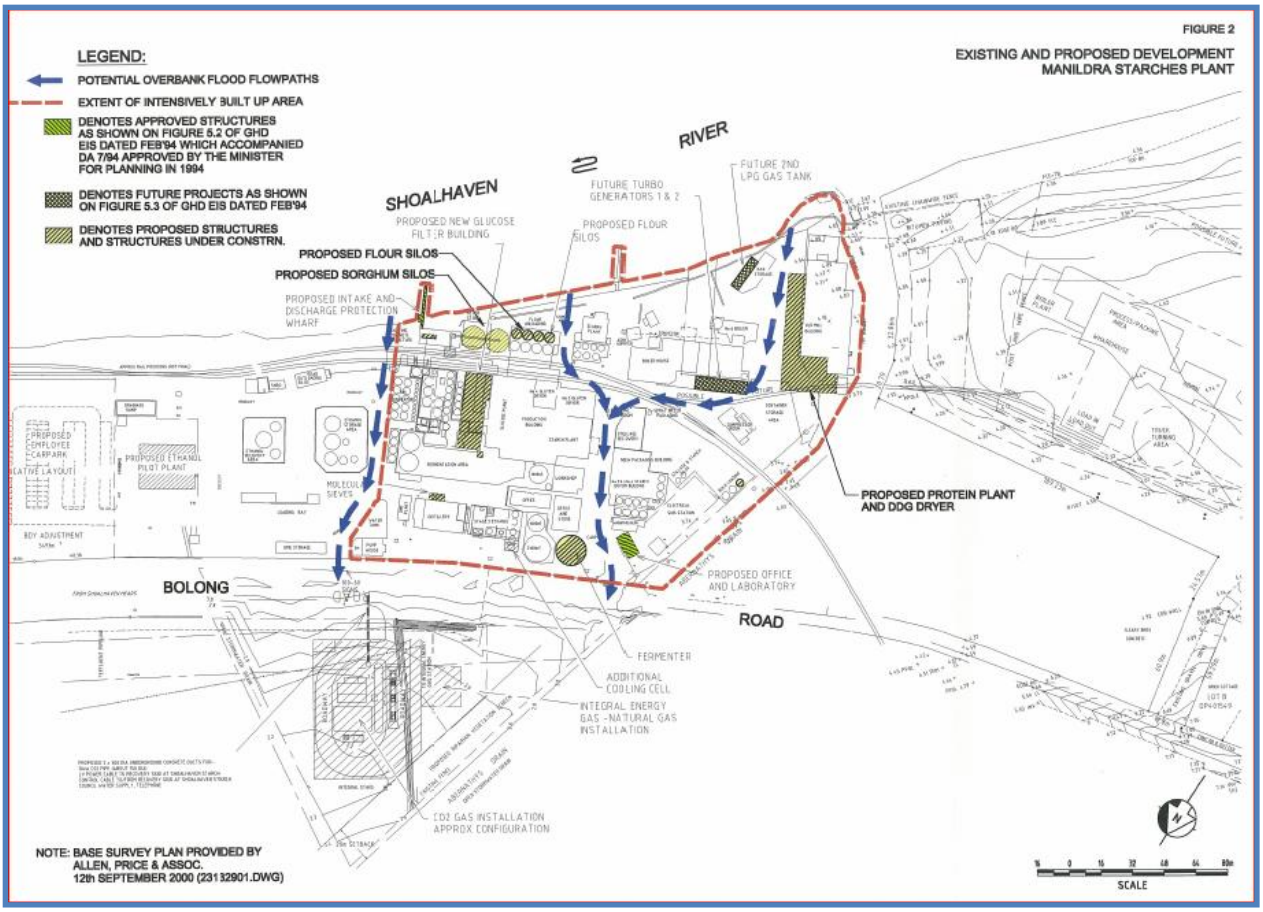


Image 3 - Agreed Extent of Intensively Built-up Area

Thus, in simple terms further works within this intensively built-up area do not require hydraulic modelling area but if located outside the intensively built-up area they do require hydraulic modelling.

The currently proposed Mod31 works are simulated by adjustments to the TUFLOW computer hydraulic model. It should be noted that the modelling of structures on the floodplain can be undertaken using two broad approaches. In simple terms these are:

- by assuming the ground levels of the grid cells covering the footprint of the structure are raised and thus floodwaters are prevented from entering those grid cells and the entire temporary floodplain storage contained within the subject grid cells is lost.
- by restricting the flow path across the grid cells by raising the friction factor (termed the Manning's "n" value). Using this approach the temporary floodplain storage contained within the subject grid cells is maintained.

There are advantages and disadvantages of each of the above approaches and the adopted 2022 Lower Shoalhaven River Flood Study (Reference 1) used both approaches but modelled the Shoalhaven Starches plant by raising the friction factor. The approach adopted in this assessment also uses both approaches but with greater emphasis on identifying each structure and "blocking" the subject cells from the grid. In this way individual structures can be more accurately added or subtracted from the grid than using the friction factor approach and the temporary loss of floodplain storage and flow conveyance are more accurately accounted for in the modelling.

Hydraulic computer modelling, whilst best practice, has many limitations and it must always be noted that a model is only a representation of reality and cannot accurately simulate every nuance of a development. The use of TUFLOW with a 15m by 15m grid as adopted in the 2022 Lower Shoalhaven River Flood Study (Reference 1) enables some structures to be modelled very accurately by "filling" their exact dimensions (e.g. a large building or a storage pond). However, with smaller structures or those with considerable openings or similar (pipe work) this is not always possible and approximations are required.

2.4. Modelling Scenarios

The hydraulic modelling assumes the same topography for 1990 and July 2025 conditions (taken from Reference 1) outside the lands owned by Shoalhaven Starches. However, within the Shoalhaven Starches lands the Reference 1 model has been revised to create the following three model scenarios.

- The works as present in 1990 (termed the 1990 Existing model).
- Those approved (built and not yet built) as of July 2025 (termed the July 2025 Existing model).
- Those approved (built and not yet built) as of July 2025 and including the Mod31 proposed development application (termed the Mod31 Design or Proposed model).

Thus, for example, the new bridge over the Shoalhaven River at Nowra is included in all three scenarios. This approach therefore only determines the cumulative effects of the works by or for Shoalhaven Starches since 1990 and has not assessed the impacts of other works on the floodplain.

3. FLOOD IMPACT ASSESSMENT

3.1. Description of Scenarios

The impacts of the proposed development on flooding have been evaluated for the following two scenarios.

- Comparison of the Proposed with the 1990 Existing model. This provides the cumulative effects of the Mod31 proposed development plus all approved (built and not yet built) works by or for Shoalhaven Starches since 1990.
- Comparison of the Proposed with the July 2025 Existing model. This determines the incremental impact of the proposed Mod31 works.

Three design flood events have been modelled, the 5% AEP, 1% AEP and PMF events. More frequent events, smaller than the 5% AEP, have not been modelled as the northern riverbank of the Shoalhaven River is not overtopped to any significant extent until an event larger than the 5% AEP. Thus, in these small more frequent events (where there is no topping of the northern overbank) there would be nil impact on peak flood levels of the proposed works. According to available records, the last event to overtop the northern overbank was the March 1978 flood. It should be noted that flooding of the northern floodplain has occurred several times since 1978 but this has been due to the rain falling directly on the floodplain, as well as from runoff from the upstream catchments ponding in low lying areas.

Larger events than the 1% AEP will occur, but these events are obviously extremely rare and are not used for flood related planning determinations by Councils, except when their failure has potential catastrophic consequences (such as dam failure).

The comparison between the scenarios is termed a flood impact map with the different colours reflecting the change in peak water levels. In summary the green / blue tones reflect a decrease in flood level whilst the yellow / orange / brown / red tones reflect an increase in peak level.

3.2. Results

3.2.1. Description of Figures

The change in peak water level for the three design events are shown on Figure 4 to Figure 15. For each of the three design events four figures are provided. These are an Entire Floodplain and a Local Area figure for the above two comparisons (Proposed v 1990 Existing and Proposed v July 2025 Existing). These figures show areas where peak flood levels have increased and decreased because of the proposed Mod31 works.

Figure 16 (Entire Floodplain) and Figure 17 (Local Area) indicate the land use zones and land owned by Shoalhaven Starches (Manildra). To identify individual properties that have been affected by an increase in flood level, Figure 18 to Figure 23 have been provided. These show Entire Floodplain and Local Area figures for each of the three design events for the comparison

of the Proposed with the 1990 Existing. A description of the information provided on these figures is as follow.

- Only properties where there is an increase in flood level on any part of the property of greater than 0.01m are identified.
- The land use of each property is identified by the following symbols.

- The colour of each property identifies the maximum increase in flood level within any part of the property. As this is the maximum increase it may be that other parts of the property are not affected by an increase in level or may not be inundated at all in the design event. The actual extent of inundation or increase in level on a property can be determined from Figure 4 to Figure 15.

3.2.2. Interpretation of Results

In summary the maximum cumulative increases in flood level since 1990 are shown below. However, in all three events most areas only experience a maximum increase of up to 0.1m.

- 5% AEP – up to 0.1m (Figure 4),
- 1% AEP – up to 0.2m (Figure 8),
- PMF – up to 0.3m (Figure 12).

The maximum incremental increases in flood level since July 2025 are shown below. However, the increases are predominantly within land owned by Shoalhaven Starches.

- 5% AEP – less than 0.01m (Figure 6),
- 1% AEP – less than 0.1m (Figure 10),
- PMF – less than 0.1m (Figure 14).

Any increase in flood level may result in the following.

- Increase in lateral extent of inundation.
- Increase in duration of inundation.
- Increase in risk to life during a flood.
- Increase in magnitude of flood damages.

Increase in lateral extent of inundation. The extent of the lateral increase in inundation will depend on the slope of the land at the floodplain extent and the magnitude of the increase in flood level. As the maximum cumulative increase in flood level since 1990 for all three design events on a property (Figure 19, Figure 21, and Figure 23) is less than 0.3m and largely below 0.1m, the lateral increase in flood extent is unlikely to be of significance.

Increase in duration of inundation. In the 1% AEP event the duration of overbank inundation on the northern floodplain may be two days or more and any increase in duration caused by the works will be minimal unless the works significantly affect the drainage paths by which the floodwaters exit to the Shoalhaven River. If this occurs, works should be undertaken to clear these drainage paths.

Increase in risk to life during a flood. The relatively small magnitude of the increase in flood levels and consequent increase in depths of inundation is unlikely to contribute to any significant increase in risk to life or significantly affect any flood evacuation routes.

Increase in magnitude of flood damages. The damages caused by flooding can be separated into three broad categories: economic, social and environmental. Economic impacts are quantified based on inundation of property and buildings to both private and public authorities (clean-up / renewal of flood affected assets, assistance to residents in clean-up, disaster relief payments, etc). Social impacts are considered through intangible damages associated with property inundation as well as inundation of roads causing traffic disruption. Environmental impacts of flooding are important to consider given the potential for chemicals or similar to enter flood waters.

The cost of damages and the degree of disruption to the community caused by flooding depends upon many factors including the following.

- The magnitude (depth, velocity, and duration) of the flood.
- Land use and susceptibility to damages.
- Awareness of the community to flooding.
- Effective warning time.
- The availability of an evacuation plan or damage minimisation program.
- Physical factors such as failure of services (sewerage), flood borne debris, sedimentation.
- The types of assets and infrastructure affected.

The estimation of flood damages tends to focus on the physical impact of damages on the human environment but there is also a need to consider the ecological cost and benefits associated with flooding. Flood damages can be defined as being tangible or intangible. Tangible damages are those for which a monetary value can be easily assigned, while intangible damages are those to which a monetary value cannot easily be attributed. The categories of flood damages are shown in Table 1.

Tangible flood damages to houses are comprised of two basic categories; direct and indirect damages (refer Table 1). Direct damages are caused by floodwaters wetting goods, structures and possessions thereby damaging them and resulting in either costs to replace or repair or in a reduction to their value. Direct damages are further classified as either internal (damage to the contents of a building including equipment and furniture), structural (referring to the structural fabric of a building such as foundations, walls, floors, windows) or external (damage to all items outside the building such as cars and equipment). Indirect damages are the additional financial

losses caused by the flood, for example the cost of temporary accommodation, loss of wages by employees, etc.

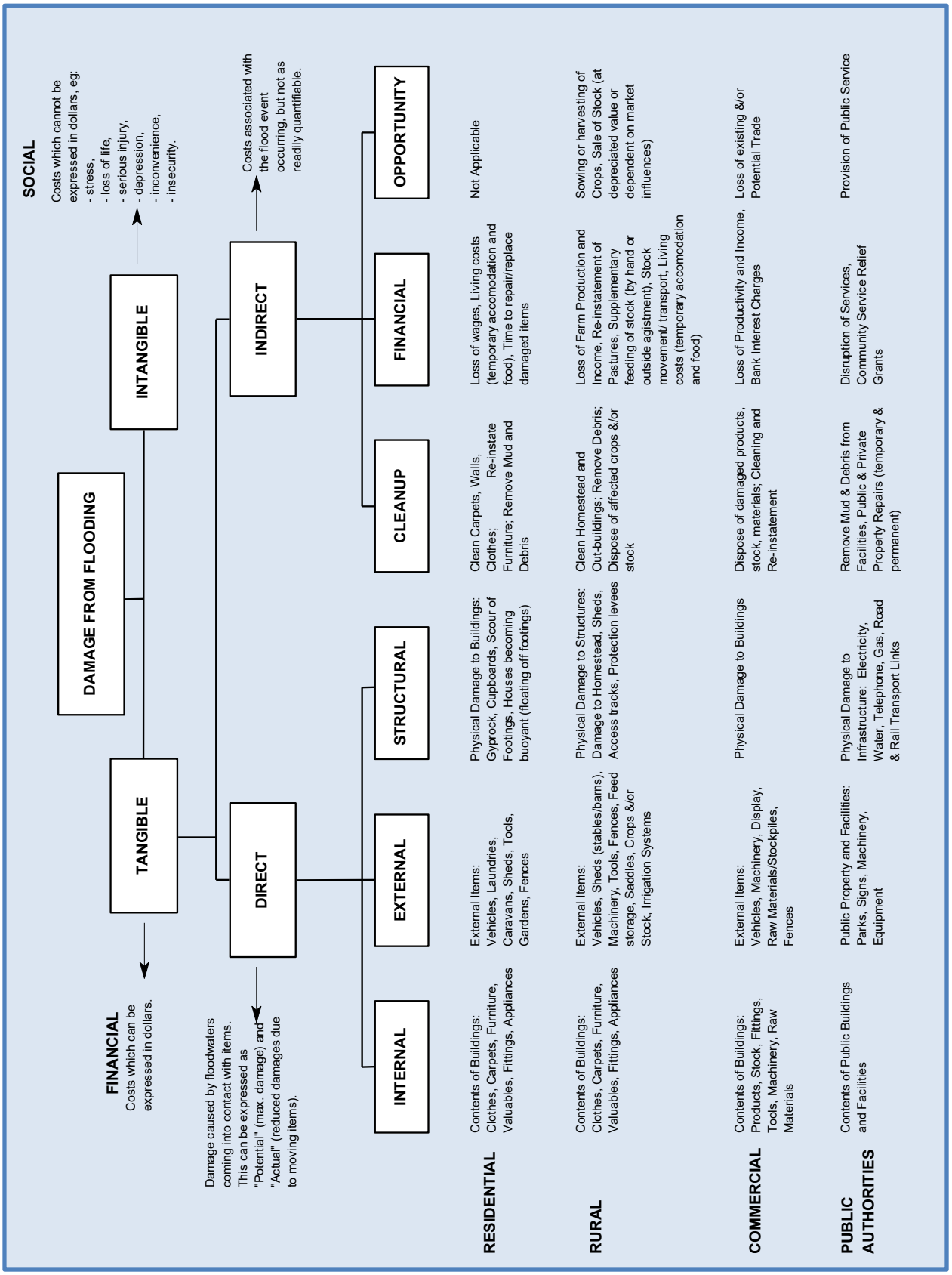
Public sector (non-building) damages include recreational/tourist facilities; water and sewerage supply; gas supply; telephone supply; electricity supply including transmission poles/lines, sub-stations, and underground cables; rail; roads and bridges including traffic lights/signs; and costs to employ emergency services and assist in cleaning up. Public sector damages can contribute a significant proportion to total flood costs but are difficult to accurately calculate or predict.

Costs to Councils from flooding typically comprise.

- Clean-up costs.
- Erosion and siltation.
- Drain cleanout and maintenance.
- Removing fallen trees.
- Inundation of Council buildings.
- Direct damage to roads, bridges, and culverts.
- Removing vehicles washed away.
- Assistance to ratepayers.
- Increases in insurance premiums.
- Closures of streets.
- Loss of working life of road pavements.
- Operational costs following and during flood events.

Given the variability of flooding and property and content values a rigorous assessment of the $value of the increase in tangible damages, due to the relatively small increase in peak flood level, cannot be accurately quantified.

Table 1: Categories of Flood Damages



The intangible damages associated with flooding, by their nature, are inherently more difficult to estimate in monetary terms. Additional costs/damages are incurred by residents affected by flooding, such as stress, risk/loss to life, injury, loss of sentimental items, etc. It is not possible to put a monetary value on the intangible damages, as they are likely to vary dramatically between each flood (from a negligible amount to several hundred times greater than the tangible damages), and depend on a range of factors such as the size of flood, the individuals affected, and community preparedness. However, it is still important that the consideration of intangible damages is included when assessing the impacts of flooding on a community.

The key points regarding the environmental impacts of flooding are:

- Floodwaters will carry large quantities of suspended sediment and other pollutants, primarily derived from the catchment.
- Floodwaters may also convey hazardous chemicals (oils, paints, etc) that might be stored on flood-affected properties.

In conclusion, all types of damages will generally increase with an increase in flood depth, however the magnitude of the increased flood damages will depend on what structure / land use is affected and the magnitude of the increase in peak level. As the cumulative increase in the peak level resulting from continued development by or for Shoalhaven Starches since 1990 is generally small (maximum of 0.3m and generally only 0.1m) the consequent increase in flood damages at each property is unlikely to be significant. However, in total the damages will be large as many properties are affected. As the incremental increase in flood level is much smaller than the cumulative increase since 1990, the consequent increase in flood damages will be very much smaller.

4. POSSIBLE MITIGATION MEASURES

4.1. Overview

As indicated in Section 3 and accompanying figures, the construction of buildings and associated plant on Shoalhaven Starches land since 1990, has increased flood levels upstream of the site, through constriction of the flow paths and loss of temporary floodplain storage. Increases in flood level will occur with all new development on the floodplain. As noted in Section 2.2 increases will result from construction of the new bridge at Nowra as will have occurred from previous levee construction at Riverview Road and along to Terara.

The Shoalhaven Starches plant was located on its present site to be on a train line and with ready access to water. Over the years it has purchased land within the northern floodplain to enable continued development of the plant in a sustainable and environmentally sensitive manner.

Shoalhaven Starches take all viable steps to minimise increases in flood level through ongoing development but it is impossible to negate the adverse flood effects of construction on the floodplain. For example, some parts of the plant can be constructed on piers to allow the free flow of floodwaters beneath, but this is not possible for all structures. Plant can also be located in areas to minimise impacts such as in the “shadow” of existing plant. It is impossible to construct sedimentation ponds that are required for the plant to operate, without reducing the temporary floodplain storage capacity. However, their impacts are minimised by constructing them in the middle of a very large floodplain.

In summary no mitigation works are possible to negate the impacts of development on the floodplain by or for Shoalhaven Starches. However, management measures to address the impact of flooding on the safety of workers and damage to the plant are addressed in the Shoalhaven Starches Flood Plan. Also, at the investigation stage for any proposed works, consideration is given to their potential flood impacts. An example is that the proposed works have been designed (as far as possible) to reduce the risk of damage during a flood as the Mod31 works includes provisions for protecting electrical installations (by elevating some and burying others).

4.2. Discussion of Possible Flood Risk Management Measures

There are three broad categories of flood risk management measures as shown in Table 2. Flood modification changes the nature of flooding, property modification are changes to the property and response modification change the response of people in a flood.

Table 2: Categories of Flood Risk Management Measures

Flood Modification	Property Modification	Response Modification
Levees	Land zoning	Flood warning
Temporary defences	Voluntary purchase	Evacuation planning
Channel construction	Building & development controls	Evacuation access
Channel modification	Flood proofing	Flood plan / recovery plan
Major structure modification	House raising	Community awareness
Drainage network modification	Flood access	
Drainage maintenance		
Retarding basins		

There are no viable flood risk modification measures which can negate or even reduce the increase in flood levels to surrounding properties caused by or for Shoalhaven Starches. Of the property modification measures, the only possible viable measures are flood proofing or house raising. For many buildings these measures cannot be undertaken due to the construction type of the building (realistically it is not possible to raise a brick building). However, it is unlikely that landowners would consider that the relatively small increase in flood level would justify the disruption and inconvenience required to implement these measures.

The only viable management measures to reduce the impact of the works by or for Shoalhaven Starches are response modification measures. These might include the following.

- Improve / update the existing BoM or other local flood warning system.
- Improve / update the evacuation planning strategy.
- It is unlikely that improving the actual evacuation access routes are possible but installation of flood depth markers or similar would assist in informing evacuees of the risk in driving through floodwaters.
- Provision of advice to landowners (by a flier or similar provided by the SES or Council) of the need to prepare a flood evacuation plan would potentially mean reduced risk and / or damages in an event. This measure would have to be repeated at regular intervals.
- One of the most beneficial and practical means of reducing flood damages to existing buildings (residential, commercial and industrial) is to improve the awareness and preparedness of the occupants. There are several ways of undertaking such a scheme and these are outlined in Table 3 and most require involvement by Council and / or the SES. Funding a scheme would assist in improving the community's flood awareness and consequently reducing flood damages. Some Councils in NSW have undertaken flood awareness flood awareness workshops with landowners.

Table 3: Flood Awareness Methods

Method	Comment
Letter/pamphlet from Council	These may be sent (annually or biannually) with the rate notice or separately. A Council database of flood liable properties/addresses makes this a relatively inexpensive measure which can be effective if residents take the time to absorb and apply the suggestions. The pamphlet can inform residents of ongoing implementation of the flood studies or similar on Council's web site, changes to flood levels, climate change or any other relevant information.
Council website	Council should continue to update and expand their website to provide both technical information on flood levels as well as qualitative information on how residents can make themselves flood aware. This would provide an excellent source of knowledge on flooding within the study area (and elsewhere in the LGA) as well as on issues such as climate change.
Community Working Group	Council could initiate a Community Flood Working Group framework (undertaken in other catchments elsewhere) and this would provide a valuable two-way conduit between the local residents and Council.
School project or local historical society	This provides an excellent means of informing the younger generation about flooding, waterway management and climate change. It may involve talks from various authorities and can be combined with other related topics such as water quality.
Displays at key locations or similar	This is an inexpensive way of informing the community and may be combined with related displays.
Historical flood markers and flood depth markers	Signs or marks can be prominently displayed on telegraph poles or such like to indicate the level reached in previous floods. Depth indicators advise of potential hazards. These are inexpensive and effective but in some flood communities are not well accepted as it is considered that they may affect their property values.
Articles in local newspapers	Ongoing articles in the newspapers will ensure that the flood and climate change issues are not forgotten. Historical features and remembrance of the anniversary of past events are interesting for residents.
Collection of peak water level data from future floods	Collection of data (photographs) assists in reinforcing to the residents that Council is aware of the problem and ensures that the design flood levels are as accurate as possible. This might also include establishment of peak water level marker poles and which house floors are inundated.
Types of information available	A recurring problem in many flood liable areas is that new owners consider they were not adequately advised that their property was flood affected on the 10.7 Certificate during the purchase process. Council may wish to advise interested parties, when they inquire during the property purchase process, regarding flood information currently available, how it can be obtained and the cost. This information also needs to be provided to all tenants and visitors who may rent for a period. Some Councils have conducted "briefing" sessions with real estate agents and conveyancers.
Establishment of a flood affectation effects database	A database would provide information on (say) which houses require evacuation, which public structures will be affected (e.g., telephone or power cuts). This database should be updated following each flood with input from the community.
Flood preparedness program	Providing information to the community regarding flooding helps to inform it of the problems and associated implications. However, it does not necessarily adequately prepare people to react effectively to the problem. A Flood Preparedness Program would ensure that the community is adequately prepared. The SES would take a lead role in this.
Develop approaches to foster community ownership of the problem	Flood damages in future events can be minimised if the community is aware of the problem and takes steps to find solutions. The development of approaches that promote community ownership should therefore be encouraged. For example, residents should be advised that they have a responsibility to advise Council if they see a problem such as debris blockage or such like. This process can be linked to water quality or other water related issues including estuary management. The specific approach can only be developed in consultation with the community.

5. COMPLIANCE WITH SHOALHAVEN CITY COUNCIL'S CHAPTER G9: DEVELOPMENT ON FLOOD PRONE LAND (DCP2014) FOR THE PROPOSED WORKS

5.1. Objectives of DCP

The objectives of the DCP are to:

I. To provide criteria for the assessment of development applications.
II. Build upon the SLEP 2014 by providing detailed objectives, and controls for development.
III. Foster ecologically sustainable development.
IV. Ensure development responds to the qualities of the subject site and to the character of the surrounding neighbourhood.
V. Encourage innovative housing, commercial and industrial design.
VI. Maintain and enhance the natural, built and cultural significance of heritage items.
VII. Manage the risks to new development from natural hazards including coastal, flood and bushfire risks.

5.2. Compliance

The following sections describe compliance with Chapter G9: Development on Flood Prone Land (DCP2014 Amended 14th December 2018) for the proposed works as described in Appendix B. As the works will not involve subdivision of lands, performance criteria for subdivision of lands have not been addressed.

5.3. Performance Criteria - General (Section 5.1 of DCP)

PERFORMANCE CRITERIA	RESPONSE
P1 Development or work on flood prone land will meet the following:	
The development will not increase the risk to life or safety of persons during a flood event on the development site and adjoining land.	The works are such that the construction will require approximately 60 additional temporary contractors and one additional full-time worker. Thus, there will not be a significant increase in the permanent workforce on the site or provide an additional threat to the safety of any worker during a flood.
The development or work will not unduly restrict the flow behavior of floodwaters.	Refer Section 3.
The development or work will not unduly increase the level or flow of floodwaters or stormwater runoff on land in the vicinity.	Refer Section 3. As the majority of local catchment runoff is entirely contained within land owned by Shoalhaven Starches, so also are any affectations.

PERFORMANCE CRITERIA	RESPONSE
The development or work will not exacerbate the adverse consequences of floodwaters flowing on the land with regard to erosion, siltation and destruction of vegetation.	The works are largely within existing built-up industrial land clear of vegetation. All runoff under existing and future conditions will reach the ground in nearly identical locations, thus the works will have no significant impact on erosion or siltation.
The structural characteristics of any building or work that are the subject of the application are capable of withstanding flooding in accordance with the requirements of the Council.	**A separate structural report will be provided.**
The development will not become unsafe during floods or result in moving debris that potentially threatens the safety of people or the integrity of structures.	**A separate structural report will be provided.**
Potential damage due to inundation of proposed buildings and structures is minimised.	Structural failure of the works during a flood will potentially increase the rate of inflow of floodwaters from the Shoalhaven River to the northern floodplain. However, the increased rate of inflow is unlikely to cause damage to surrounding buildings or structures outside Shoalhaven Starches lands.
The development will not obstruct escape routes for both people and stock in the event of a flood.	The works will not occupy escape routes or cause workers to become trapped.
The development will not unduly increase dependency on emergency services.	The works are such that their construction will not significantly increase the number of workers on the site or provide an additional threat to the safety of any worker during a flood.
Interaction of flooding from all possible sources has been taken into account in assessing the proposed development against risks to life and property resulting from any adverse hydraulic impacts.	Refer Section 3.
The development will not adversely affect the integrity of floodplains and floodways, including riparian vegetation, fluvial geomorphologic environmental processes and water quality.	The works will be constructed on land designated as part high hazard floodway in the 1% AEP event. The site is industrial land with nil existing vegetation (apart from grass) and is beyond the influence of normal fluvial geomorphic processes. The works will have no impact on water quality or the integrity of the floodplain and floodways.

5.4. Performance Criteria - General (Section 5.2 of DCP)

PERFORMANCE CRITERIA	RESPONSE
P2 Filling or excavation on flood prone land will meet the following:	
High hazard floodway areas are kept free of fill and/or obstructions.	Part of the works may be in a high hazard floodway as that is the only possible location for the works within the existing plant layout.
The proposed fill or excavation will not unduly restrict the flow behaviour of floodwaters.	Refer Section 3.
The proposed fill or excavation will not unduly increase the level or flow of floodwaters or stormwater runoff on land in the vicinity, including adjoining land.	Refer Section 3.
The proposed fill or excavation will not exacerbate erosion, siltation and destruction of vegetation caused by floodwaters flowing on the land.	The works are largely within existing built-up industrial land clear of vegetation. The works will not exacerbate erosion, siltation and destruction of vegetation caused by floodwaters flowing on the land.
The proposed fill or excavation will not be carried out on flood prone land if sufficient flood free area is available for development within the subject property.	The proposed locations of the works are the only possible locations within the existing plant layout.
The proposed excavation does not create new habitable rooms, non-habitable storage areas or carparks with floor levels below the existing ground level.	No excavation will be undertaken apart for creation of foundations or similar. There are no proposed habitable rooms. All non-habitable and the storage of hazardous or similar material which will be flood proofed to the 1% AEP flood level (including climate change) or above. Any floor levels will be set as high as practical for safe access in an industrial plant.

5.5. Site Specific Flood Related Development Controls – Lower Shoalhaven River (Section 5.4.4 of DCP)

Specific Controls	RESPONSE
INDUSTRIAL DEVELOPMENT AT BOMADERRY	
The potential hydraulic effects of any future construction works shall be minimised through locating them in the "shadow" of other buildings or away from the main flow paths where possible.	Refer responses in Section 5.3 and 5.4.

Specific Controls	RESPONSE
Any proposed works must be designed and located to minimise any increase in flood damages to other users/occupiers of the floodplain.	Refer responses in Section 5.3 and 5.4.
A full hydraulic assessment will be required prior to any future development or redevelopment to assess the potential impacts upon flooding.	As undertaken in this Report and refer to responses in Section 5.3 and 5.4.

6. ADDITIONAL ISSUES

6.1. Response to Clause 5.21 of Council's LEP

(1) The objectives of this clause are as follows—

(a) to minimise the flood risk to life and property associated with the use of land, Every reasonable endeavour has been made by Shoalhaven Starches to achieve these goals. However, the Shoalhaven Starches plant has been at this site for over 50 years and it is not viable to relocate it to a flood free site. Expansion must occur to be economic and meet the demands of consumers. The works are such that the construction will require approximately 60 additional temporary contractors and one additional full-time worker. Thus, there will not be a significant increase in the permanent workforce on the site or provide an additional threat to the safety of any worker during a flood. Possible flood risk management measures are addressed in Section 4.2 of this Report.

(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change, As noted above the incremental hydraulic impacts associated with this Mod31 works are within Council's tolerable range of +/- 50mm. The proposal involves a modification to an existing industrial complex established on the subject land prior to flood planning provisions and understanding of flood function and behaviour. This proposal involves modifications and installation of additional plant within this existing established industrial complex. Climate change has been considered in Section 3 a) below and in Section 6.2 and Appendix C.

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment, Refer Section 3 of this Report. As most of the surrounding floodplain is land owned by Shoalhaven Starches, so also are the affectations. Possible flood risk management measures are addressed in Section 4.2 of this Report.

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood. Every reasonable endeavour has been made by Shoalhaven Starches to achieve these goals and already has a comprehensive flood evacuation plan. This will be updated to include the proposed works but the proposed works do not reduce the ability of workers to safely leave the site. The works are such that the construction will require approximately 60 additional temporary contractors and one additional full-time worker. Thus, there will not be a significant increase in the permanent workforce on the site or provide an additional threat to the safety of any worker during a flood. The works will not occupy escape routes or cause workers to become trapped.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—

(a) is compatible with the flood function and behaviour on the land, Refer response in Point 1. b) above.

(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 This has been demonstrated by the modelling results. Refer to Section 3 of this Report.

(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, As noted above in Point 1 a) and d) above.

(d) incorporates appropriate measures to manage risk to life in the event of a flood, As noted above in Point 1 d).

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses. The works are largely within existing built-up industrial land clear of vegetation and clear of riverbanks and watercourses. The works will thus not exacerbate erosion, siltation and destruction of vegetation caused by floodwaters flowing on the land.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—

(a) the impact of the development on projected changes to flood behaviour as a result of climate change, Climate change will potentially affect the Shoalhaven Starches plant in two ways. Firstly, a rise in the ocean will potentially raise flood levels at the site. This can largely be ignored as the site is some 15 kms from the ocean, thus the flood levels at the site are dominated by the flow in the Shoalhaven River rather than the ocean level. Secondly, a rise in rainfall intensity or duration in a design event due to climate change will impact the site by raising design flood levels.

Anthropomorphic rainfall increase climate change has been included in the hydrologic and hydraulic modelling for the design flood contours and depth figures in Appendix C.

In summary, climate change rainfall increases will change the absolute design flood levels for a design scenario but generally not the relative flood level increases (i.e existing v design scenario).

Climate change was considered in the November 2022 Lower Shoalhaven River Flood Study (Reference 1) providing the following summary.

The study also assessed the potential impacts of both Climate Change induced rainfall increases and sea level rise using current recommended ARR2019 values based on global climate modelling. Increased rainfall due to climate change has the biggest impact in the Shoalhaven River upstream of Nowra Bridge due to the increased flows and the incised valley. The increased flow dominates changes in expected flood levels to approximately Terara, with sea level rise having impacts in the Shoalhaven River downstream of Terara and in the Crookhaven River/Crookhaven Creek floodplain. Only minor increases in flood level are observed in the Broughton Creek floodplain.

For the 1% AEP, with rainfall increases of 16.3% due to Climate Change, associated increased flows may result in increases in flood levels in the Shoalhaven River upstream of Nowra by up to

almost 1.4m at Grassy Gully and 1.1m at Gradys Caravan Park reducing to 200mm at Nowra Bridge. Increases in the lower floodplain areas are generally less than 150mm for all scenarios up to 7.6% rainfall increase with increases typically 150 – 250 mm for the 16.3% (2090 RCP 8.5) rainfall increase.

In combination with Sea Level Rise a further increase in water levels may be expected around low-lying foreshore areas and up to 400mm total water level increases near the Shoalhaven and Crookhaven River entrances.

(b) the intended design and scale of buildings resulting from the development, The proposed works are as far as possible located to minimise the affectation on flood levels but as noted above, the existing plant cannot be moved.

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood, As noted above in Point 1 a) and d).

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion. Coastal erosion is not relevant for this site being 15 kms upstream. The proposal involves a modification to an existing industrial complex established on the subject land prior to flood planning provisions and understanding of flood function and behaviour. Consideration was given to modifying the design and relocation of the proposed buildings and plant / works during preparation of the proposed works to minimise potential hydraulic impacts, as noted in 3 b) above. Where practical this was undertaken. Possible flood risk management measures are addressed in Section 4.2.

6.2. Response to Climate Change Issues

Climate change has the potential to impact flooding through two main actions, sea level rise and rainfall increase. Sea level rise will have no significant impact on flooding at the Shoalhaven Starches site (assuming the current typical Year 2100 sea level rise scenario), as the site is some 15 kms upstream of the Pacific Ocean at Shoalhaven Heads.

Potential rainfall increase is less well understood. If it is assumed that the rainfall increase climate change will result in increased runoff in a flood event, this will most likely result in a greater frequency of flooding and an increase in the design flood levels. For example, the current 1% AEP flood level might increase, and the subsequent climate change 1% AEP level may reach the level of the current 0.5% AEP or 0.2% AEP flood level. The increase in frequency of flooding will potentially affect production at the plant as it will be closed more frequently. Increased flood levels will also increase flood damages at the site in each design flood event.

Climate change cannot be resolved on a local scale, it is a world wide phenomenon and as such must be addressed by each country through development controls.

7. REFERENCES

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Figures

FIGURE 1
SHOALHAVEN RIVER STUDY AREA

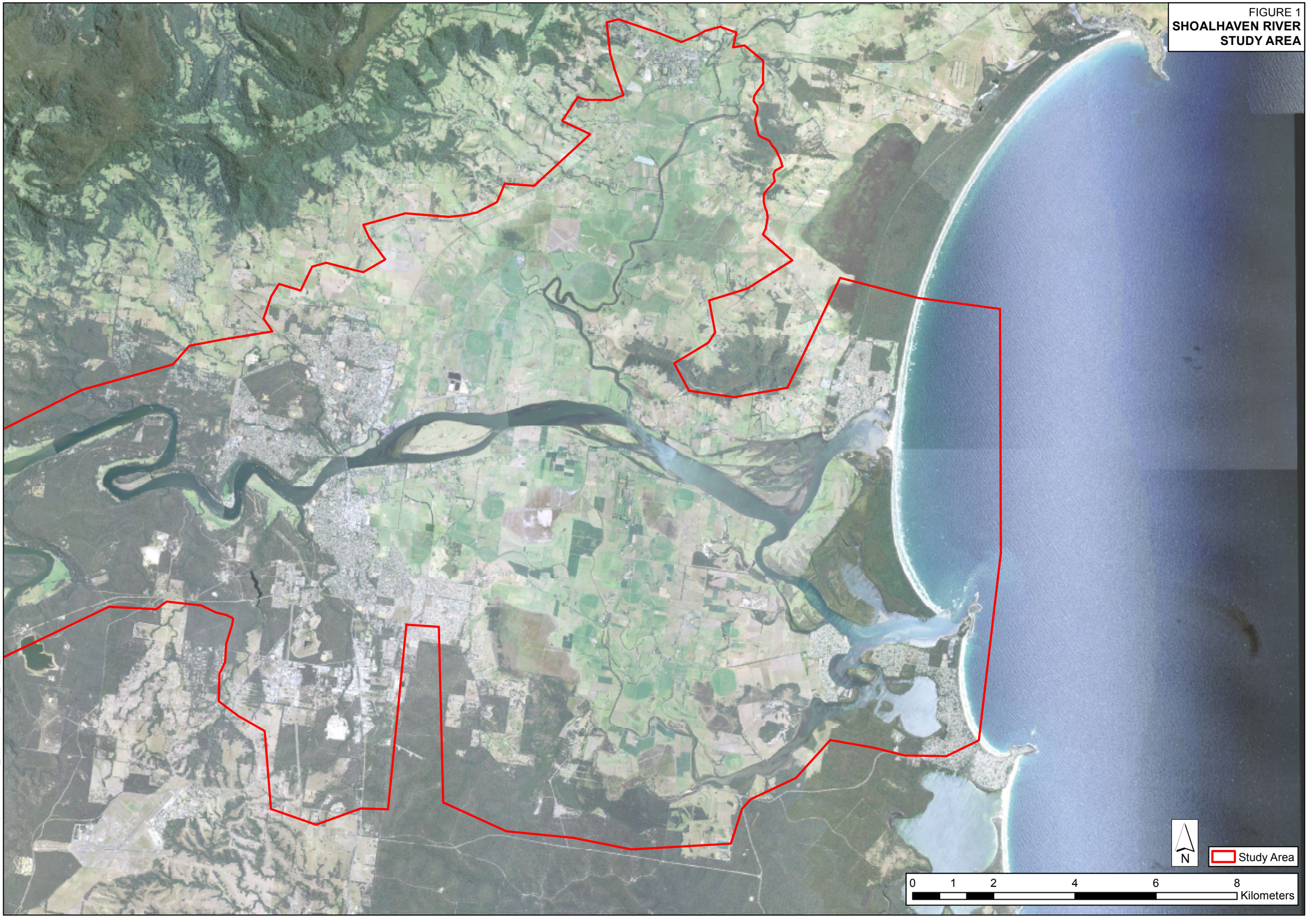

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FIGURE 2
LAYOUT OF PROPOSED WORKS

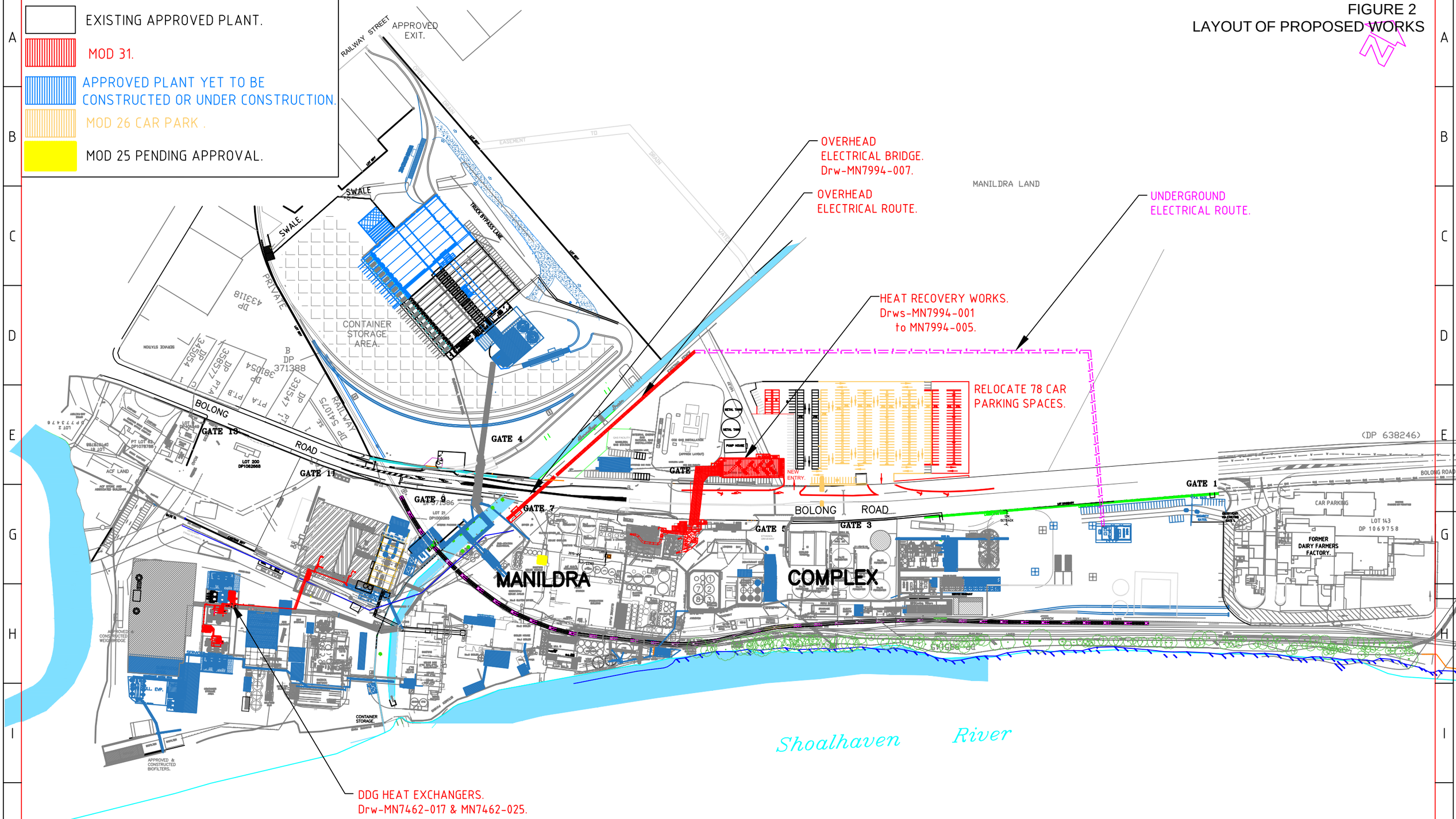
EXISTING APPROVED PLANT.

MOD 31.

APPROVED PLANT YET TO BE CONSTRUCTED OR UNDER CONSTRUCTION.

MOD 26 CAR PARK .

MOD 25 PENDING APPROVAL.



REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P08	E4	Electrical Bridge Amended	P.C.	23-05-25	MP	
P07	E5	Electrical route adjacent to creek above ground.	P.C.	21-05-25	DJ	
P06	All	Was mod 30,car park mods,electrical route added.	P.C.	08-05-25	MP	
P04	All	To match engineers.	P.C.	25-11-24	MP	
P03	All	Starch dryers ect. & packer extension removed.DDG heat exch. relocated.	P.C.	11-11-24	CJ	
P01	All	First issue.	P.C.	12-07-24	J.S.	

Commitment to Excellence
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MANILDRA GROUP
100% AUSTRALIAN

PC Drafting
0439 436508

DRAWN PC	DATE 25-06-24	SITE MANILDRA-SHOALHAVEN STARCHES PTY LTD.	SHT SIZE A3
DESIGNED. AT	DATE	JOB TITLE NOWRA PLANT.	SHEET
CHKD SR	DATE	DWG TITLE MOD 31. OVER ALL SITE PLAN.	OF
APPD BH	DATE		REV. P08
	SCALE 1:3000	PROJECT No. 7462-001	DWG No. MN7462-001

FIGURE 3
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
REVISED EXISTING CASE
NOVEMBER 2022 FLOOD STUDY V MARCH 2013 FLOOD STUDY
1% AEP EVENT

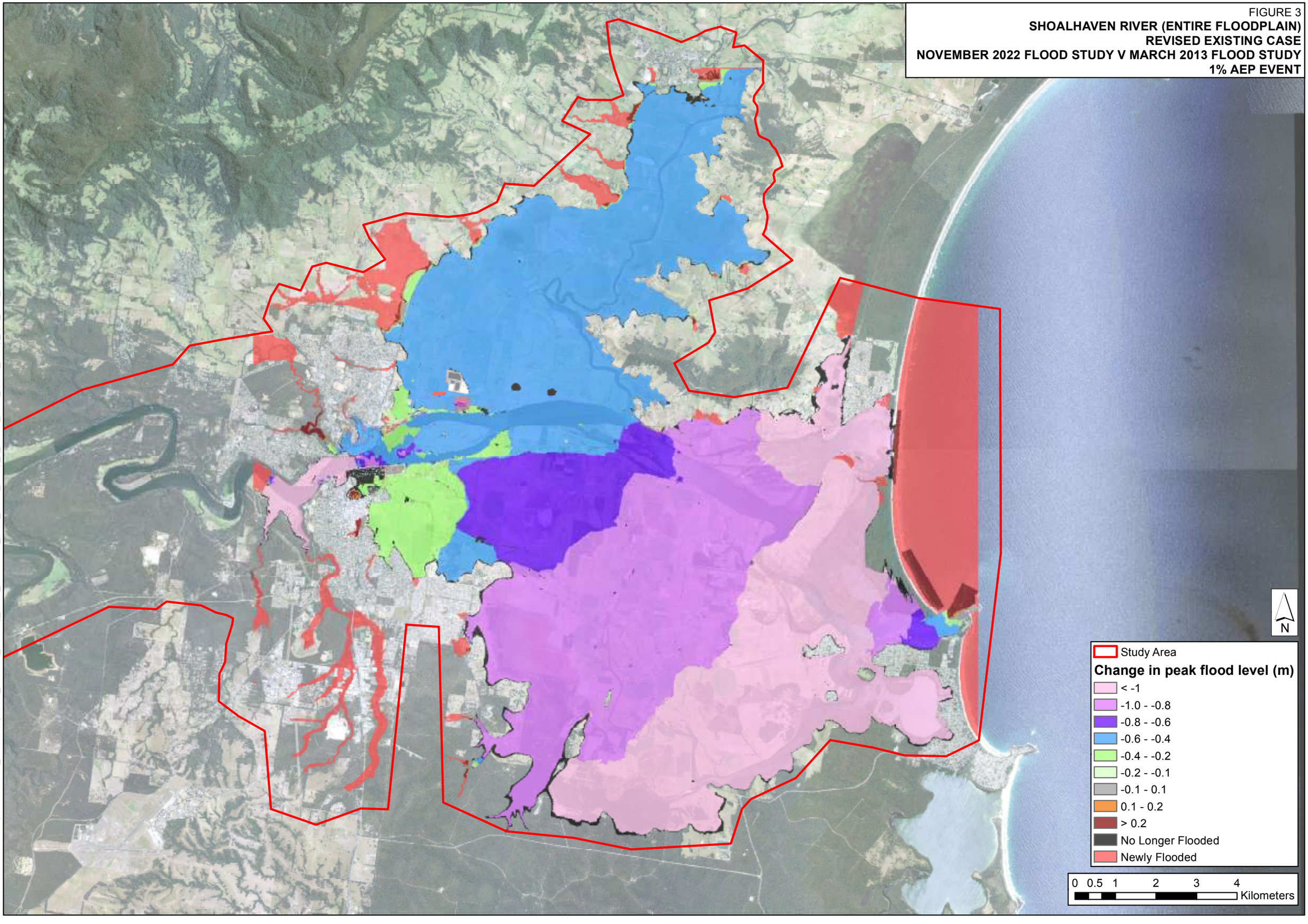

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FIGURE 4
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
IMPACT PROPOSED DEVELOPMENT
1990 EXISTING V MOD31 DESIGN
5% AEP EVENT

N

Study Area

Impact (m)

- < -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- > 0.4
- No Longer Flooded
- Newly Flooded

0 0.5 1 2 3 4 Kilometers

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FIGURE 5
SHOALHAVEN RIVER (LOCAL AREA)
IMPACT PROPOSED DEVELOPMENT
1990 EXISTING V MOD31 DESIGN
5% AEP EVENT

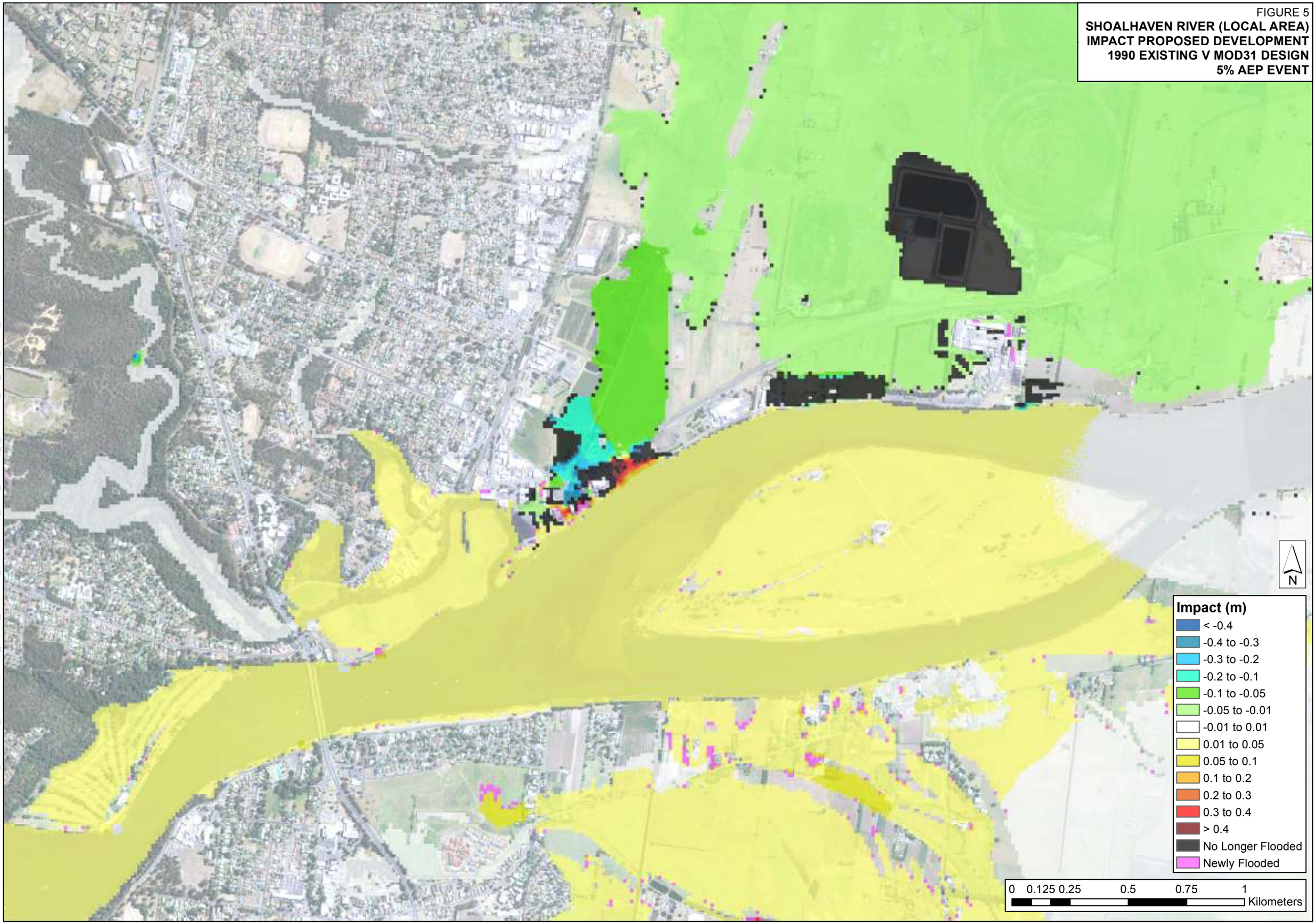

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FIGURE 6
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
IMPACT PROPOSED DEVELOPMENT
JULY2025 EXISTING V MOD31 DESIGN
5% AEP EVENT

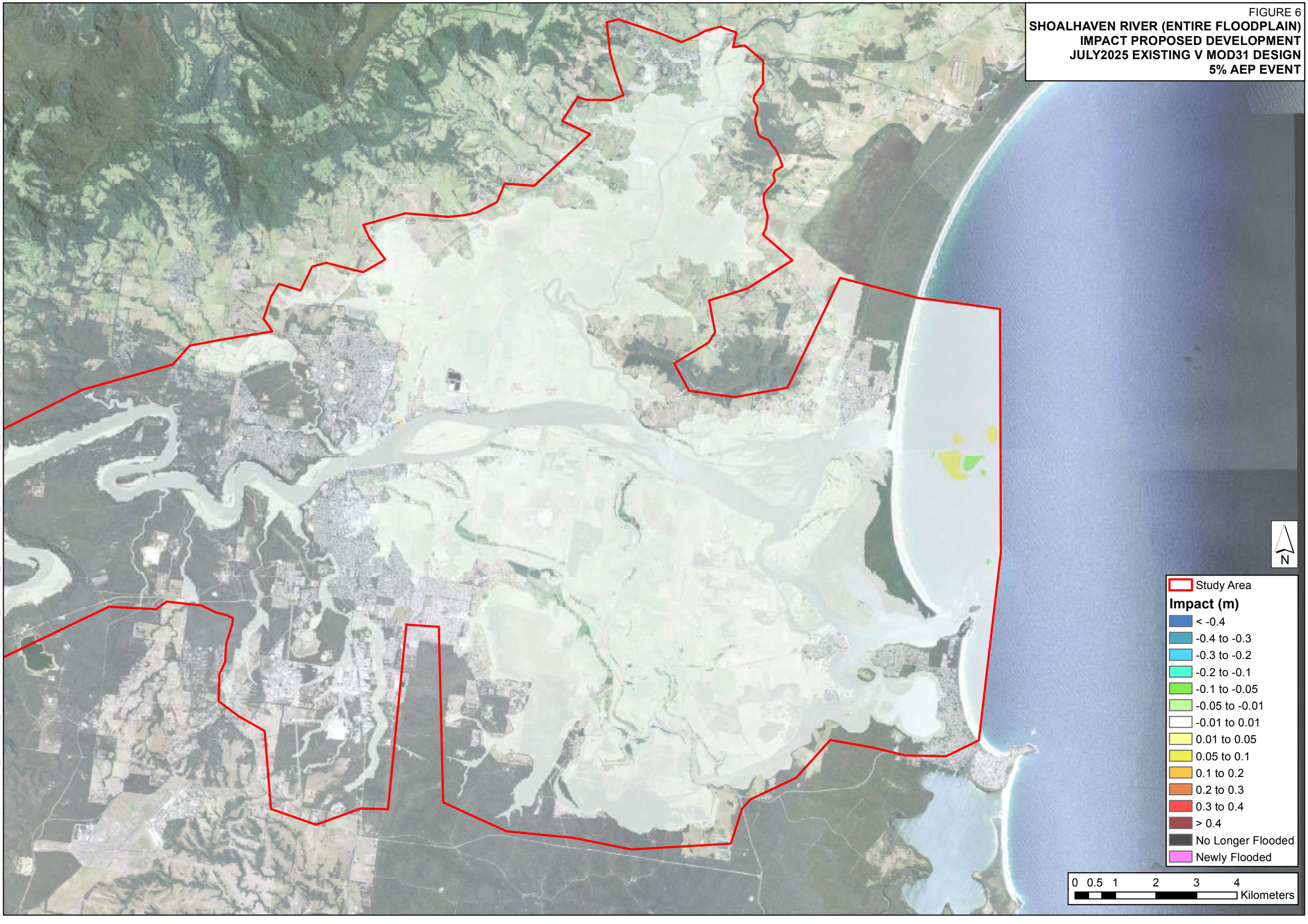

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FIGURE 7

SHOALHAVEN RIVER (LOCAL AREA)
IMPACT PROPOSED DEVELOPMENT
JULY2025 EXISTING V MOD31 DESIGN
5% AEP EVENT

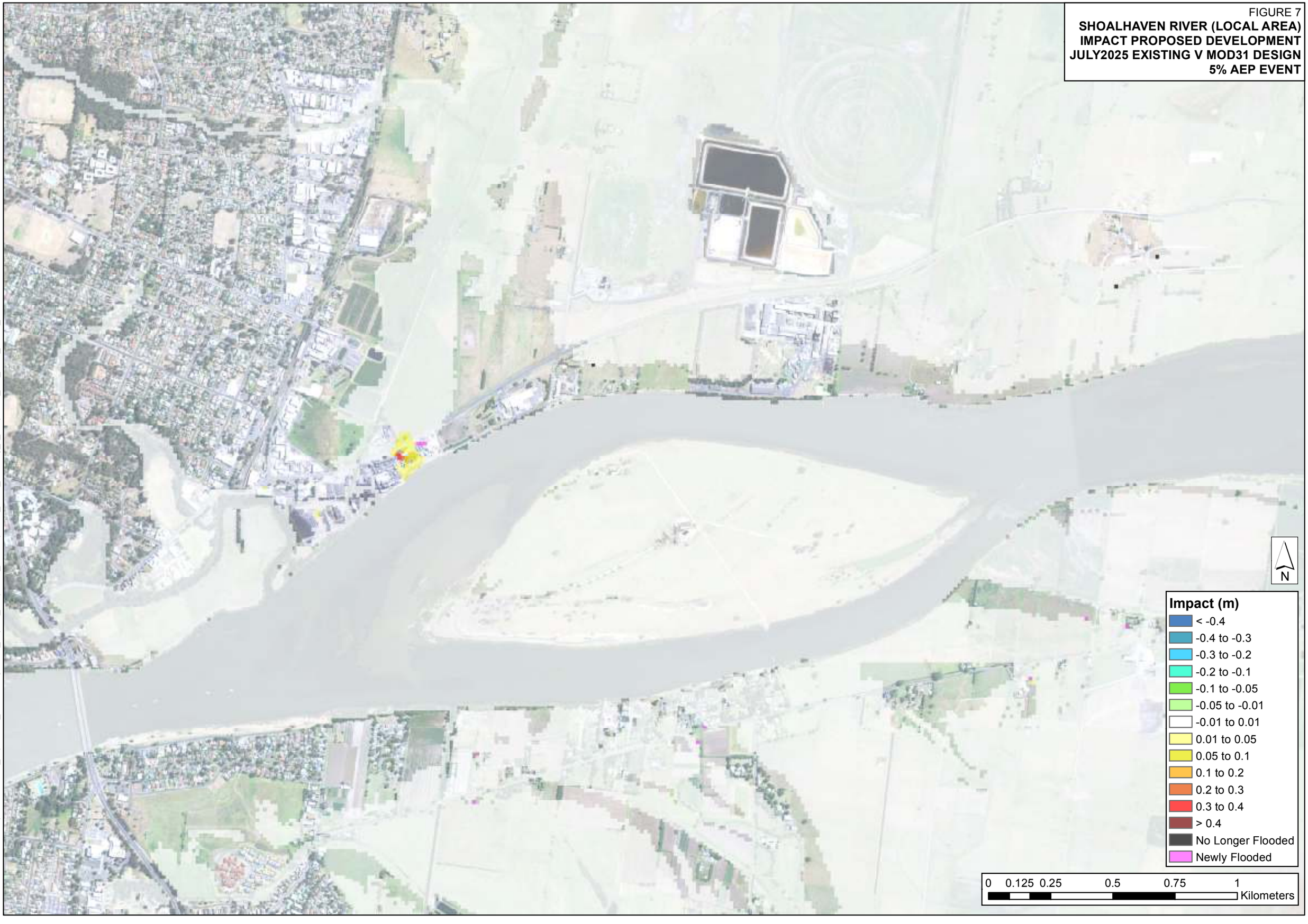

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FIGURE 8
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
IMPACT PROPOSED DEVELOPMENT
1990 EXISTING V MOD31 DESIGN
1% AEP EVENT

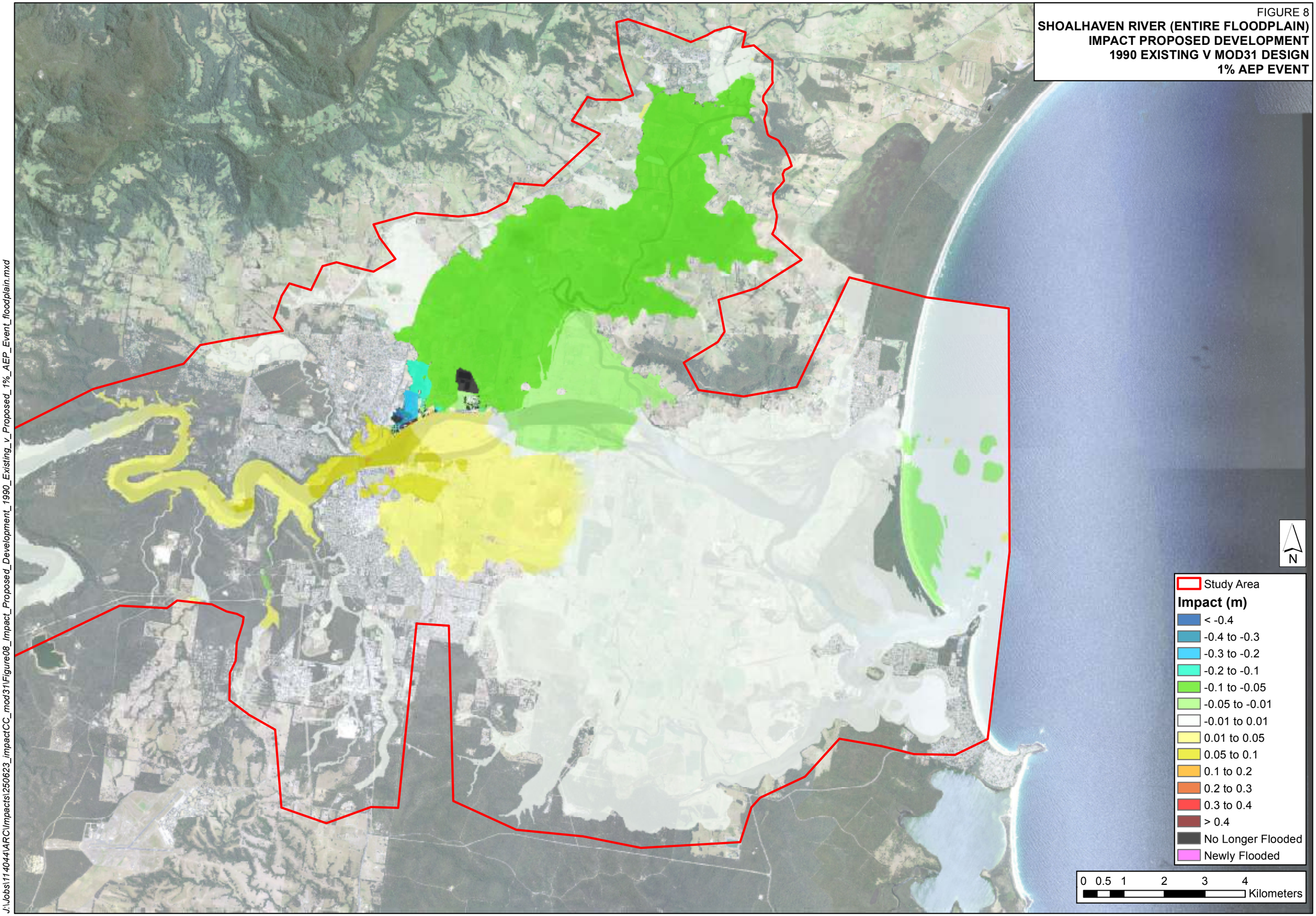

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FIGURE 9

SHOALHAVEN RIVER (LOCAL AREA)
IMPACT PROPOSED DEVELOPMENT
1990 EXISTING V MOD31 DESIGN
1% AEP EVENT

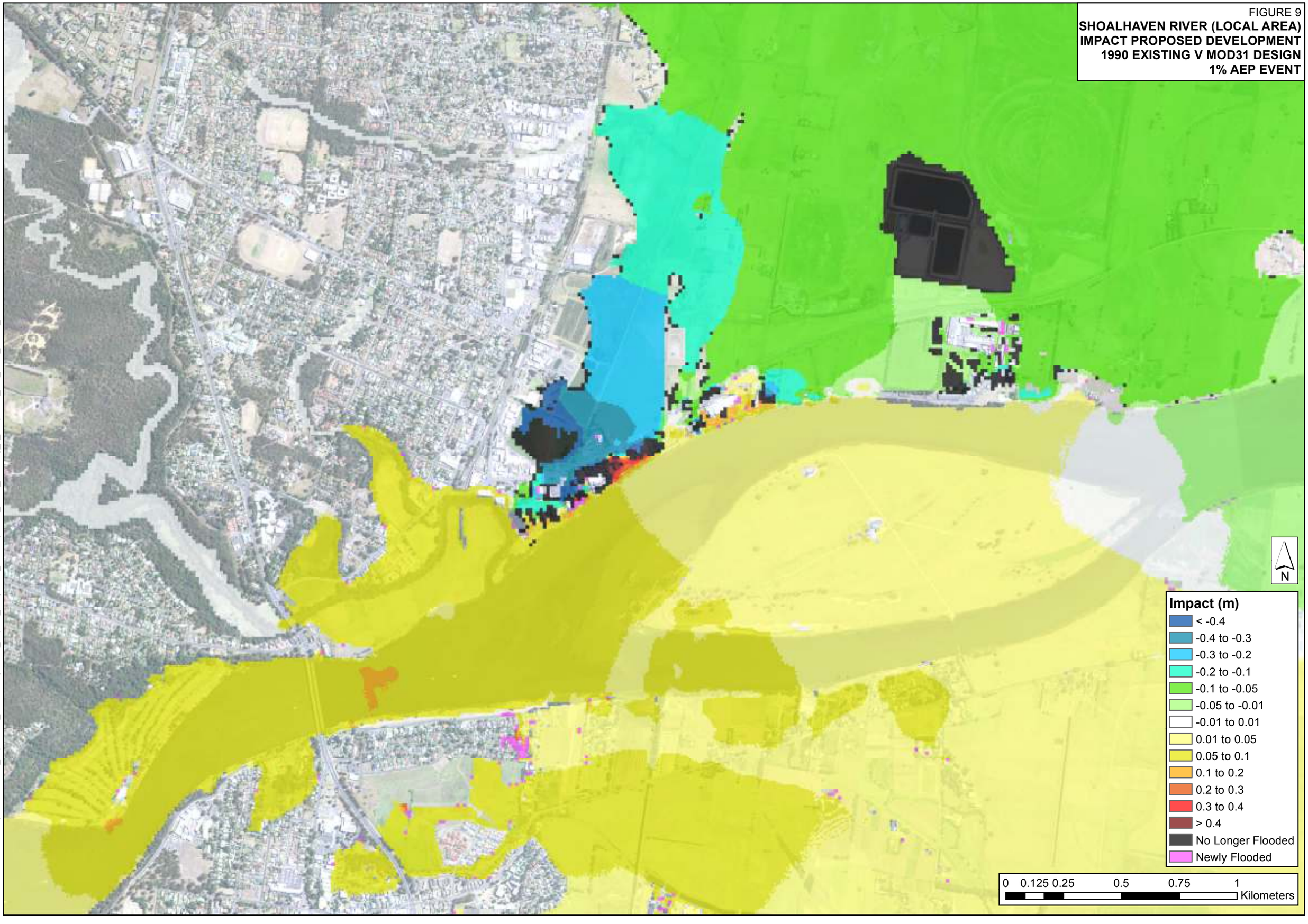

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FIGURE 10
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
IMPACT PROPOSED DEVELOPMENT
JULY2025 EXISTING V MOD31 DESIGN
1% AEP EVENT

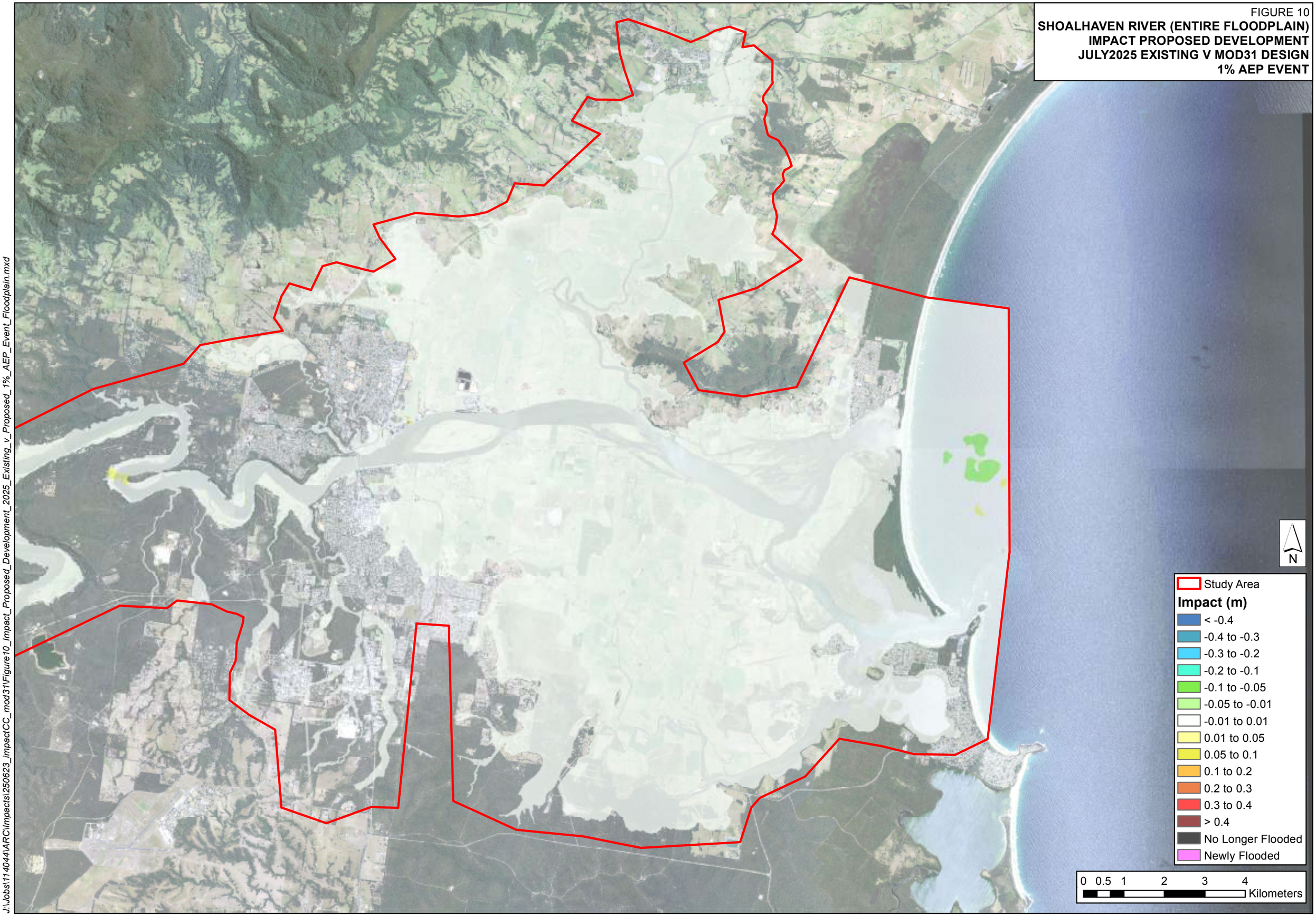

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FIGURE 11

SHOALHAVEN RIVER (LOCAL AREA)
IMPACT PROPOSED DEVELOPMENT
JULY2025 EXISTING V MOD31 DESIGN
1% AEP EVENT

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FIGURE 12
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
IMPACT PROPOSED DEVELOPMENT
1990 EXISTING V MOD31 DESIGN
PMF EVENT

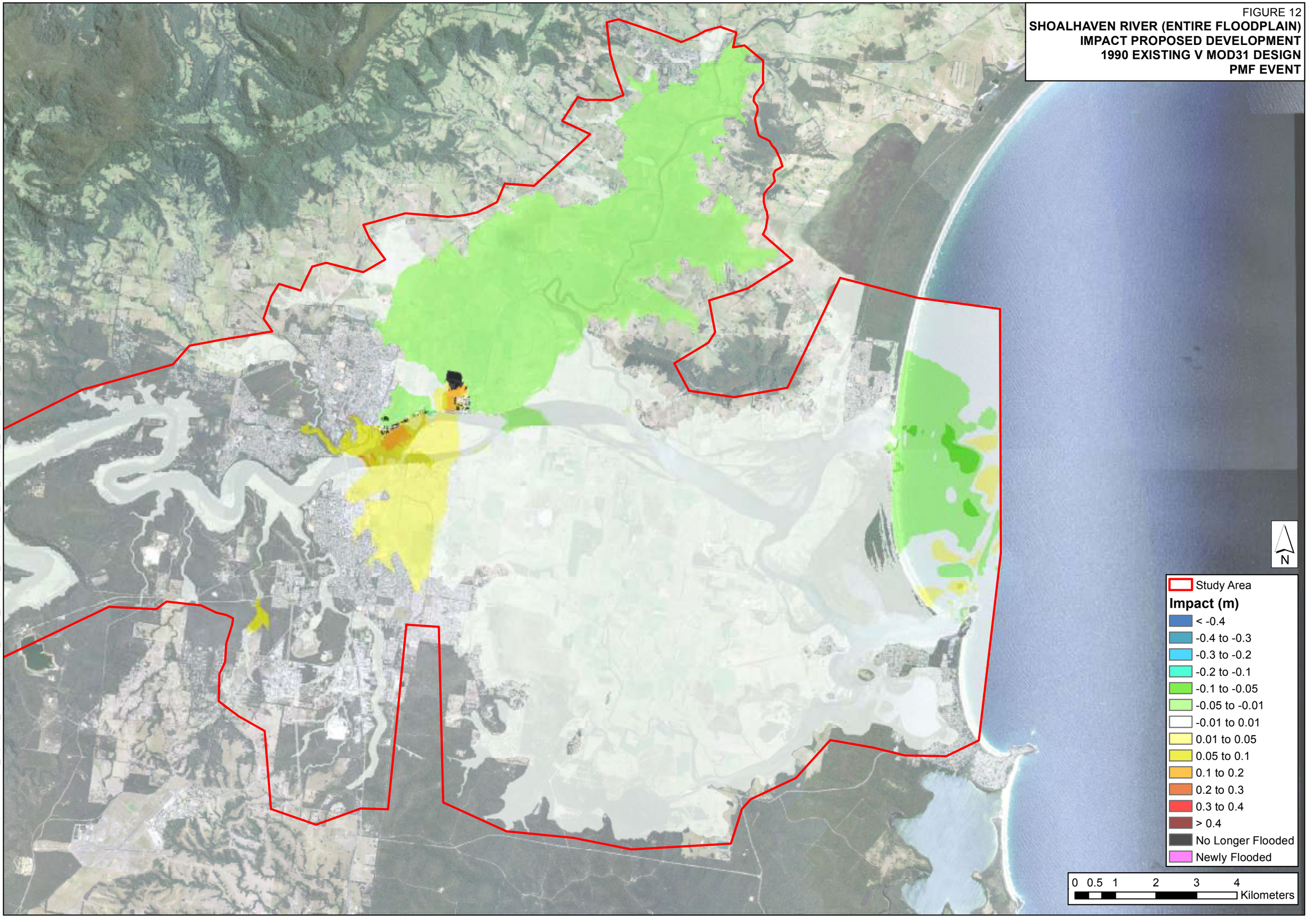

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FIGURE 13
SHOALHAVEN RIVER (LOCAL AREA)
IMPACT PROPOSED DEVELOPMENT
1990 EXISTING V MOD31 DESIGN
PMF EVENT

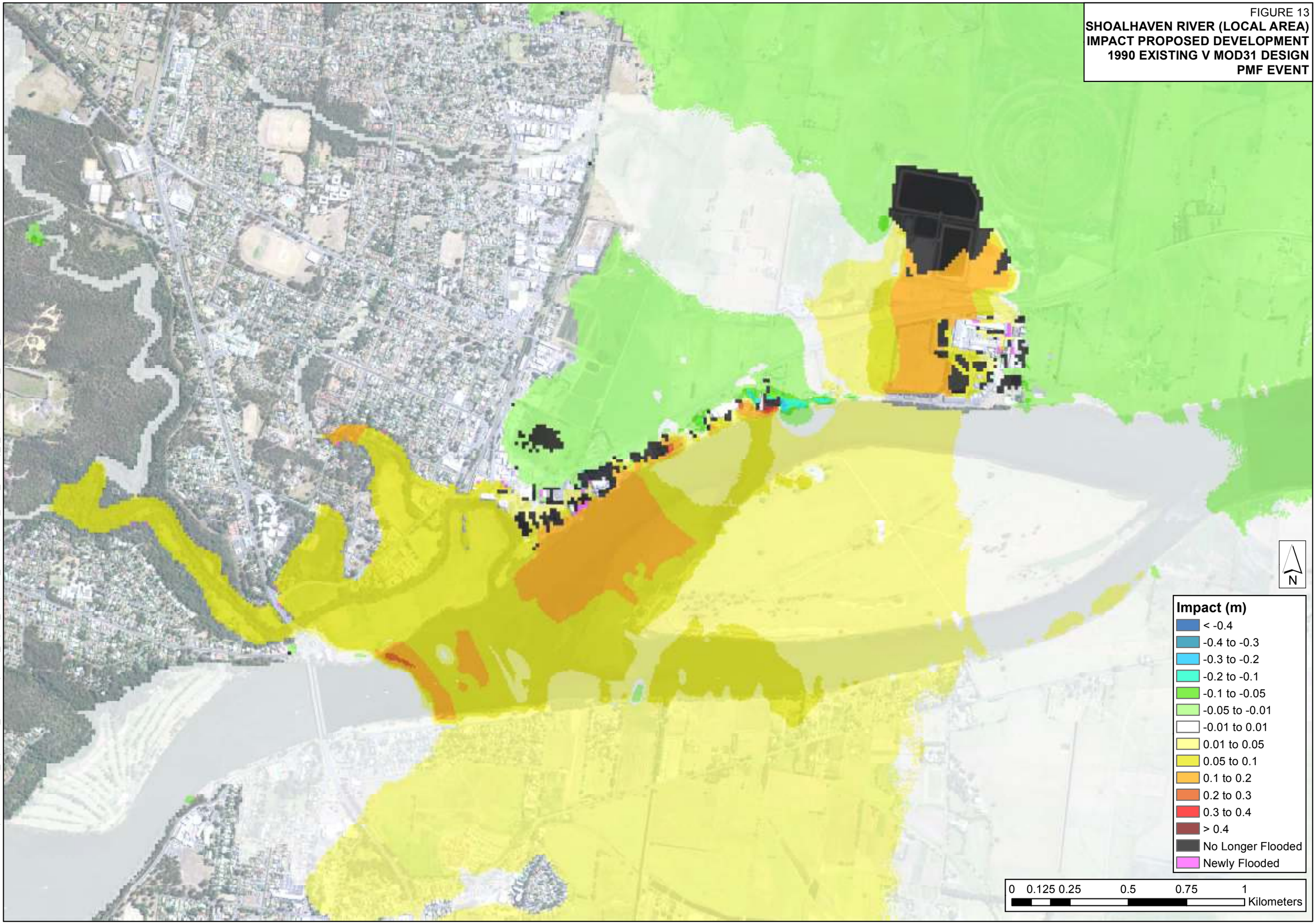

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FIGURE 14
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
IMPACT PROPOSED DEVELOPMENT
JULY2025 EXISTING V MOD31 DESIGN
PMF EVENT

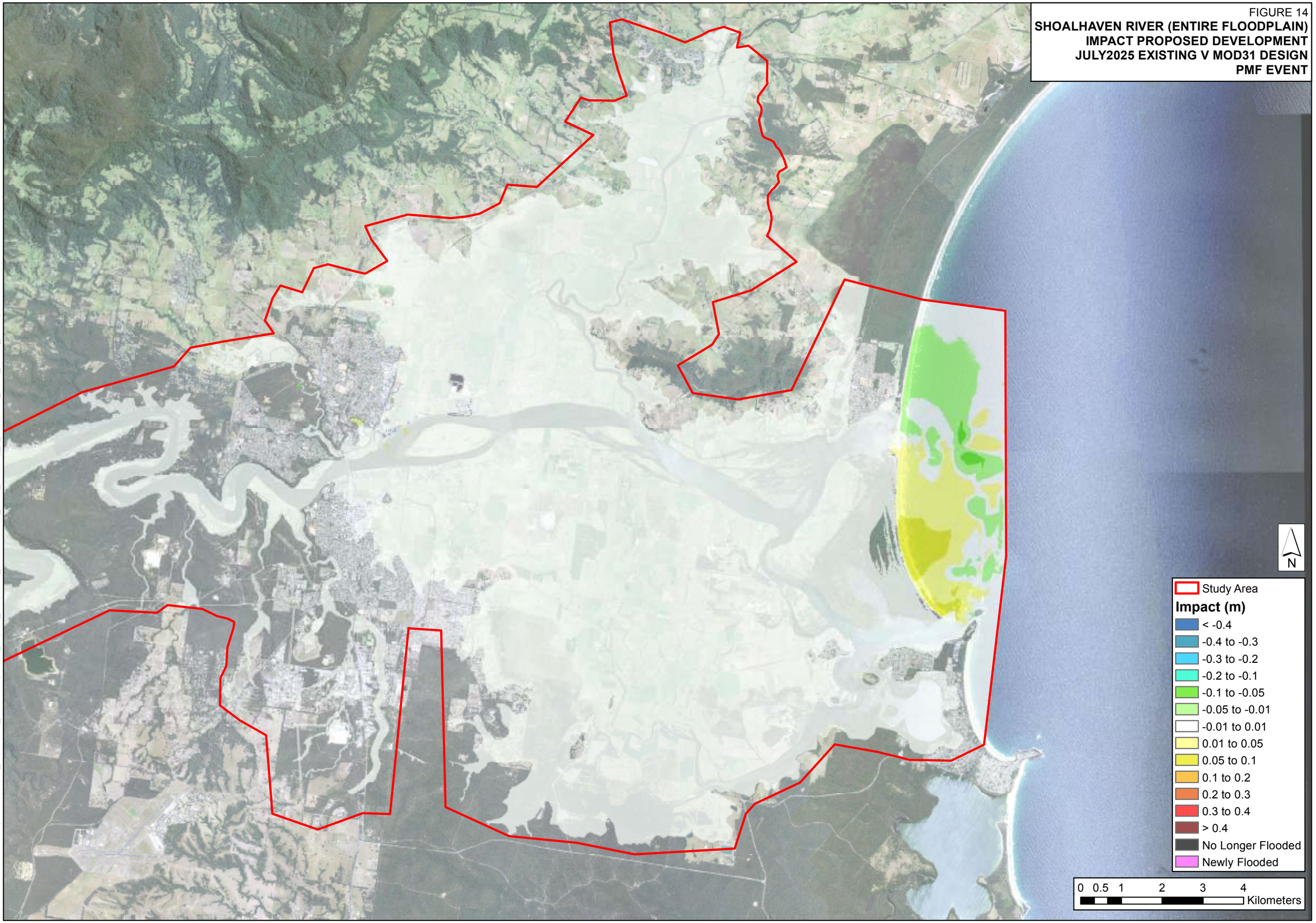

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FIGURE 15

SHOALHAVEN RIVER (LOCAL AREA)
IMPACT PROPOSED DEVELOPMENT
JULY2025 EXISTING V MOD31 DESIGN
PMF EVENT

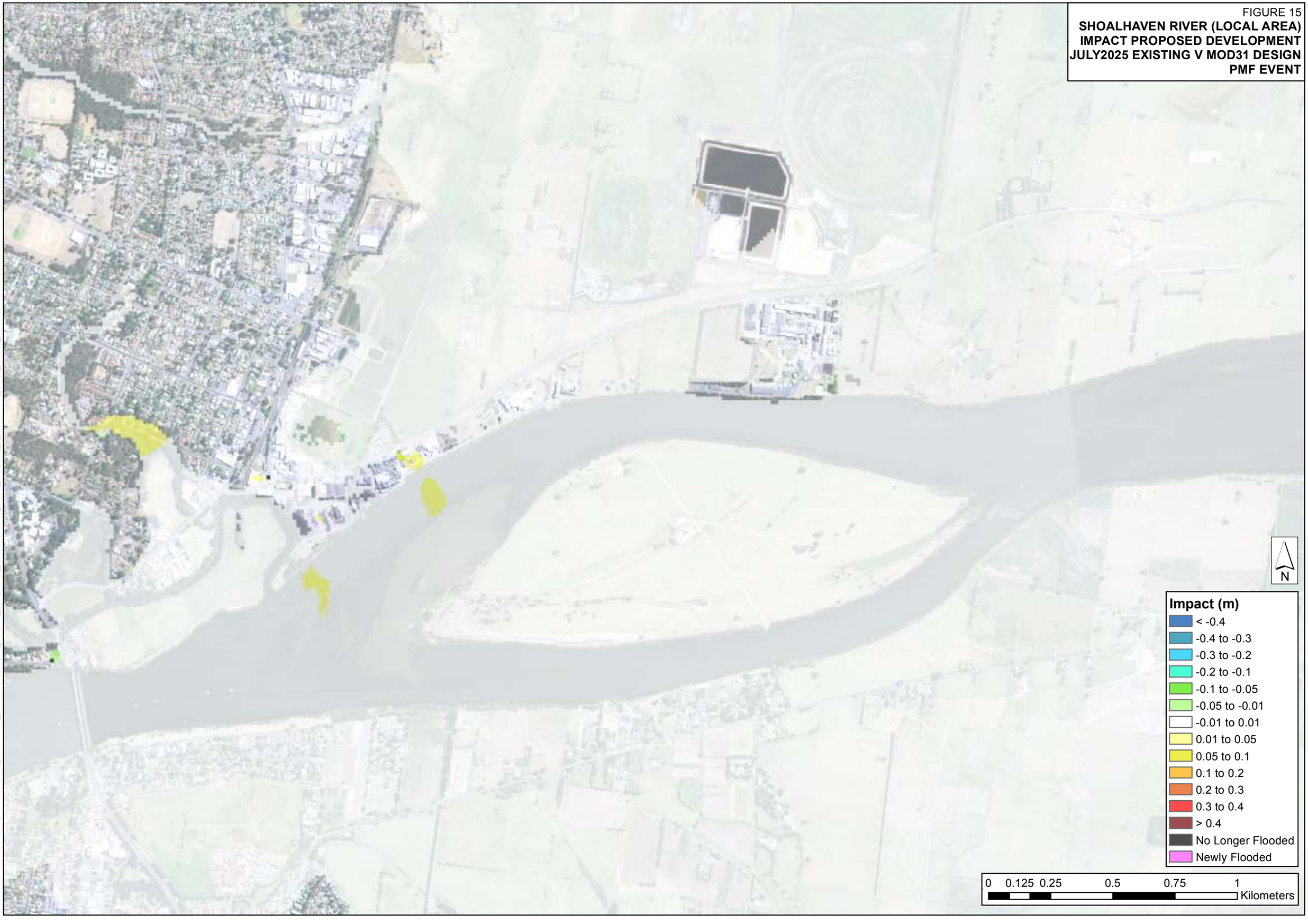

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FIGURE 16
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
LAND USE ZONES

N

Study Area
Cadastre
Properties owned by manildra group

Land Use Zones

Commercial & Industrial
Environmental
Mixed use
Residential
Recreation
Rural
Special

0 1 2 4 6 8
Kilometers

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FIGURE 17
SHOALHAVEN RIVER (LOCAL AREA)
LAND USE ZONES

N

Study Area
Cadastre
Properties owned by manildra group

Land Use Zones

Commercial & Industrial
Environmental
Mixed use
Residential
Recreation
Rural
Special

0 0.125 0.25 0.5 0.75 1
Kilometers

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FIGURE 18
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
PROPERTIES IMPACTED
1990 EXISTING V MOD31 DESIGN
5% AEP EVENT

Property Type
- Commercial & Industrial
- Residential
- Rural
- Mixed Use

Maximum Change in flood level (m)
- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Study Area

N

0 0.5 1 2 3 4 Kilometers

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FIGURE 19

SHOALHAVEN RIVER (LOCAL AREA)
PROPERTIES IMPACTED
1990 EXISTING V MOD31 DESIGN
5% AEP EVENT

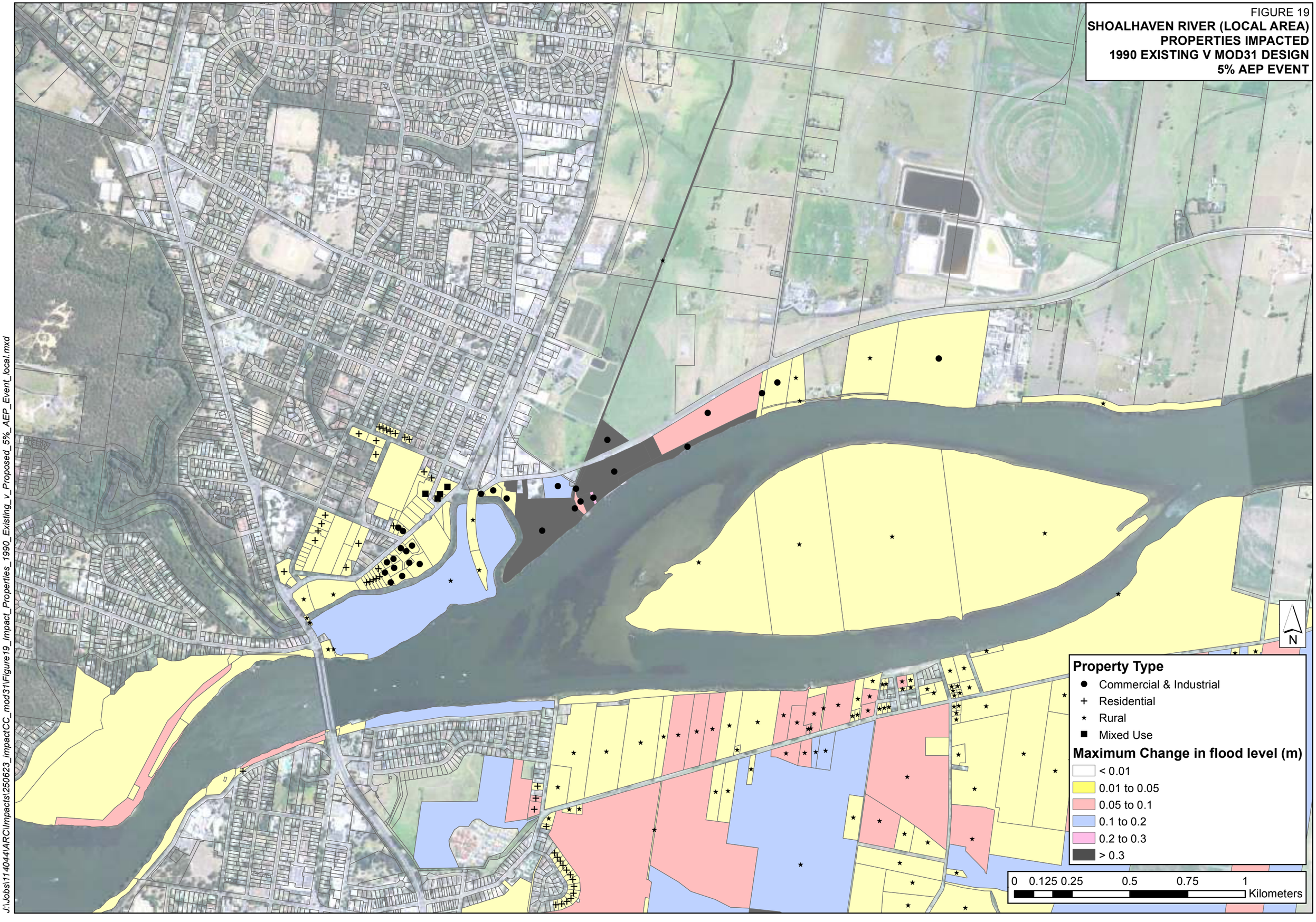

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FIGURE 20
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
PROPERTIES IMPACTED
1990 EXISTING V MOD31 DESIGN
1% AEP EVENT

N

Study Area

Property Type

- Residential
- Rural
- Commercial & Industrial
- Mixed Use

Maximum Change in flood level (m)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3

0 0.5 1 2 3 4 Kilometers

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FIGURE 21
SHOALHAVEN RIVER (LOCAL AREA)
PROPERTIES IMPACTED
1990 EXISTING V MOD31 DESIGN
1% AEP EVENT

Property Type
- Commercial & Industrial
- Residential
- Rural
- Mixed Use

Maximum Change in flood level (m)
- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3

N

0 0.125 0.25 0.5 0.75 1 Kilometers

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FIGURE 22
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
PROPERTIES IMPACTED
1990 EXISTING V MOD31 DESIGN
PMF EVENT

N

Property Type
- Commercial & Industrial
- Residential
- Rural
- Mixed Use

Maximum Change in flood level (m)
- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- Study Area

0 0.5 1 2 3 4 Kilometers

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FIGURE 23
SHOALHAVEN RIVER (LOCAL AREA)
PROPERTIES IMPACTED
1990 EXISTING V MOD31 DESIGN
PMF EVENT

Property Type
- Commercial & Industrial
- Residential
- Rural
- Mixed Use

Maximum Change in flood level (m)
- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3

N

0 0.125 0.25 0.5 0.75 1 Kilometers

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Glossary of Terms

Appendix A

APPENDIX A: GLOSSARY of TERMS

Taken from the Flood Risk Management Manual (June 2023 edition)

Term	Definition	Context for use / additional information
Annual exceedance probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage	AEP is generally the preferred terminology. ARI is the historical way of describing a flood event, for example, a 1% AEP flood has a 1% or 1 in 100 chance of being reached or exceeded in any given year
Australian height datum (AHD)	A common national surface level datum often used as a referenced level for ground, flood and flood levels	0.0 m AHD corresponds approximately to mean sea level
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
Catchment	The area of land draining to a specific location	It includes the catchment of the primary waterway as well as any tributary streams and flowpaths
Catchment flooding	Flooding due to prolonged or intense rainfall (e.g. severe thunderstorms, monsoonal rains in the tropics, tropical cyclones)	Types of catchment flooding include riverine, local overland and groundwater flooding
Chance	The likelihood of something happening that will have adverse or beneficial consequences	In FRM this generally relates to the adverse consequences of floods with chance being related to AEP, for example, 1% chance or 1 in 100 chance per year is equivalent to 1% AEP
Coastal inundation	Inundation due to tidal or storm-driven coastal events, including storm surges in lower coastal waterways. This can be exacerbated by wind-wave generation from storm events	
Consent authority	The authority or agency with the legislative power to determine the outcome of development and building applications	This may be the relevant local council or Minister
Consequence	The outcomes of an event or situation affecting objectives, expressed qualitatively or quantitatively	Consequences can be adverse (e.g. death or injury to people, damage to property and disruption of the community) or beneficial
Continuing flood risk	Risk to existing and future development that may be reduced by EM measures	Flood risk to the existing development and future development may be reduced by EM measures depending on flood constraints, however, these measures cannot remove all risk and a residual risk will remain
Defined flood event (DFE)	The flood event selected as a general standard for the management of flooding to development	Aims to reduce the frequency of flooding but does not remove all flood risk, for example, in selecting a 1% AEP flood as a DFE you are accepting that there is a 1 in 100 chance that a larger event will occur in any year. This risk is being built into the decision
Design flood	The flood selected as part of the FRM process that forms the basis for physical works to modify the impacts of flooding	The design flood may be considered the flood mitigation standard, for example, a levee may be designed to exclude a 2% AEP flood, which means that floods rarer than this may breech the structure and impact upon the protected area. In this case, the 2% AEP flood would not equate to the crest level of the levee, because this generally has a freeboard allowance, but it may be the level of the spillway to allow for controlled levee overtopping
Development	May be treated differently depending on the following categorisation: • **infill development**: the development of vacant blocks of land that are generally	New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power

Term	Definition	Context for use / additional information
	surrounded by developed properties and is permissible under current land zoning • **new development**: development of a completely different nature to that associated with the former land-use (e.g. the urban subdivision of a previously rural area) • **redevelopment**: rebuilding in an area (e.g. as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale)	Redevelopment generally does not require either rezoning or major extensions to urban services
Development control plan (DCP)	See Environmental Planning and Assessment Act 1979	
Emergency management (EM)	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	May include measures to reduce flood frequency or consequences through prevention and mitigation measures, and preparation, as well as response and recovery should a flood occur (see PPRR)
Ecologically sustainable development (ESD)	As outlined in the *Local Government Act 1993*	Principles of ESD are outlined in the *Local Government Act 1993*
Existing flood risk	The risk an existing community is exposed to as a result of its location on the floodplain	Existing flood risk may be reduced by existing or proposed FRM measures leaving a residual flood risk to the existing community. Residual flood risk may be further reduced by addressing continuing risk
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	Flooding results from relatively high stream flow that overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flowpaths associated with major drainage, and/or oceanic inundation resulting from super-elevated ocean levels
Flood (hydrologic and hydraulic) modelling	Hydrologic and hydraulic computer models to simulate catchment processes of rainfall, run-off, stream flow and distribution of flows across the floodplain or similar	They typically involve consideration of the local flood history, available collected data, and the development of models that are calibrated and validated, where possible, against historic flood events and extended to determine the full range of flood behaviour
Flood affected land	Equivalent to flood prone land	See the definition of flood prone land
Flood awareness	An appreciation of the likely effects of flooding, and a knowledge of the relevant flood warning, response and evacuation procedures facilitating prompt and effective community response to a flood threat	In communities with a low degree of flood awareness, flood warnings may be ignored or misunderstood, and residents confused about what they should do, when to evacuate, what to take with them and where to go
Flood constraints	Key constraints that flooding place on land	These include flood function, flood hazard, flood range, and flood emergency response classification. These can be used to inform FRM including consideration of options such as mitigation works, EM and land-use planning
Flood damage	The tangible (direct and indirect) and intangible costs (financial, opportunity costs, clean-up) of flooding	Tangible costs are quantified in monetary terms (e.g. damage to goods) Intangible damages are difficult to quantify in monetary terms and include the increased levels of physical, emotional and psychological health problems suffered by flood affected people that are attributed to a flood
Flood education	Seeks to provide information to raise community awareness of flooding so as to enable individuals to understand how to manage themselves and their property in response to flood warnings	

Term	Definition	Context for use / additional information
Flood evacuation	The movement of people from a place of danger to a place of relative safety, and their eventual return	People are usually evacuated to areas outside of flood prone land with access to adequate community support Livestock may be relocated to areas outside of the influence of flooding
Flood fringe areas	That part of the flood extents for the event remaining after the flood function areas of floodway and flood storage areas have been defined	
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	A flood that has the potential to cause harm or conditions with the potential to result in loss of life, injury and economic loss	The degree of hazard varies with the severity of flooding and is affected by flood behaviour (extent, depth, velocity, isolation, etc.)
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	These studies are generally undertaken for development and are to be prepared by a suitably qualified engineer experienced in hydrological and hydraulic analysis for FRM
Flood liable land	Equivalent to flood prone land	See the definition of flood prone land
Flood plan (local or state) (LFP)	A sub-plan of an EM plan that deals specifically with flooding; they can exist at state, zone and local levels	The NSW Government develops flood plans as a legislative responsibility to determine how best to respond to floods. These community-based plans describe the risk to the community, outline agency roles and responsibilities, the agreed community emergency response strategy and how floods will be managed
Flood planning area (FPA)	The area of land below the FPL	The FPA is generally developed based on the FPL for typical residential development. Different types of development may have different FPLs applied within the FPA. In addition development controls will vary across the FPA due to varying flood constraints
Flood planning level (FPL)	The combination of the flood level from the DFE and freeboard selected for FRM purposes	Different FPLs may apply to different types of development Determining the FPL for typical residential development should generally start with a DFE of the 1% AEP flood plus an appropriate freeboard (typically 0.5 m). This assists in determining the FPA
Flood prone land	Land susceptible to flooding by the PMF event	Flood prone land is also known as the floodplain, flood liable land and flood affected land
Flood risk	Risk is based on the consideration of the consequences of the full range of flood behaviour on communities and their social settings, and the natural and built environment	See also risk. The degree of risk varies with circumstances across the full range of floods. It is affected by factors including flood behaviour and hazard, topography and EM difficulties
Flood risk management (FRM)	The management of flood risk to communities	
Flood risk management manual: the policy and manual for the management of flood liable land		
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	See also flood function, floodways and flood fringe areas

Term	Definition	Context for use / additional information
	behaviour is sensitive to changes that impact on temporary storage of water during a flood	
Flood study	A comprehensive technical investigation of flood behaviour undertaken in accordance with the principles in this manual and consistent with associated guidelines A flood study defines the nature of flood behaviour and hazard across the floodplain by providing information on the extent, level and velocity of floodwaters, and on the distribution of flood flows considering the full range of flood events up to and including extreme events, such as the PMF	A flood study is undertaken in accordance with the FRM process outlined in this manual to support the understanding and management of flood risk. It is different from a flood impact and risk assessment (FIRA)
Flood warnings	Warnings issued when there is more certainty that flooding is expected, are more targeted and are issued for specific catchments	Flood warnings include more specific predictions of the severity of expected flooding and may give quantitative figures such as expected river water heights at gauge stations
Floodplain	Equivalent to flood prone land	See the definition of flood prone land
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	See also flood function, floodways and flood fringe areas Floodways are sometimes known as flow conveyance areas
Flow	The rate of flow of water measured in volume per unit time, for example, cubic metres per second (m^3/s)	Flow is different from the speed or velocity of flow, which is a measure of how fast the water is moving
Freeboard	A factor of safety typically used in relation to the setting of minimum floor levels or levee crest levels	Freeboard aims to provide reasonable certainty that the risk exposure selected in deciding on a specific event for development controls or mitigation works is achieved. Freeboards for development controls and mitigation works will differ. In addition freeboards for development control may vary with the type of flooding and with the type of development
Frequency	The measure of likelihood expressed as the number of occurrences of a specified event in a given time	For example, the frequency of occurrence of a 20% AEP or 5-year ARI flood is once every 5 years on average
FRM measures	Measures that can reduce flood risk	FRM measures may include FRM, flood mitigation, EM and land-use planning measures
FRM options	The FRM measures that might be feasible for the management of a particular area of the floodplain	Preparation of an FRM plan requires a detailed evaluation of FRM options
FRM plan	A management plan developed in accordance with the principles in this manual and its supporting guidelines	Previously known as a floodplain risk management plan or floodplain management plan. It may describe how particular areas of flood prone land are to be used and managed to achieve defined objectives
FRM study	A management study developed in accordance with the principles in this manual and its supporting guidelines	Previously known as a floodplain risk management study or floodplain management study
Future flood risk	The risk future development and its users are exposed to as a result of its location on the floodplain	Future flood risk may be reduced by existing or proposed FRM measures and land-use planning controls that consider the flood constraints on the land. This leaves a residual flood risk to the new development and its users. This residual flood risk may be further reduced by addressing continuing flood risk
Gauge height	The height of a flood level at a particular water level gauge site related to a specified datum	The datum may or may not be the AHD

Term	Definition	Context for use / additional information
Hazard	A source of potential harm or conditions that may result in loss of life, injury and economic loss due to flooding	
Hydraulics	The study of water flow in waterways and flowpaths; in particular, the evaluation of flow parameters such as water level and velocity	
Hydrology	The study of the rainfall and run-off process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods	
Integrated planning and reporting framework (IP&R)	The IP&R framework includes a suite of integrated plans that set out a vision and goals and strategic actions to achieve them. It involves a reporting structure to communicate progress to council and the community as well as a structured timeline for review to ensure the goals and actions are still relevant	Preparation of FRMS and plans and implementation and maintenance of works requires linkages to the IP&R framework
Likelihood	A qualitative description of probability and frequency	See also frequency and probability
Likelihood of occurrence	The likelihood that a specified event will occur	With respect to flooding, see also AEP and ARI
Local environmental plan (LEP)	See *Environmental Planning and Assessment Act 1979*	
Local government area (LGA)		The area serviced by the local government council
Local overland flooding (LOF)	Inundation by local run-off on its way to a waterway, rather than overbank flow from a waterway	
Local strategic planning statement (LSPS)		Local strategic planning statements assist councils to implement the priorities set out in their community strategic plan and actions in regional and district plans
Loss	Any negative consequence or adverse effect, financial or otherwise	
Merit-based 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	The merit approach operates at 2 levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk, which are formulated into council plans, policy and environmental planning instruments At a site-specific level, it involves consideration of the merits of a development consistent with council LEPs, DCPs and local FRM policies, and consistent with FRM plans
NSW Floodplain Management Program	The NSW Government's program of technical support and financial assistance to local councils to enable them to understand and manage their flood risk	The program, manual and FRM guides support the delivery of the policy through a partnership across governments
NSW Flood prone land policy	The *NSW Flood prone land policy* included in this document	
Prevention, preparedness, response and recovery (PPRR)	Involves: • **prevention:** to eliminate or reduce the level of the risk or severity of emergencies • **preparedness:** enhances the capacity of agencies and communities to cope with the consequences of emergencies	In the flood context prevention involves FRM (including flood mitigation), EM and land-use planning measures

Term	Definition	Context for use / additional information
	• **response:** to ensure the immediate consequences of emergencies to communities are minimised • **recovery:** measures that support individuals and communities affected by emergencies in the reconstruction of physical infrastructure and restoration of physical, emotional, environmental and economic wellbeing	
Probability	A statistical measure of the expected chance of a flood	For example, AEP
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	This is equivalent to the probable maximum precipitation flood in Australian Rainfall and Runoff (ARR) The PMF in ARR is used for estimating dam design floods
Probable maximum precipitation (PMP)	The greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organization 1986)	PMP is the primary input to PMF estimation
Rainfall intensity	The rate at which rain falls, typically measured in millimetres per hour (mm/h)	Rainfall intensity varies throughout a storm in accordance with the temporal pattern of the storm
Residual flood risk	The risk to the existing and future community that remains with FRM, EM and land-use planning measures in place to address flood risk	FRM measures cannot remove all flood risk, but rather they reduce residual flood risk
Risk	The effect of uncertainty on objectives' (ISO 2018)	See also flood risk. 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
Risk analysis	The systematic use of available information to determine how often specified (flood) events occur and the magnitude of their likely consequences	
Run-off	The amount of rainfall that ends up as streamflow, also known as rainfall excess	
State environmental planning policy (SEPP)	See Environmental Planning and Assessment Act 1979	
Scenario	A scenario may relate to current, historical or assumed future floodplain, catchment and climate conditions	Flood behaviour varies over time with changes in key catchment and floodplain (such as the scale of development) and climatic conditions (including climate change), and due to the implementation of FRM measures. A range of scenarios are generally needed to understand and assess flood behaviour
Stage	Equivalent to water level; measured with reference to a specified datum	Measurement may relate to AHD, a local datum or a local water level gauge
Storm surge	The increases in coastal water levels above predicted astronomical tide level (i.e. tidal anomaly) resulting from a range of location-dependent factors	These factors may include the inverted barometer effect, wind and wave setup and astronomical tidal waves, together with any other factors that increase tidal water level
Technical working group (TWG)		

Term	Definition	Context for use / additional information
Velocity	The speed of floodwaters, measured in metres per second (m/s)	
Vulnerability	The degree of susceptibility and resilience of a community, its social setting, and the built environment to flooding	Vulnerability is assessed in terms of ability of the community and environment to anticipate, cope and recover from flood events

Plans of the Works Provided by the Client

Appendix B

MOD 31.
HEAT EXCHANGES.

PROJECT No.7462WAE.A.
23/05/25

Drawing No.	REV.	
MN7462-000	P06	SITE ELEVATION.
MN7462-001	P08	O/A SITE PLAN.
MN7462-017	P04	DDG DRYERS HEAT EXCHANGERS SITE ELEVATION.
MN7462-025	P02	DDG DRYERS HEAT EXCHANGERS SITE PLAN.

MOD 31.
BG1 & BG2 HEAT RECOVERY.

PROJECT No.7994

MN7994-001	P09	SITE PLAN.
MN7994-002	P06	SITE ELEVATION.
MN7994-003	P05	GANTRY SECTIONAL ELEVATION.
MN7994-004	P05	DISTILLERY HEAT RECOVERY BUILDING.
MN7994-005	P05	DISTILLERY HEAT RECOVERY EVAPORATORS.
MN7994-006	P16	CONTROL ROOM ADDITIONS.
MN7994-007	P03	OVERHEAD ELECTRICAL BRIDGE.
8122	P01	STRUCTURAL DETAILS.

EXISTING APPROVED PLANT.

MOD 31.

APPROVED PLANT YET TO BE CONSTRUCTED OR UNDER CONSTRUCTION.

MOD 26 CAR PARK .

MOD 25 PENDING APPROVAL.

OVERHEAD ELECTRICAL BRIDGE. Drw-MN7994-007.

OVERHEAD ELECTRICAL ROUTE.

UNDERGROUND ELECTRICAL ROUTE.

HEAT RECOVERY WORKS. Drws-MN7994-001 to MN7994-005.

RELOCATE 78 CAR PARKING SPACES.

DDG HEAT EXCHANGERS. Drw-MN7462-017 & MN7462-025.

MANILDRA LAND

MANILDRA COMPLEX

RAILWAY STREET

APPROVED EXIT.

SWALE

TRUCK BYPASS LANE

CONTAINER STORAGE AREA.

PRIVATE

BOLONG ROAD

GATE 13

GATE 11

GATE 9

GATE 7

GATE 4

GATE

GATE 5

GATE 3

GATE 1

NEW ENTRY.

LOT 200 DP1062868

ACF LAND

LOT 21 DP1000268

CAR PARKING

LOT 143 DP 1069758

FORMER DAIRY FARMERS FACTORY.

(DP 638246)

APPROVED CONSTRUCTED WEIGHBRIDGE

APPROVED & CONSTRUCTED BIOFILTERS.

CONTAINER STORAGE.

Shoalhaven River

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P08	E4	Electrical Bridge Amended	P.C.	23-05-25	MP	
P07	E5	Electrical route adjacent to creek above ground.	P.C.	21-05-25	DJ	
P06	All	Was mod 30,car park mods,electrical route added.	P.C.	08-05-25	MP	
P04	All	To match engineers.	P.C.	25-11-24	MP	
P03	All	Starch dryers ect. & packer extension removed.DDG heat exch. relocated.	P.C.	11-11-24	CJ	
P01	All	First issue.	P.C.	12-07-24	J.S.	

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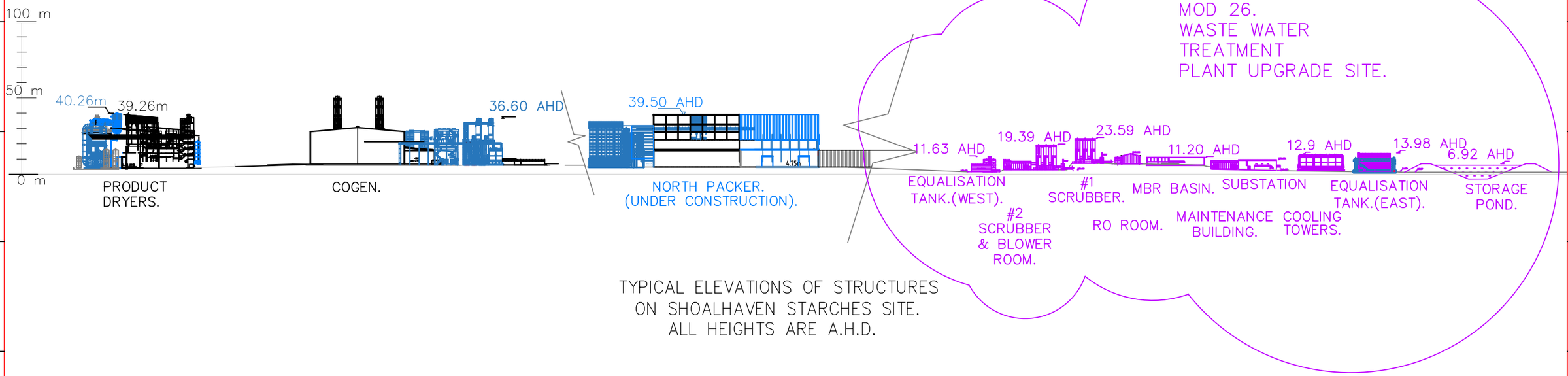
DRAWN PC	DATE 25-06-24	SITE MANILDRA-SHOALHAVEN STARCHES PTY LTD.	SHT SIZE A3
DESIGNED. AT	DATE	JOB TITLE NOWRA PLANT.	SHEET
CHKD SR	DATE	DWG TITLE MOD 31. OVER ALL SITE PLAN.	OF
APPD BH	DATE		REV. P08
	SCALE 1:3000	PROJECT No. 7462-001	DWG No. MN7462-001

EXISTING APPROVED PLAN.

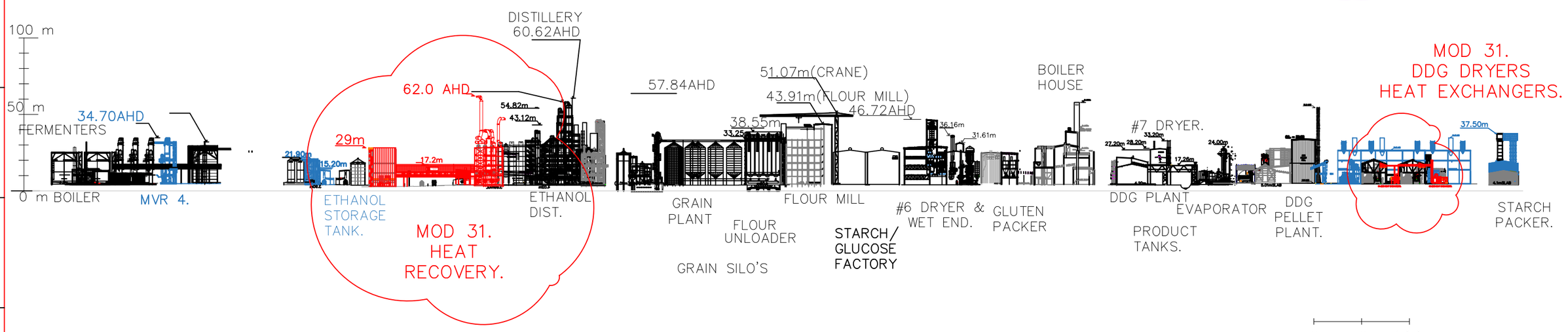
APPROVED PLANT YET TO BE CONSTRUCTED OR UNDER CONSTRUCTION.

MOD 31.

MOD 26.



TYPICAL ELEVATIONS OF STRUCTURES
ON SHOALHAVEN STARCHES SITE.
ALL HEIGHTS ARE A.H.D.



0 50m 100m

SCALE 1:2500

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P07	All	Waste Water Treatment Plant moved to Mod 26	B.M.	21-07-25	All	JS
P06	All	Changed to match engineers design.	B.M.	28-05-25	All	JS
P05	All	Was Mod 30.	P.C.	07-05-25	All	JS
P04	All	Changed to match engineers design.	P.C.	25-11-24	All	JS
P03	All	Starch dryers ect removed.	P.C.	15-11-24	All	JS
P01	All	Latest revision.	P.C.	05-09-24	All	B.H.

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DRAWN P.C.	DATE 05/09/24	JOB TITLE	SHOALHAVEN STARCHES.BOMADERRY. NSW
CHKD JS	DATE	DWG TITLE	MOD 31. SITE ELEVATIONS GA.
APPD	DATE		
	SCALE 1:2500	PROJECT No. 7462-000	DWG No. MN7462-000

SHT SIZE A3

REV. P07

EXISTING APPROVED PLANT.

MOD 31.

APPROVED PLANT YET TO BE CONSTRUCTED OR UNDER CONSTRUCTION.

COGEN PLANT.

DDG HEAT EXCHANGERS.

DDG DRYER 5.

DDG DRYER 6.

ACCESS ROAD

Site Office & 1st Aid

ACCESS ROAD

DDG STORAGE

DDG LOADOUT

DDG STORAGE

SUB/STN

EVAPORATOR

SUB/STN S/ROOM ELEC.

EVAPORATORS

ELECT S/ROOM

EVAPORATORS

COOLING TOWERS

PIT

SERVICES BRIDGE

SUBSTATION OVER.

MAINTENANCE ACCESS ROAD

FINISHED

REV	ZONE		DRN	DATE	CHKD	APPD
P04	ALL	Mod 29 now approved,Mod 22 removed.	P.C.	22-01-25	AT	
P03	ALL	Cooling towers/stack ect removed.Ht/ex relocated.	P.C.	12-11-24	AT	
P01	ALL	Conceptual plan.	P.C.	16-8-24	AT	

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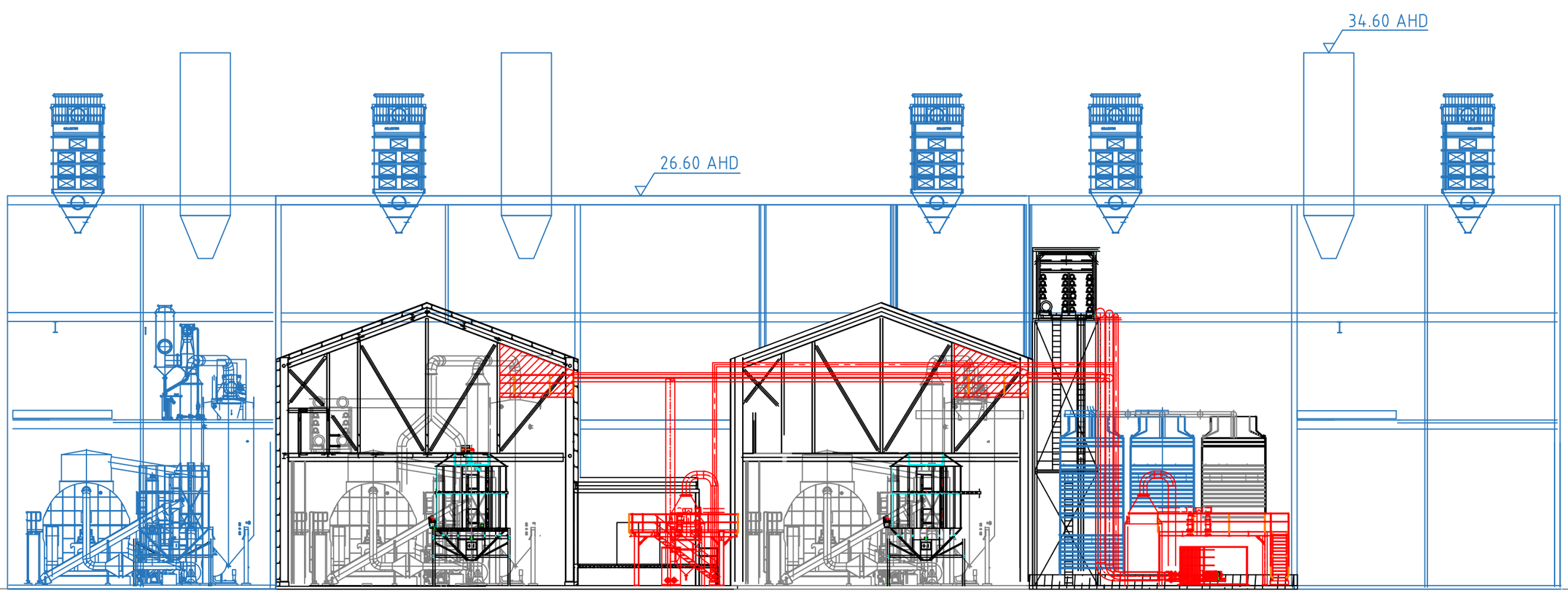
P.C.	15-1-24	SHOALHAVEN STARCHES.BOMADERRY. NSW	A3
CHKD	DATE	DWG TITLE: DDG HEAT EXCHANGERS. SITE PLAN.	REV. P04
APPD	DATE		
SCALE 1:500		PROJECT No. 7462-019	DWG No. MN7462-017

EXISTING APPROVED PLANT.

MOD 31.

APPROVED PLANT YET TO BE CONSTRUCTED OR UNDER CONSTRUCTION.



#4 DDG HEAT EXCHANGERS.

#5 DDG HEAT EXCHANGERS.

EASTERN ELEVATION.

REV	ZONE		DRN	DATE	CHKD	APPD
P02	ALL	Mod 29 now approved,Mod 22 removed.	P.C.	22-01-25	AT	
P01	ALL	First issue.	P.C.	12-11-24	AT	

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P.C.	15-1-24	SHOALHAVEN STARCHES.BOMADERRY. NSW	A3
CHKD	DATE	DWG TITLE	
APPD	DATE	DDG HEAT EXCHANGERS. SITE ELEVATION.	REV.
	SCALE 1:250	PROJECT No. 7462-019 / DWG No. MN7462-025	P02

EXISTING APPROVED PLANT.

MOD 31.

MOD 26 APPROVAL CAR PARK.

APPROVED PLANT YET TO BE CONSTRUCTED OR UNDER CONSTRUCTION.

TOTAL CAR PARKING SPACES- 434.
Existing- 64.
Mod 26- 276.
Mod 31- 94.

6.6M SETBACK

UNDERGROUND ELECTRICAL CABLES.

EXISTING FENCE

ABOVEGROUND ELECTRICAL CABLES.

Abernathys Drain

BRIDGE

141.37

METAL TANK

METAL TANK

PUMP HOUSE

GAS FACILITY
MANILDRA GAS STATION

INTEGRAL ENERGY GAS NATURAL GAS INSTALLATION

MANILDRA LAND

CO2 GAS INSTALLATION

APPROVED CAR PARK

DISTILLERY HEAT RECOVERY BUILDING.

15.5M

GATE 2

NEW ENTRY.

MINIMUM WIDTH OF 90° ANGLE PARKING IS 2.4M x 5.4M LONG. MINIMUM WIDTH OF ROAD IS 6.2M. (AS/NZS 2890.1:2004). AREAS USED FOR CAR PARKS.

LIGHT TOWERS~~(12)~~ AHD 16M.

UNDERGROUND ELECTRICAL CABLES.

WALKWAY

NEW EXIT.

ACCELERATION LANE.

5.7M MINIMUM SETBACK

DECELERATION LANE.

PEDESTRIAN REFUGE ISLAND. OPENING IN CENTRE FENCE.

OVERHEAD ELECTRICAL BRIDGE.

GATE 7

BOLONG ROAD

8.2M

10.5M MIN. SETBACK

BUNDED EVAPORATORS.

GATE 5

GATE 3

ETHANOL DRIVEWAY

LOADING BAY

DENATURANT STORE

ETHANOL RECOVERY AREA

COOLING TOWERS

No.1 FERMENTER

No.2 FERMENTER

No.3 FERMENTER

STAGE 3 ETHANOL

DISTILLERY

LABORATORY

FERMENTATION AREA

DRYER #6

No.13 FERMENTER

No.12 FERMENTER

No.16 FERMENTER

MVR #4

Evaporator

Substation

Cooling Towers

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P09	ALL	Electrical Bridge Amended	P.C.	23-05-25	MPoole	DJ
P08	ALL	Electrical route adjacent to creek now above ground.	P.C.	1-05-25	DJ	
P07	ALL	Layout mods to engineers design.Car park extension.Electrical route.	P.C.	2-05-25	DJ	
P06	ALL	Car park now included in mod 26.	P.C.	6-02-25	DJ	
P05	ALL	Car park now included in mod 30.	P.C.	22-01-25	DJ	
P04	ALL	Changes to match engineers design.	P.C.	22-11-24	MPoole	
P01	ALL	Construction layout.	P.C.	16-05-24	D.J.	

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P.C.

CHKD DATE

APPD DATE

SCALE 1:1000

SHOALHAVEN STARCHES.BOMADERRY. NSW

DWG TITLE
MOD 31.BG1 & BG2 HEAT RECOVERY.
O/A SITE PLAN.

PROJECT No. 7994-001

DWG No. MN7994-001

SHT SIZE A3

REV. P09

EXISTING APPROVED PLANT.

MOD 31.

62.0 AHD

DISTILLERY HEAT
RECOVERY BUILDING.

29.0m

BGD1

BGD2

SWITCH ROOM

SWITCH ROOM EVCAV.

OVERHEAD GANTRY.

17.2m

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EXISTING
CONTROL
ROOM

3.33m

3.74m

5M(Nom)

2.96m

2.67m

5.7M

16.05M

Min. SETBACK

BOLONG ROAD

DISTILLERY HEAT
RECOVERY EVAPORATORS.

EASTERN ELEVATION.

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P06	ALL	Changes to match engineers design.	B.M.	28.05.25	MPoole	
P05	ALL	Changes to match engineers design.Fan build/bridge width & height increased.	P.C.	05-05-25	MPoole	
P04	ALL	Changes to match engineers design.	P.C.	22-11-24	MPoole	
P01	ALL	Construction layout.	P.C.	16-05-24	D.J.	

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0439 436508

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CHKD DATE

APPD DATE

SCALE 1:250

SHOALHAVEN STARCHES.BOMADERRY. NSW

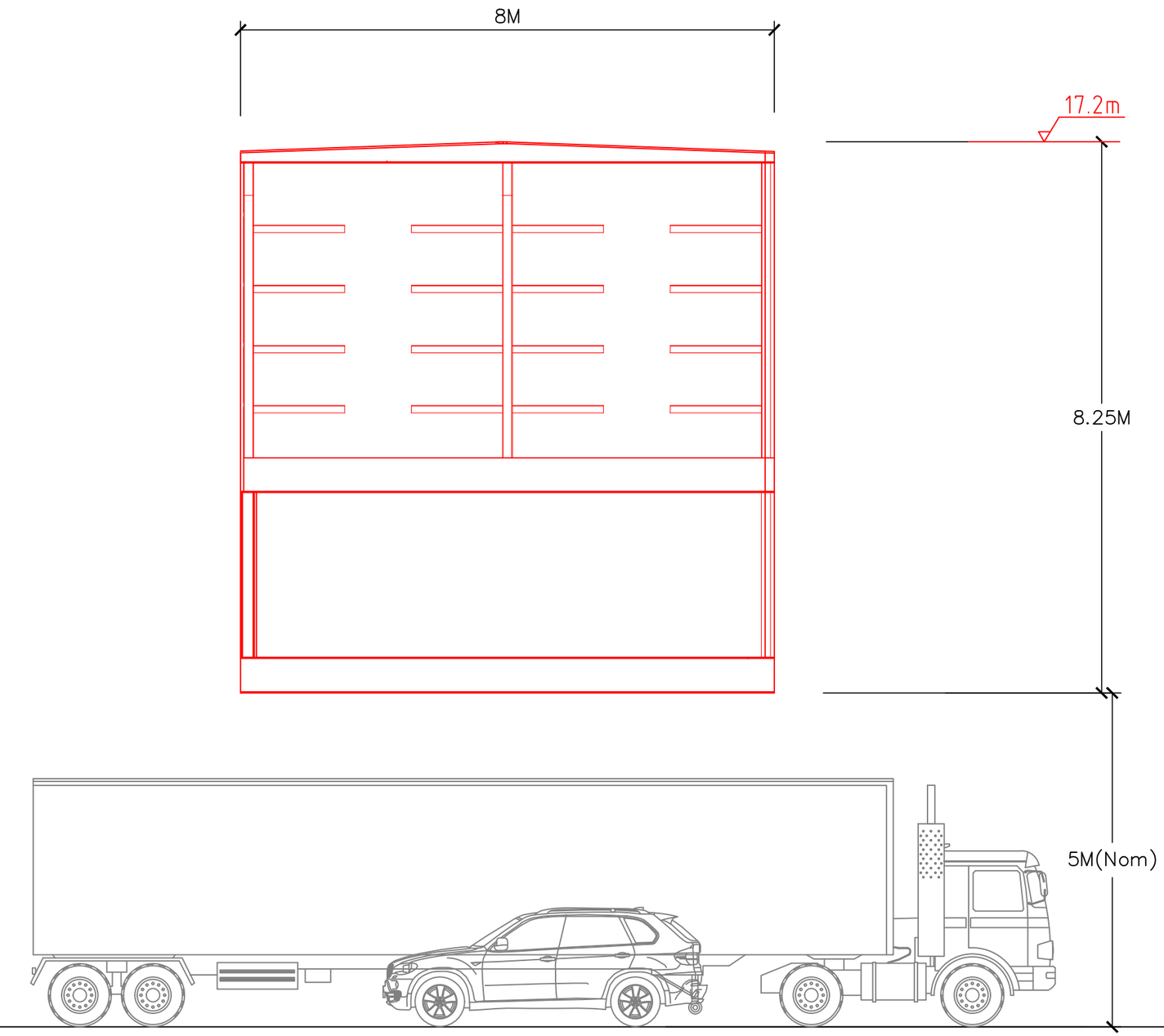
DWG TITLE
MOD 31.BG1 & BG2 HEAT RECOVERY.
SITE ELEVATION.

PROJECT No. 7994 WAE

DWG No. MN7994-002

SHT SIZE A3

REV. P06



REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P04	ALL	Changes to match engineers design.Width & height increased.	P.C.	05-05-25	MPoole	
P04	ALL	Changes to match engineers design.	P.C.	22-11-24	MPoole	
P01	ALL	Construction layout.	P.C.	16-05-24	D.J.	

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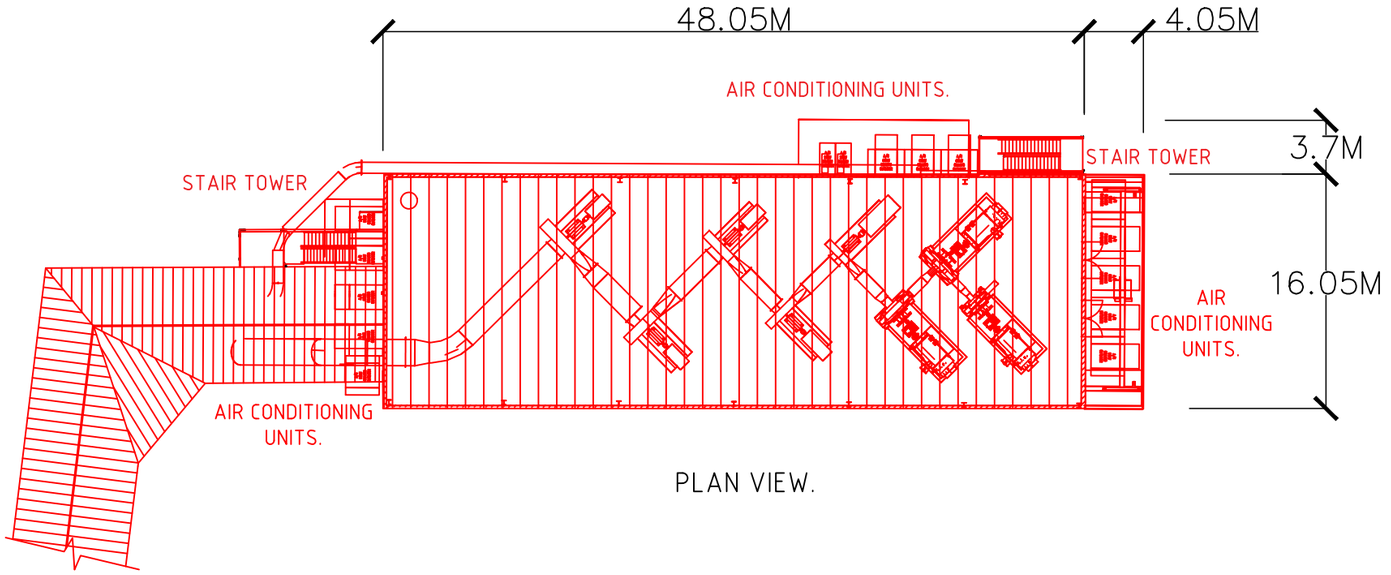
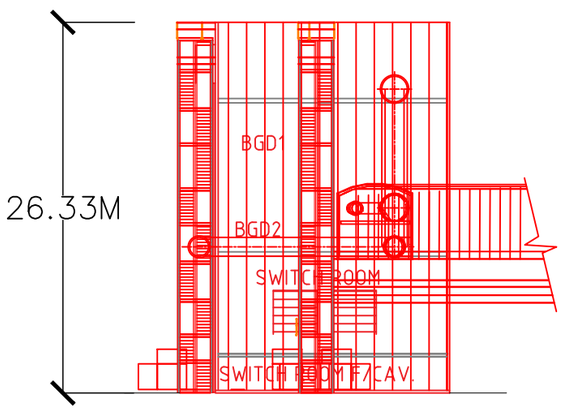
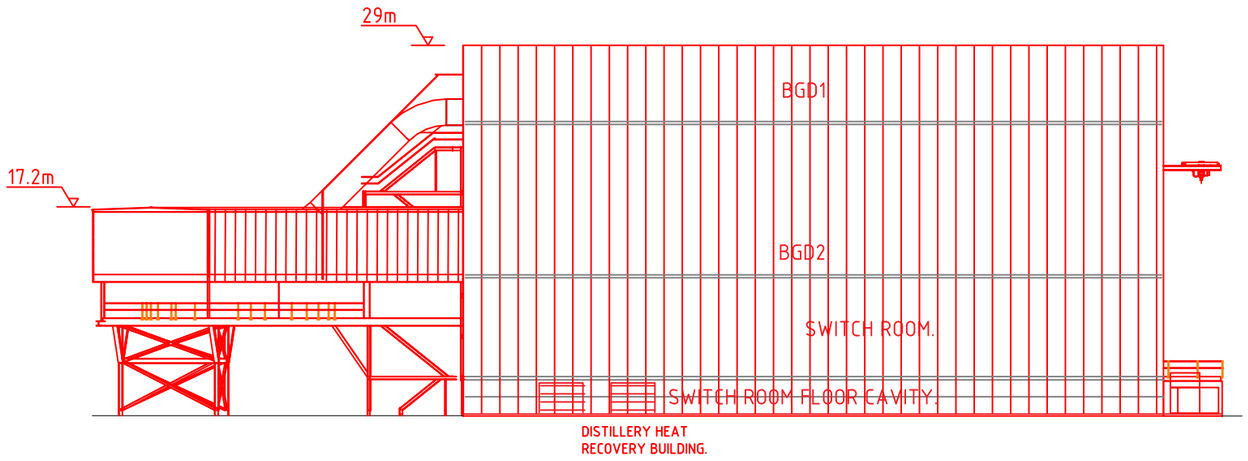
P.C.		SHOALHAVEN STARCHES.BOMADERRY. NSW	SHT SIZE A3
CHKD	DATE	DWG TITLE MOD 31.BG1 & BG2 HEAT RECOVERY. GANTRY SECTIONAL ELEVATION.	
APPD	DATE		REV. P05
	SCALE 1:75	PROJECT No. 7994 WAE	DWG No. MN7994-003



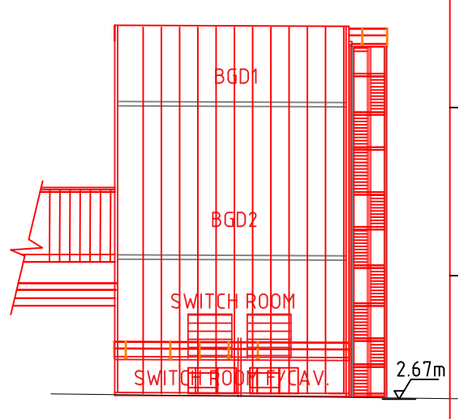
PLAN VIEW.



BACK ELEVATION.



SIDE ELEVATION.



FRONT ELEVATION.

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P05	ALL	Changes to match engineers design.Width & height increased.	P.C.	05-05-25	MPoole	
P04	ALL	Changes to match engineers design.	P.C.	22-11-24	MPoole	
P01	ALL	Construction layout.	P.C.	16-05-24	D.J.	

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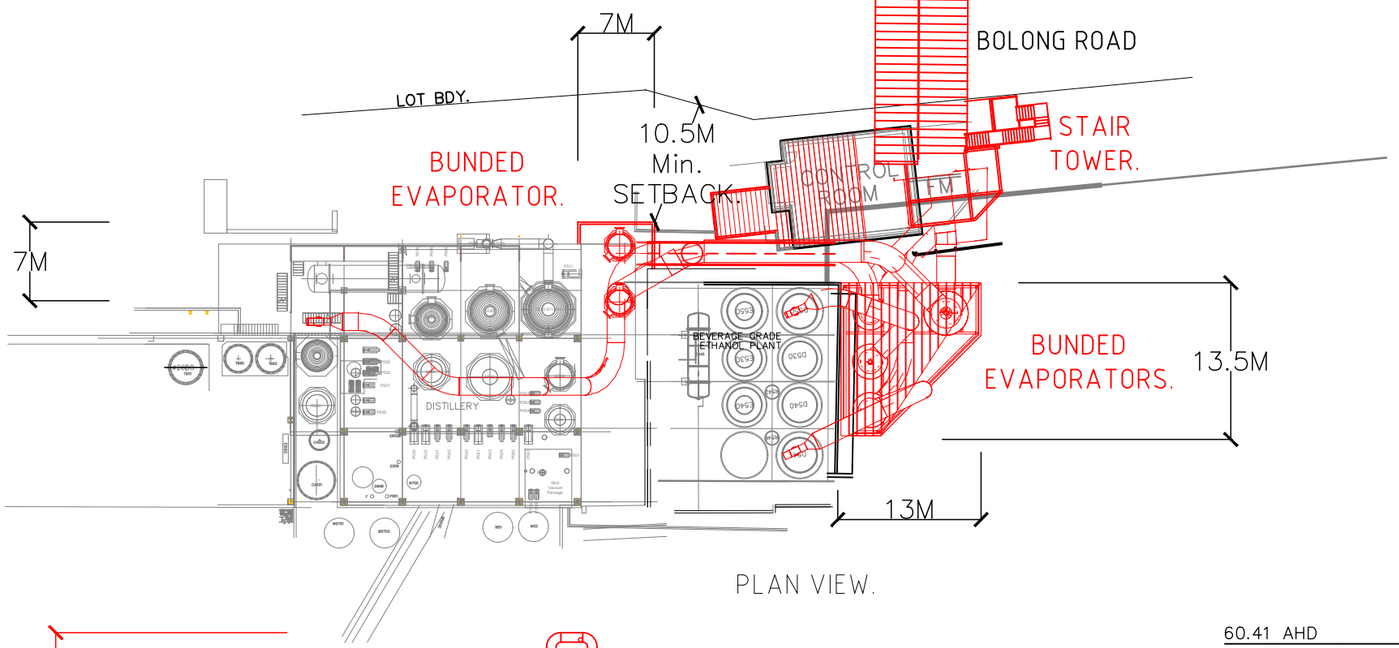
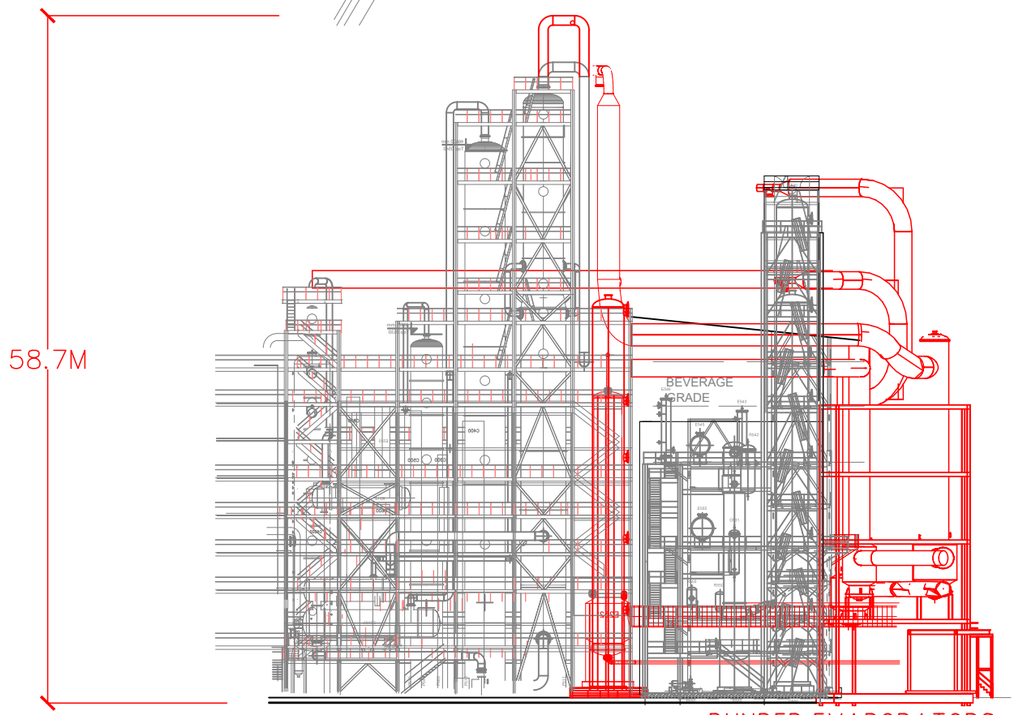
P.C.		SHOALHAVEN STARCHES.BOMADERRY. NSW	SHT SIZE A3
CHKD	DATE	DWG TITLE MOD 31.BG1 & BG2 HEAT RECOVERY. DISTILLERY HEAT RECOVERY BUILDING.	
APPD	DATE		REV. P05
	SCALE 1:400	PROJECT No. 7994 WAE	DWG No. MN7994-004

EXISTING APPROVED PLANT.

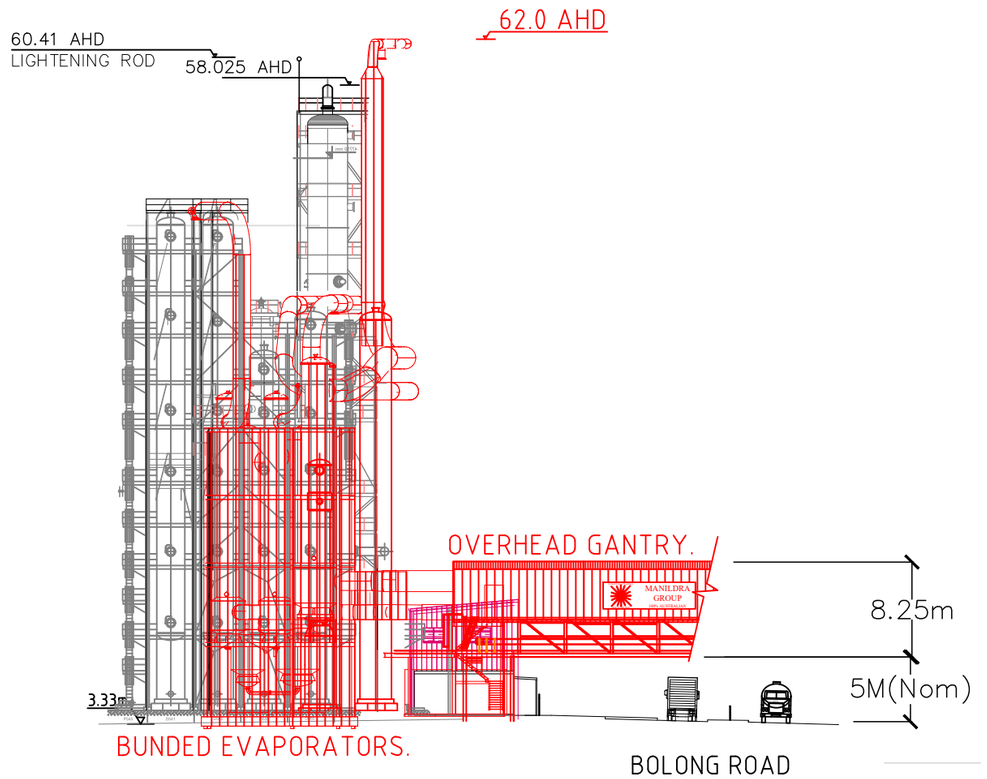
MOD 31.



PLAN VIEW.



SOUTHERN ELEVATION.



EASTERN ELEVATION.

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P06	ALL	Changes to match engineers design.	B.M.	28-05-25	MPoole	
P05	ALL	Changes to match engineers design.	P.C.	06-05-25	MPoole	
P04	ALL	Changes to match engineers design.	P.C.	22-11-24	MPoole	
P01	ALL	Construction layout.	P.C.	16-05-24	D.J.	

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P.C.

CHKD | DATE

APPD | DATE

SCALE 1:500

SHOALHAVEN STARCHES.BOMADERRY. NSW

DWG TITLE
MOD 31.BG1 & BG2 HEAT RECOVERY.
DISTILLERY HEAT RECOVERY EVAPORATORS.

PROJECT No. 7994 WAE

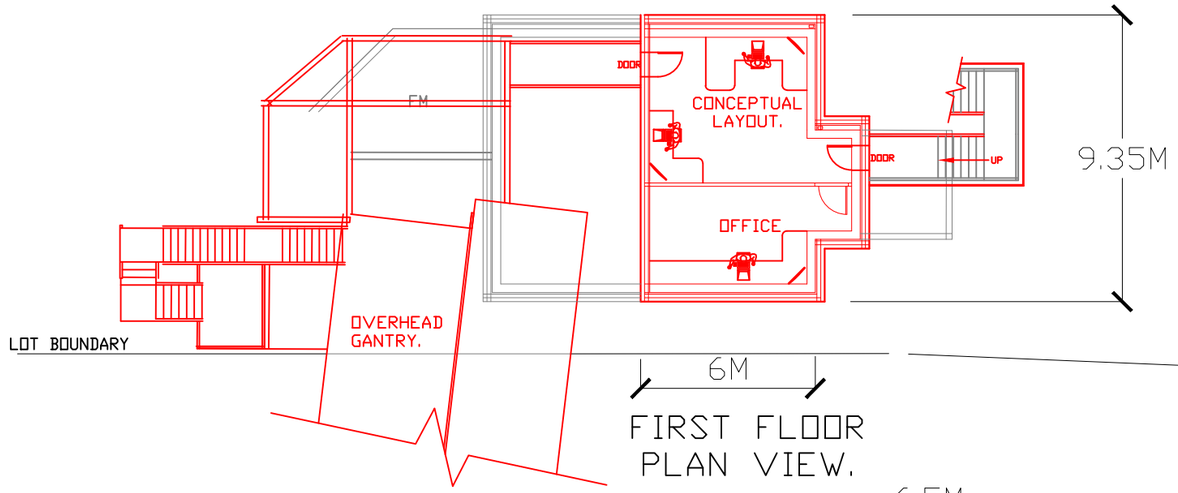
DWG No. MN7994-005

SHT SIZE A3

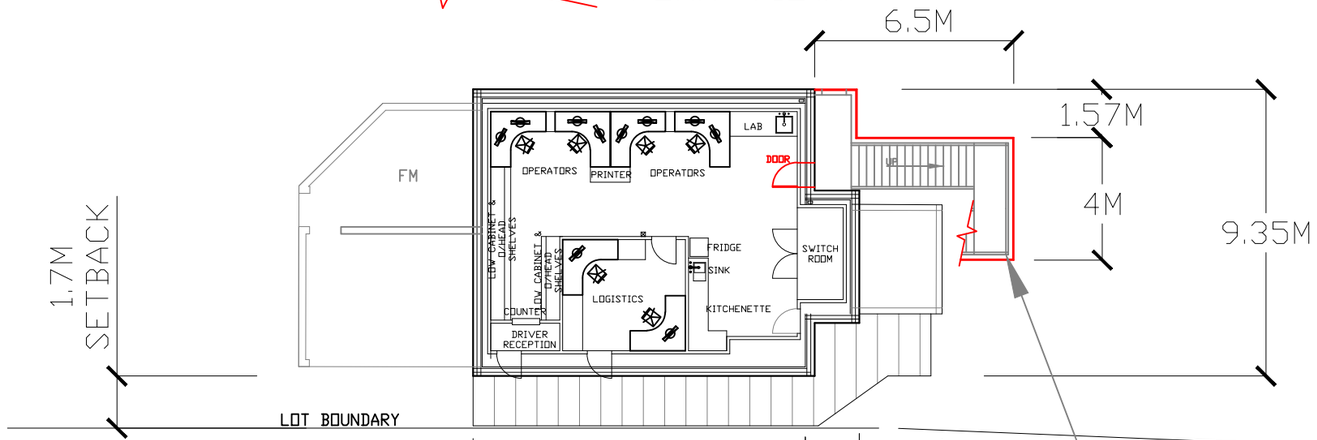
REV. P06

EXISTING APPROVED PLANT.

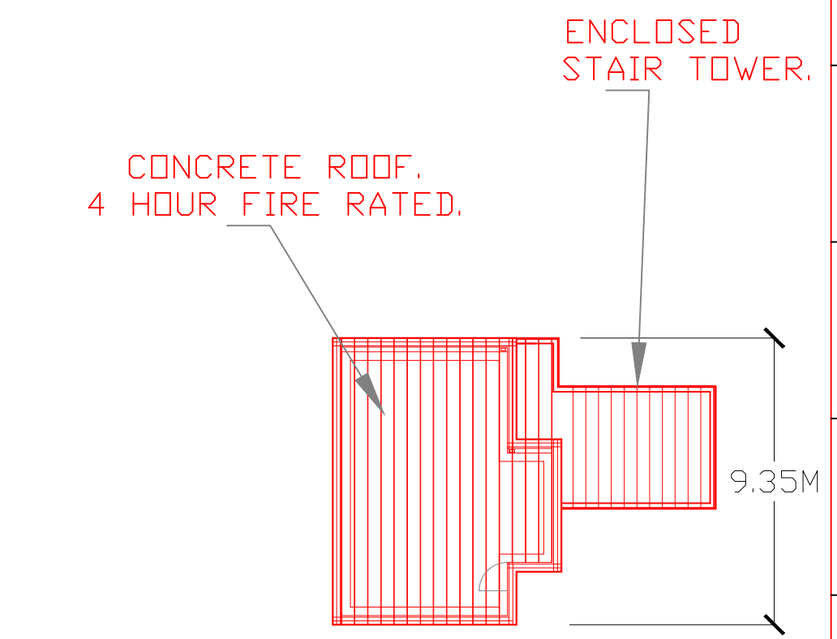
MOD 31.



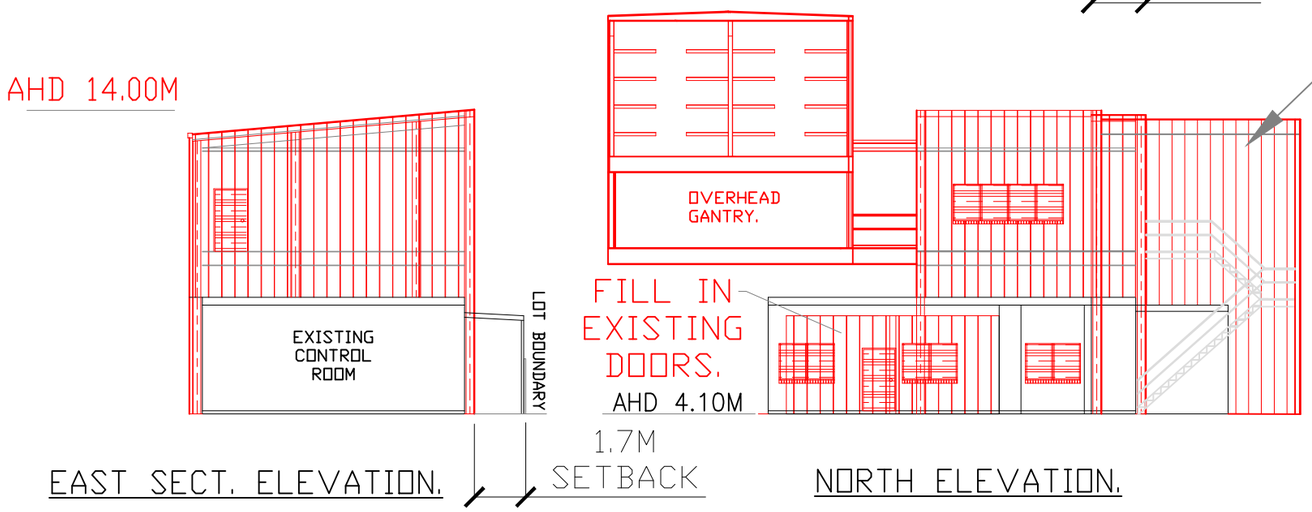
FIRST FLOOR PLAN VIEW.



GROUND FLOOR.



ROOF PLAN.



EAST SECT. ELEVATION.

NORTH ELEVATION.

WEST ELEVATION.

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
P16	ALL	Southern door removed.Egress to gantry shown in plan view.	P.C.	07-05-25	J.S.	
P15	ALL	Was Mod 22, was full length.	P.C.	07-05-25	J.S.	
P14	I7	Western window removed.	P.C.	20-09-23	A.T.	
P13	ALL	Some building details added for fire rating.	P.C.	06-09-23	A.T.	
P12	ALL	Existing veranda shown.	P.C.	01-8-22	BH	
P11	ALL	Was Mod 23.	P.C.	04-5-21	BH	
P10	ALL	Now Mod 23.	P.C.	25-03-21	BH	

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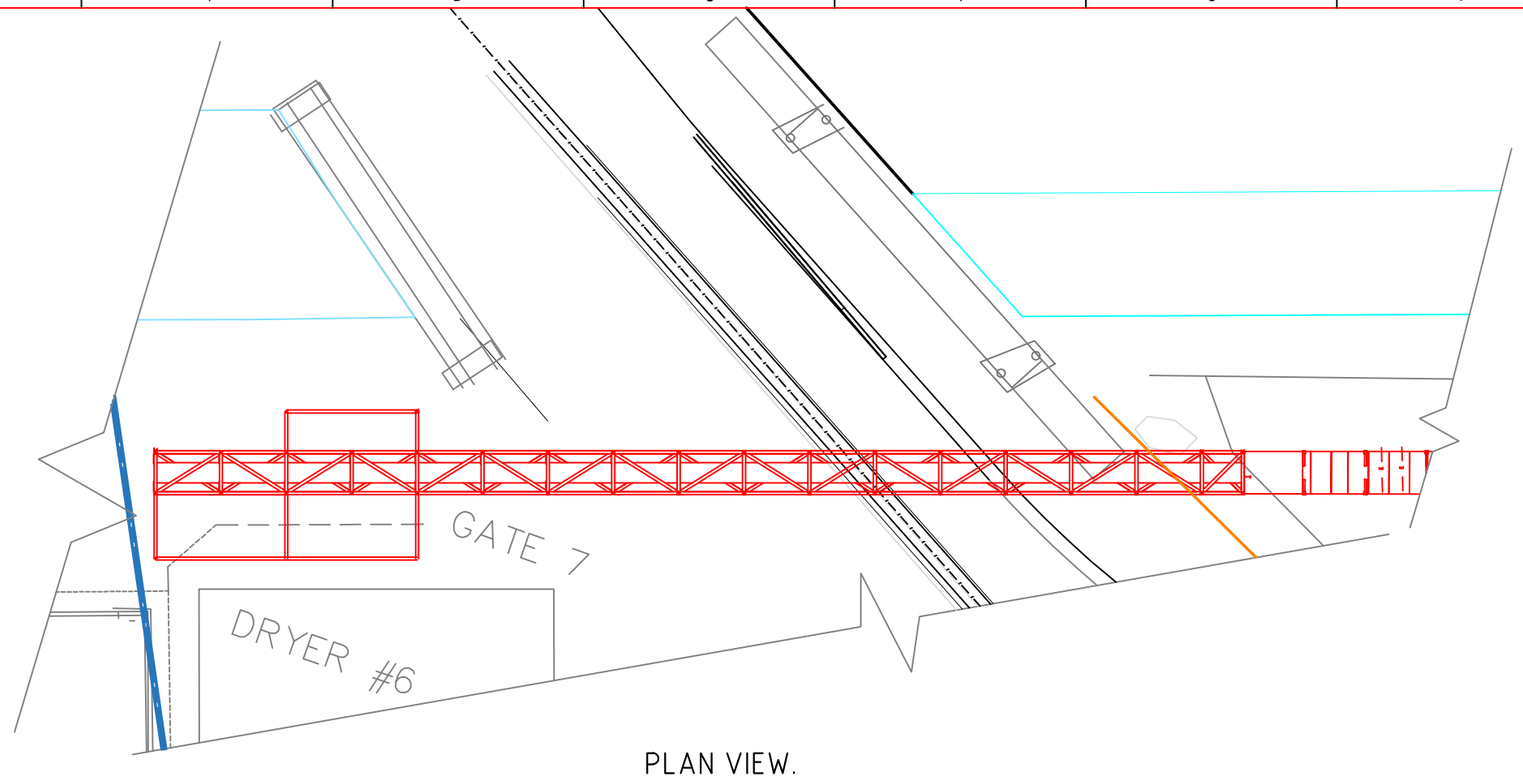
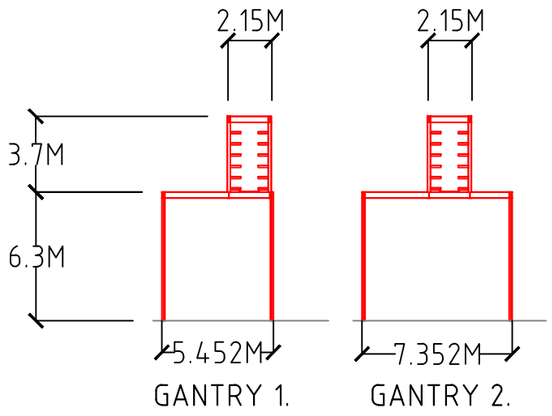
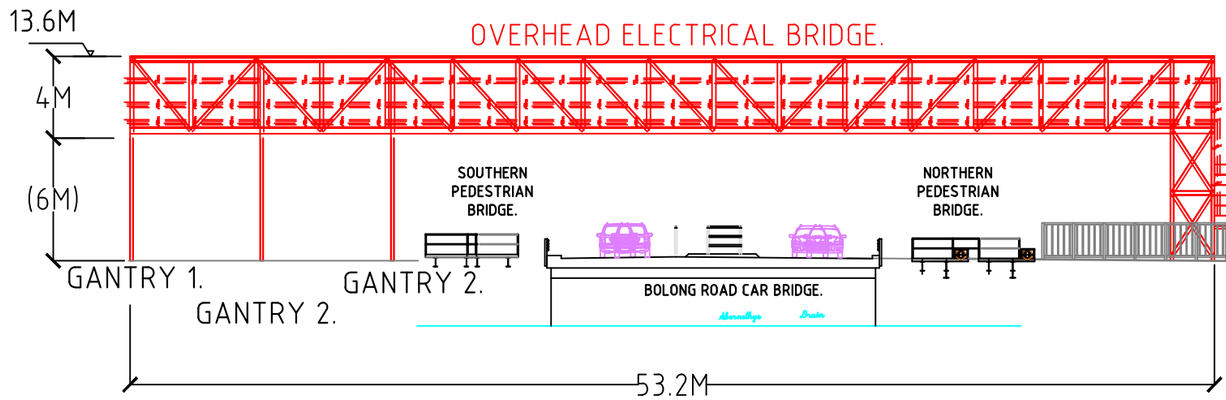
DRAWN P.C.	DATE 25/06/19	JOB TITLE SHOALHAVEN STARCHES.BOMADERRY. NSW	SHT SIZE A3
CHKD T.J.	DATE	DWG TITLE MOD 31. CONTROL ROOM ADDITIONS.	REV. P16
APPD	DATE		
	SCALE 1:200	PROJECT No. 7193WAE	DWG No. MN7994-006



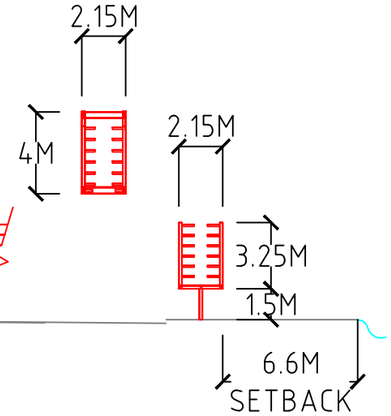
PLAN VIEW.



END ELEVATION.



EASTERN ELEVATION.



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P02	ALL	Electrical now above ground.End els added.	P.C.	21/05/25	DJ	
P01	ALL	First issue.	P.C.	09/05/25	MP	

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P.C.
CHKD DATE
APPD DATE
SCALES 1:300

EASTERN ELEVATION.

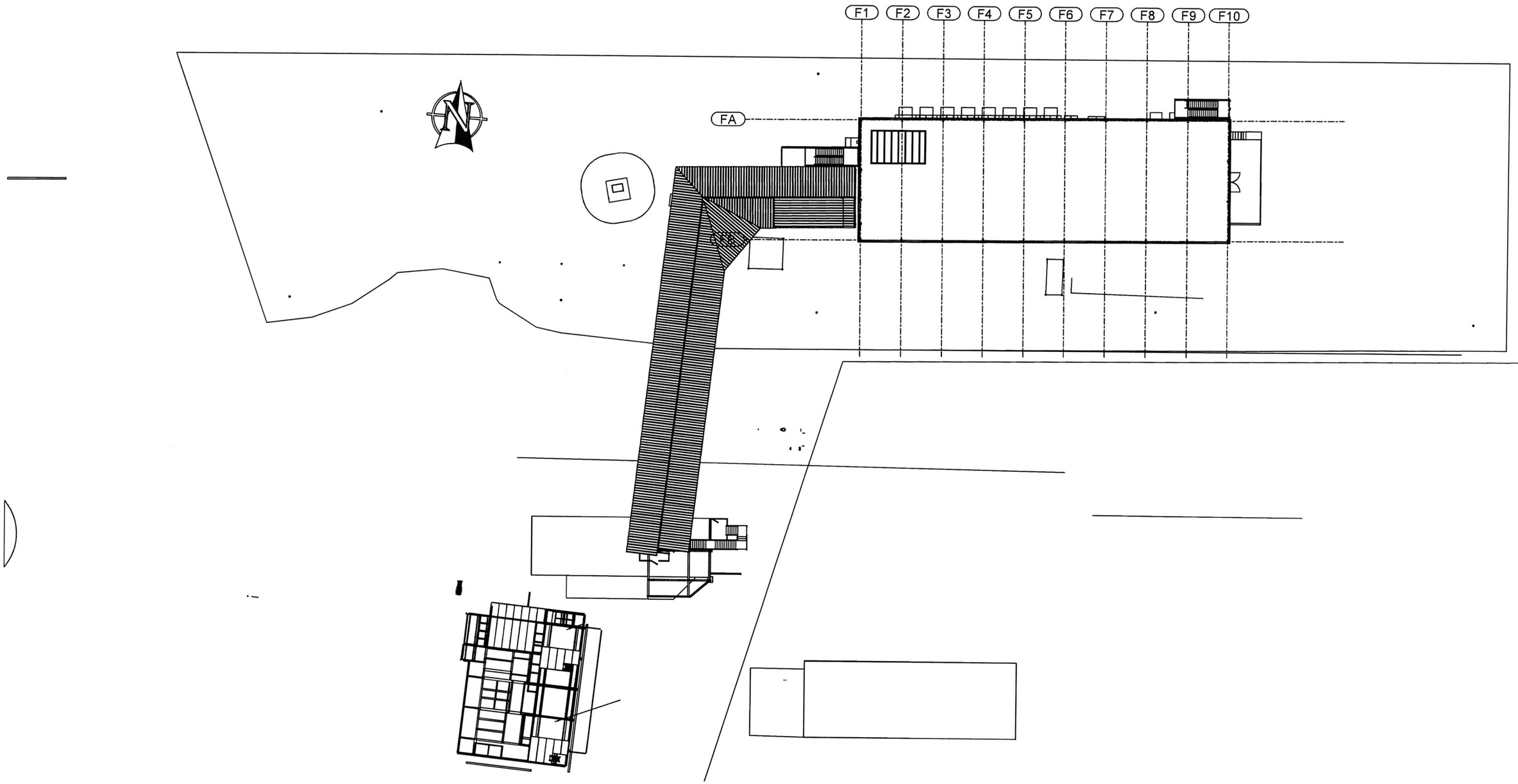
SHOALHAVEN STARCHES.BOMADERRY.NSW.

DWG TITLE
MOD 31.ELECTRICAL ROUTE.
OVERHEAD ELECTRICAL BRIDGE.

PROJECT No. MN7994-007
DWG No. MN7994-007

SHT SIZE A3
REV. P03

A1



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P1	FOR INFORMATION ONLY	20/11/24	P.L.	D.P.		

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TITLE:
PLAN VIEW
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SCALE	JOB No.	DRAWING No.	REV.
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DRAWN P.L.

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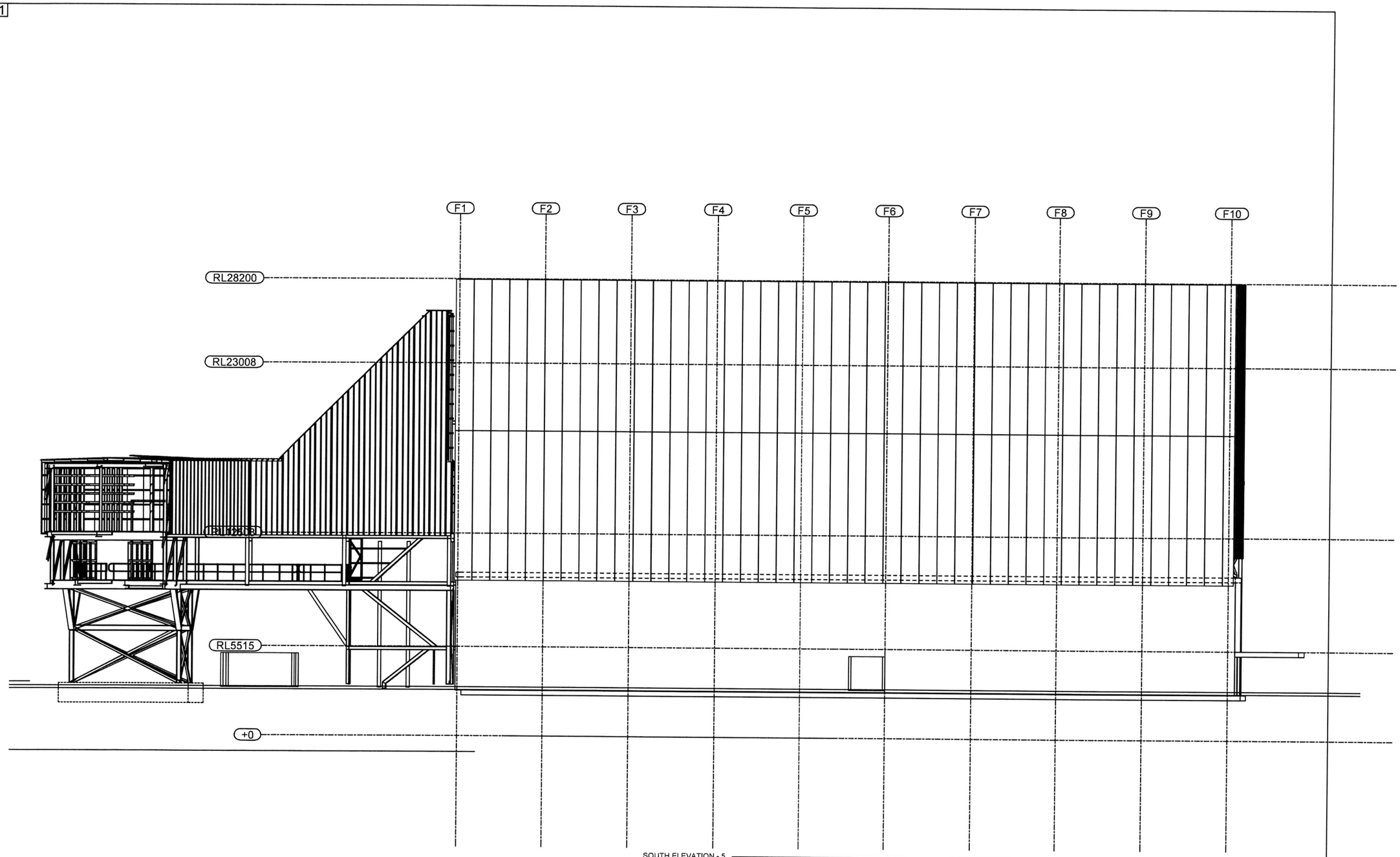

SOUTH ELEVATION - 5

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TITLE:
SOUTH ELEVATION
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SCALE	JOB No.	DRAWING No.	REV.
1:100	1208	SK02	P2

DRAWN P.L.

REV	REVISION DETAILS	DATE	DRG BY	DRG CHK	DESIGN CHK	DESIGN APPROVAL
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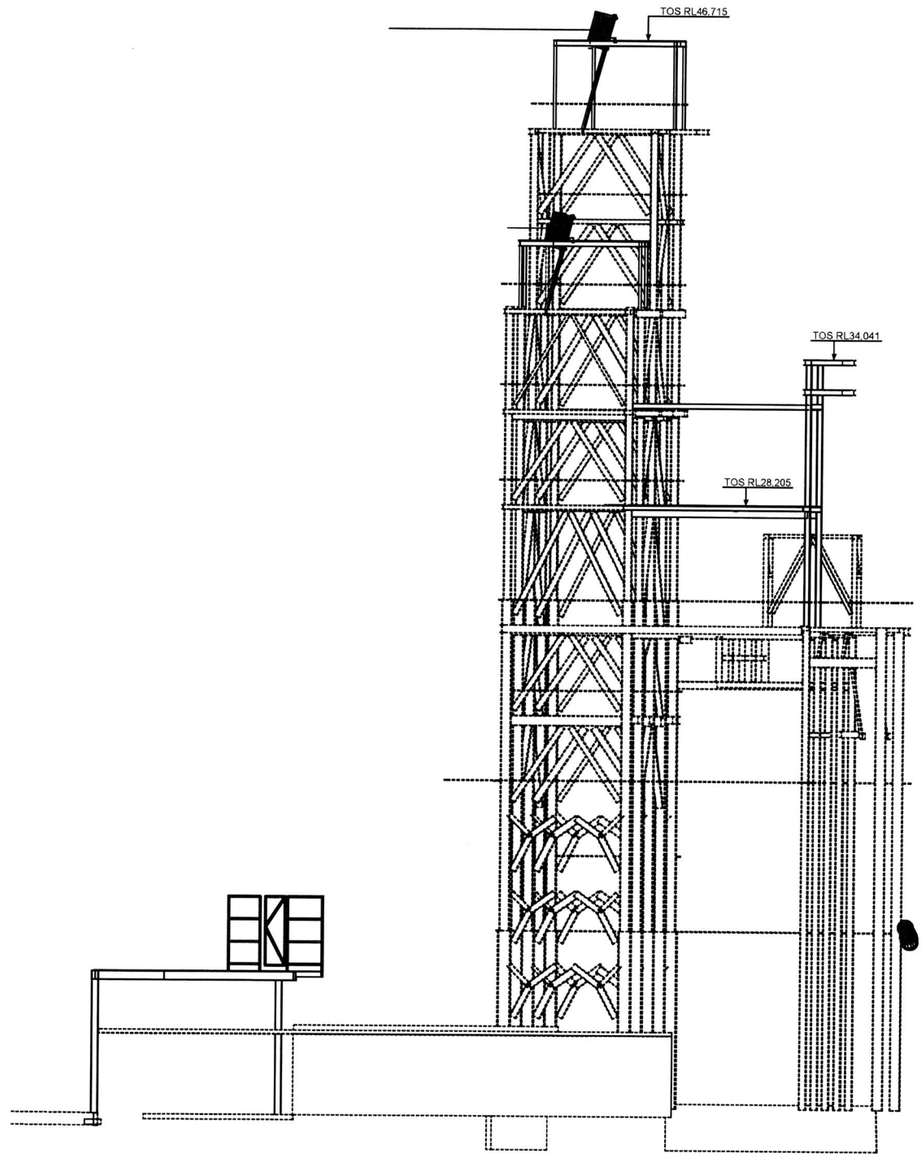
P1	FOR INFORMATION ONLY	20/11/24	P.L.	D.P.		

A1



EAST ELEVATION AT EVAPORATORS

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P1	FOR INFORMATION ONLY	20/11/24	P.L.	D.P.		

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TITLE:
EAST ELEVATION AT EVAPORATORS

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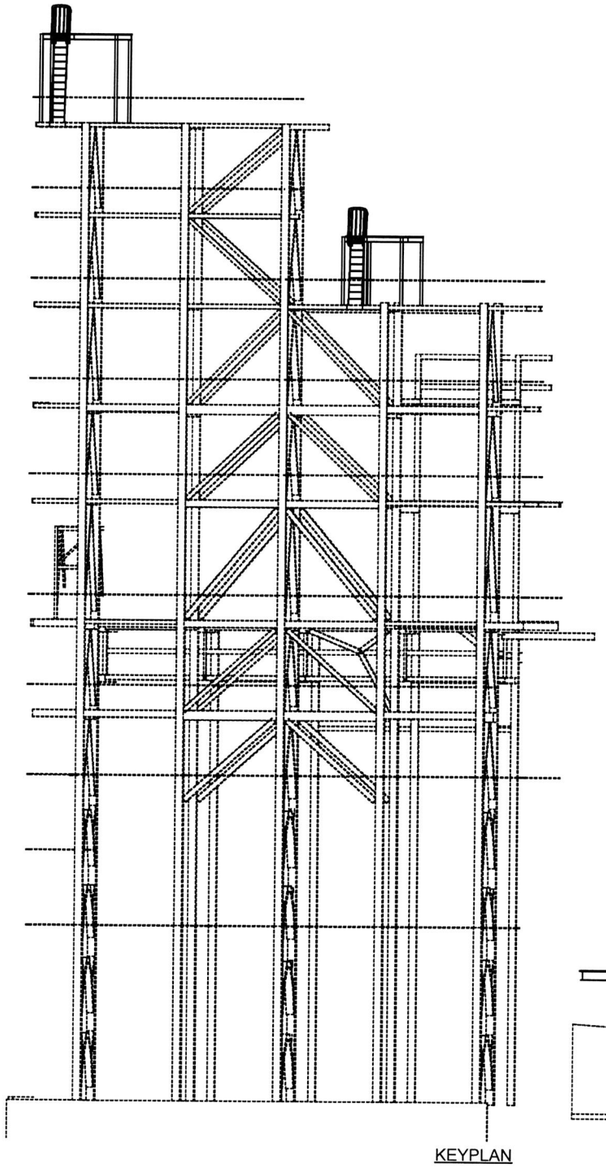
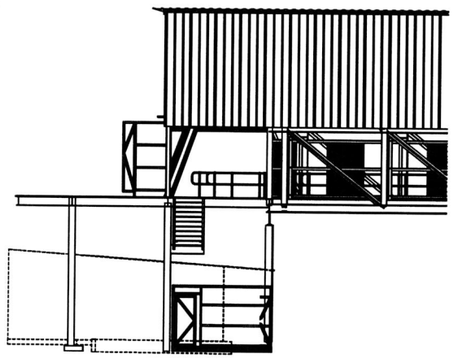


KEYPLAN



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NORTH ELEVATION
.

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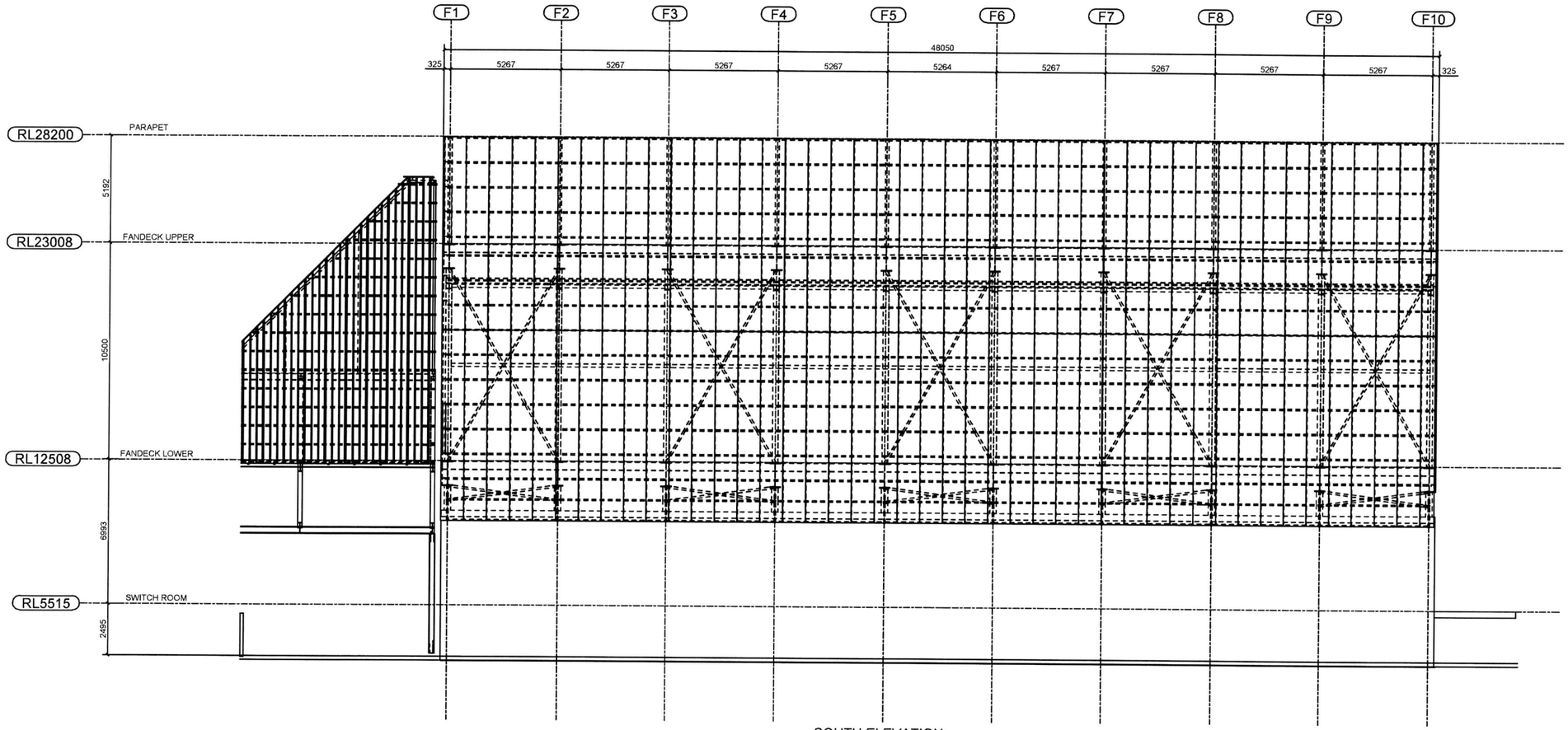
A1



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P1	FOR INFORMATION ONLY	28/03/25	P.L.	D.P.		

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SCALE	JOB No.	DRAWING No.	REV.
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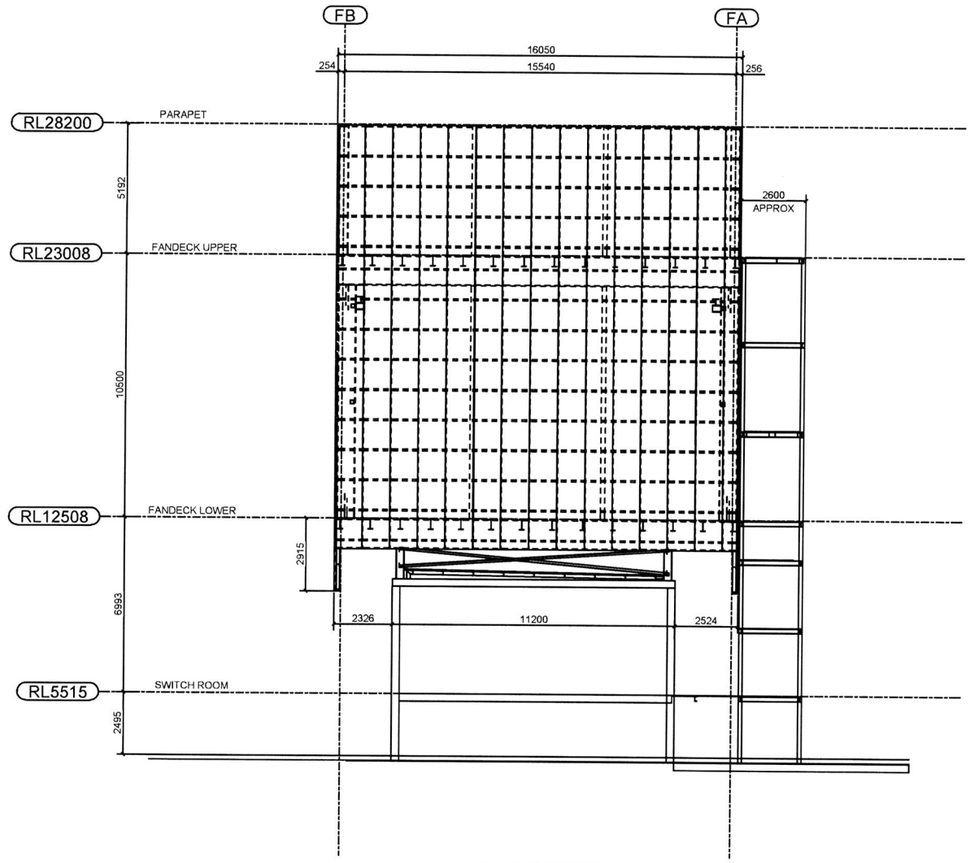
DRAWN P.L.

A1



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P1	FOR INFORMATION ONLY	28/03/25	P.L.	D.P.		

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FAN BUILDING
EAST ELEVATION

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DRAWN P.L.

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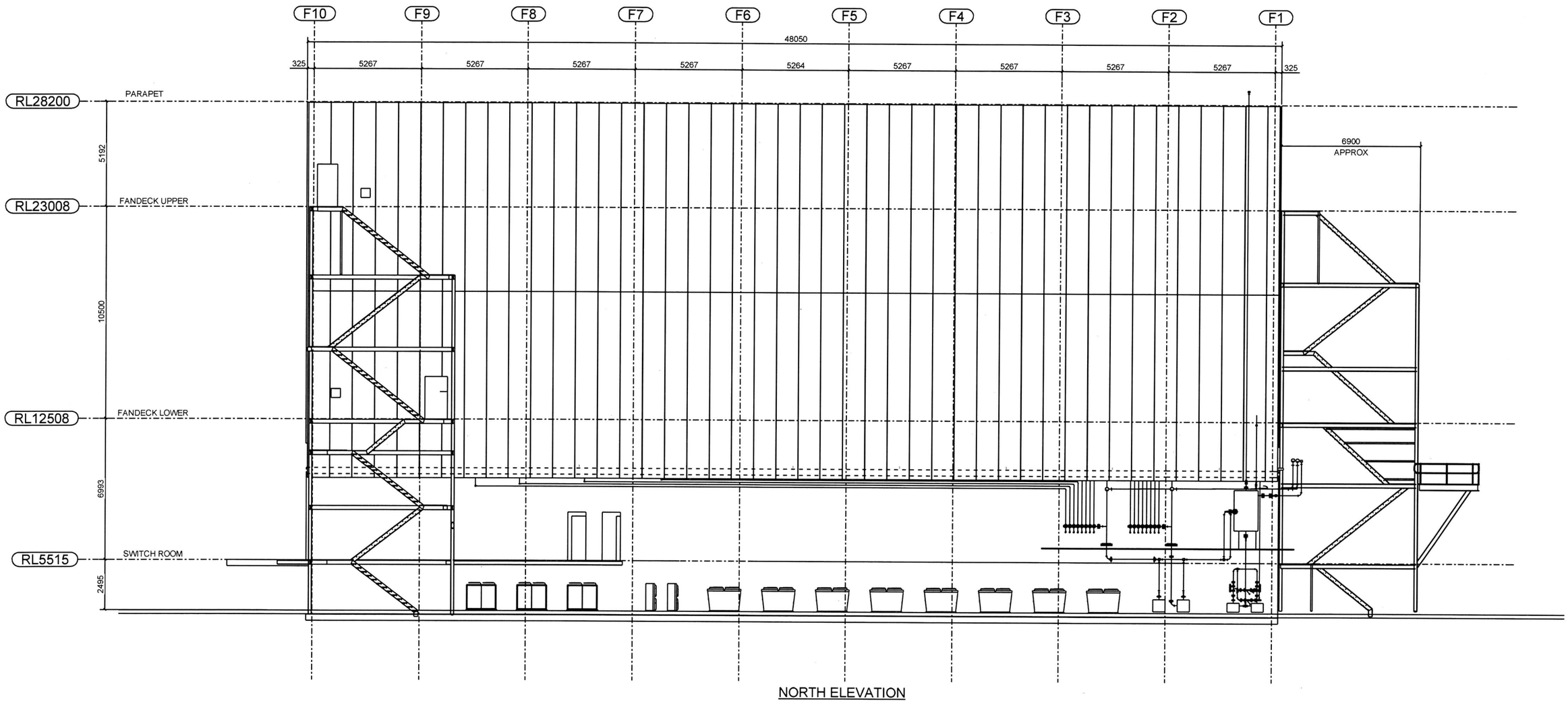

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P1	FOR INFORMATION ONLY	28/03/25	P.L.	D.P.		

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FAN BUILDING
NORTH ELEVATION

SCALE	JOB No.	DRAWING No.	REV.
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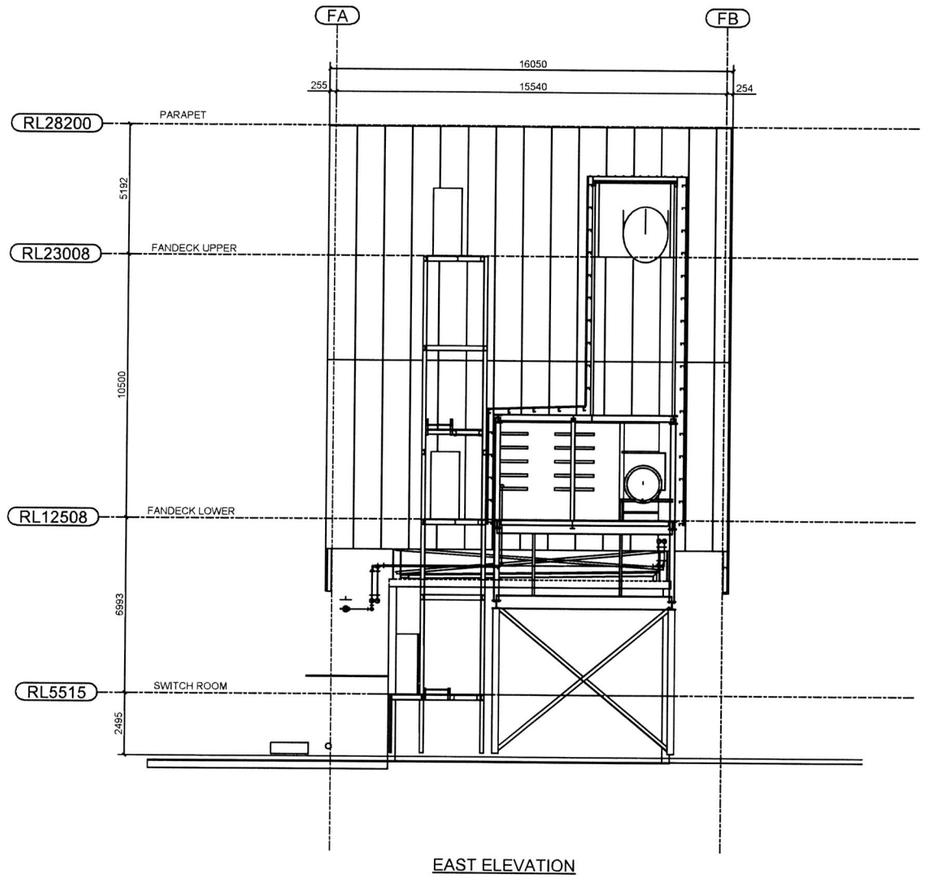

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EAST ELEVATION

SCALE	JOB No.	DRAWING No.	REV.
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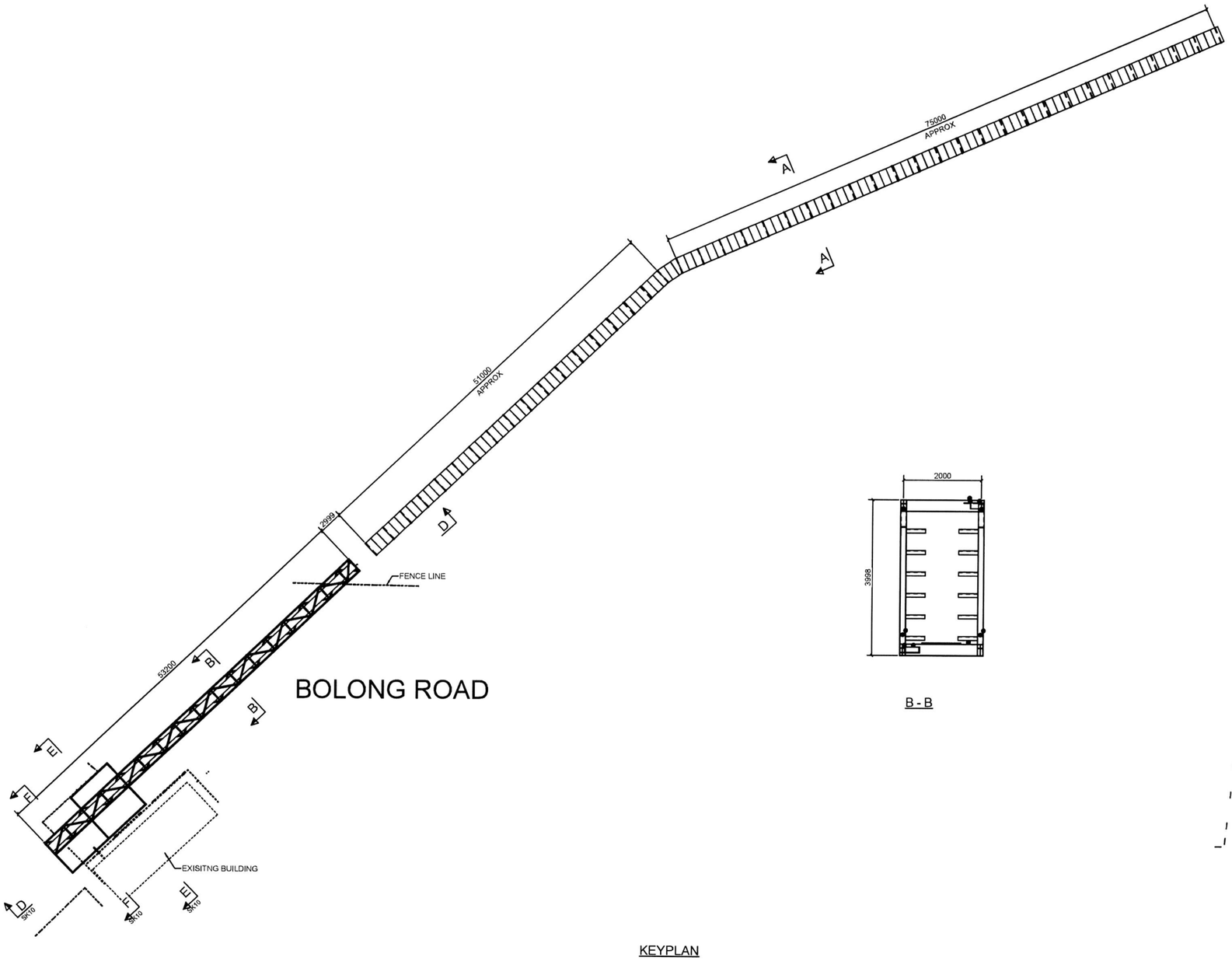

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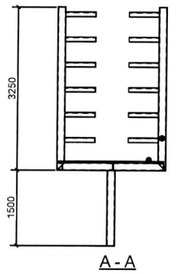

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B - B

KEYPLAN

REV	REVISION DETAILS	DATE	DRG BY	DRG CH'K	DESIGN CH'K	DESIGN APPROVAL
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TITLE:
ELEC BRIDGE PLAN

SCALE	JOB No.	DRAWING No.	REV.
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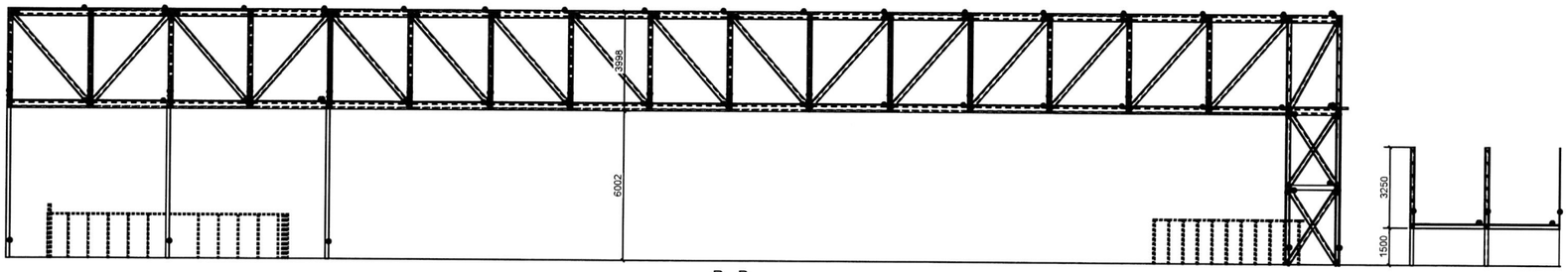
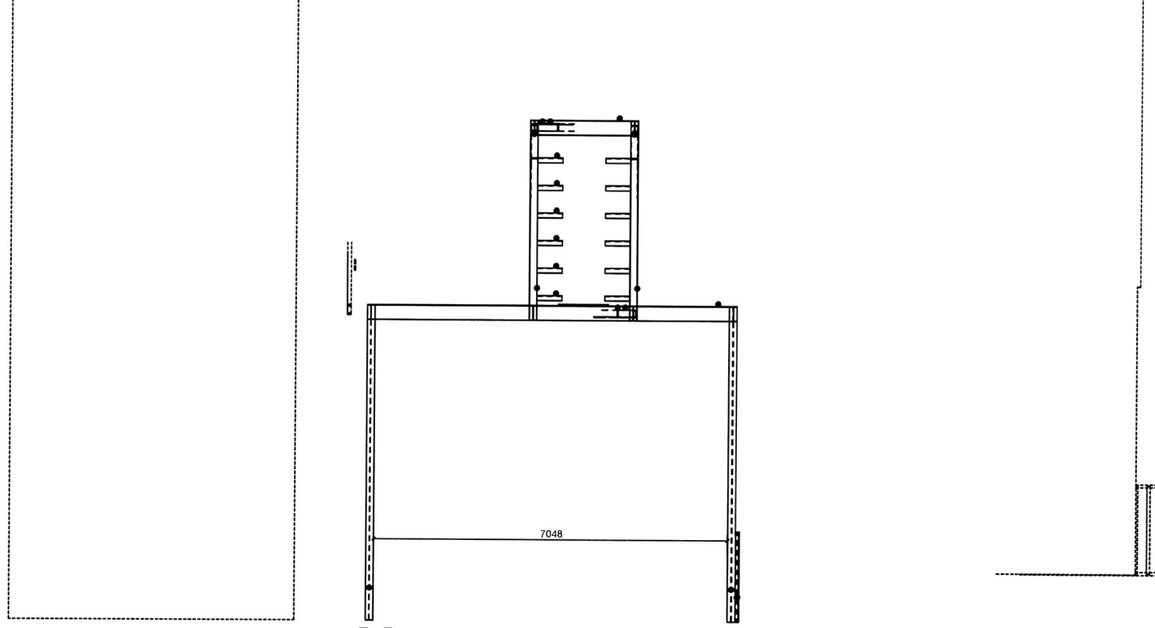
DRAWN P.L.

A1



D - D
SK09



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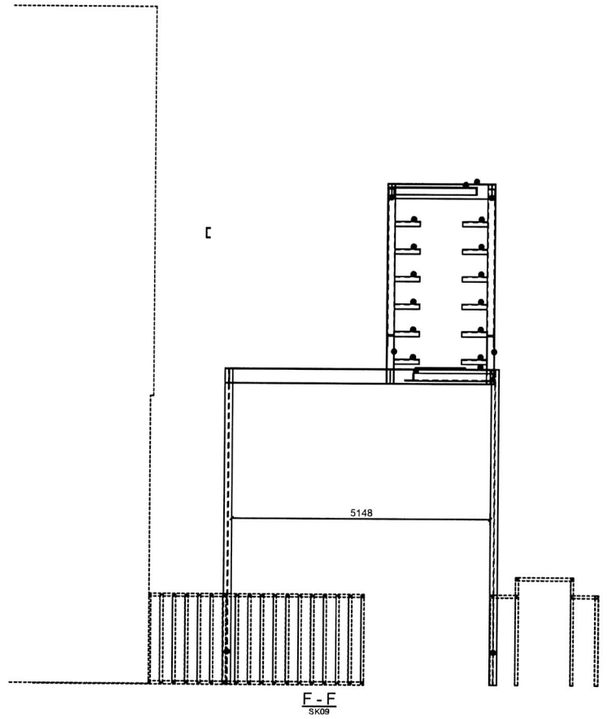

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TITLE:
ELEC BRIDGE SECTIONS

SCALE	JOB No.	DRAWING No.	REV.
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DRAWN P.L.

REV.	REVISION DETAILS	DATE	DRG BY	DRG CH'K	DESIGN CH'K	DESIGN APPROVAL
P2	FOR INFORMATION ONLY	11/04/25	P.L.	D.P.		

Inclusion of August 2024 Australian Rainfall & Runoff Version 4.2 Climate Change

Appendix C

APPENDIX C: Inclusion of August 2024 Australian Rainfall & Runoff Version 4.2 Climate Change

C1 Introduction

The hydrologic and hydraulic modelling in this report was taken from the November 2022 Lower Shoalhaven River Flood Study which was adopted by Shoalhaven City Council for application of design flood levels on the lower Shoalhaven River floodplain. The 2022 Flood Study adopted the 2019 ARR (Reference 4) approach for design flood modelling which was the best practice approach at the time and undertook a climate change analysis with the summary text provided below.

The study also assessed the potential impacts of both Climate Change induced rainfall increases and sea level rise using current recommended ARR2019 values based on global climate modelling. Increased rainfall due to climate change has the biggest impact in the Shoalhaven River upstream of Nowra Bridge due to the increased flows and the incised valley. The increased flow dominates changes in expected flood levels to approximately Terara, with sea level rise having impacts in the Shoalhaven River downstream of Terara and in the Crookhaven River/Crookhaven Creek floodplain. Only minor increases in flood level are observed in the Broughton Creek floodplain.

For the 1% AEP, with rainfall increases of 16.3% due to Climate Change, associated increased flows may result in increases in flood levels in the Shoalhaven River upstream of Nowra by up to almost 1.4m at Grassy Gully and 1.1m at Gradys Caravan Park reducing to 200mm at Nowra Bridge. Increases in the lower floodplain areas are generally less than 150mm for all scenarios up to 7.6% rainfall increase with increases typically 150 – 250 mm for the 16.3% (2090 RCP 8.5) rainfall increase.

In combination with Sea Level Rise a further increase in water levels may be expected around low-lying foreshore areas and up to 400mm total water level increases near the Shoalhaven and Crookhaven River entrances.

C2 August 2024 Engineers Australia ARR Version 4.2

In August 2024 Engineers Australia released ARR Version 4.2. The most significant change was inclusion of an updated anthropomorphic climate change approach. This provided a methodology to include climate change increases in design rainfall intensities to those adopted in the 2022 Flood Study, as stated below.

There is unequivocal evidence that greenhouse gas emissions have caused global warming. The Intergovernmental Panel on Climate Change's sixth assessment report concluded that global surface temperatures have significantly increased above pre-industrial levels, with significant further warming expected (IPCC, 2023). This warming is causing an increase in many drivers of flood risk, including an intensification of extreme rainfall events and the elevation of average and extreme sea levels (IPCC, 2023).

Traditionally, design flood estimation has assumed that historical observations are representative of current and future conditions. This is no longer the case. Records on historical flooding or flood drivers (such as extreme rainfall or sea level) can no longer be assumed to provide a direct analogue of current or future flood risk. To account for significant observed and projected changes to the drivers of flooding, it is necessary to account for the non-stationarity of flooding in the assessment of current and future flood risks.

Key differences from the ARR 2019 Climate Change Considerations chapter (Version 4.1) include the following.

- Recognition that global temperatures have increased over the historical period used to derive design rainfall information.
- A recommendation to adjust 2016 Intensity-Frequency-Duration curves to present (i.e. current climate) conditions.
- Provision of information to support a range of approaches to decision-making.
- Provision of guidance across the range of AEP considered in ARR up to and including the PMP.
- Provision of uncertainty estimates.
- Consideration of additional factors that influence design flood estimates; that is, changes in rainfall losses, temporal patterns, and sea level rise.

C3 Description of August 2024 ARR Climate Change Approach

The latest Intergovernmental Panel on Climate Change (IPCC) temperature projections are based on Shared Socioeconomic Pathways (SSPs) that cover a broad range of potential future development options referred to as very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5) emissions pathways. SSPs are the current 'what if' scenarios used to explore the consequences of greenhouse gases accumulating in the atmosphere. Each SSP outlines ways the world might change in the future, including different types of energy generation, rates of population growth, economic development and land uses. These lead to different levels of greenhouse gas emissions over time.

The SSP "names" consist of the following two parts. The "SSP Family" code based on one of the five global socio-economic narratives, and the extra energy reaching the earth by the year 2100. This is summarised Diagram C1 with the projected temperature increases for each SSP shown on Diagram C2.

Diagram C1: Representation of SSPs

	SSP1-1.9 "SUSTAINABILITY"	SSP1-2.6 "SUSTAINABILITY"	SSP2-4.5 "MIDDLE OF THE ROAD"	SSP3-7.0 "REGIONAL RIVALRY"	SSP5-8.5 "FOSSIL-FUELLED DEVELOPMENT"
RCP equivalent	No equivalent RCP	RCP2.6	RCP4.5	No equivalent RCP	RCP8.5
THE WAY THE WORLD MIGHT CHANGE IN THE FUTURE					
Emissions reduction	Very high and immediate	High and immediate	Moderate from 2040s	None (minor slowing)	None (accelerating)
Energy sources	Renewables	Renewables and biofuels	Renewables and fossil fuels	Fossil fuels	Increased fossil fuels
Carbon dioxide removal	New technology	New technology	None	None	None
Global socio-economic trends	Gradual move towards sustainability and environmental respect; increasing action towards Sustainable Development Goals (SDGs)	Gradual move towards sustainability and environmental respect; increasing action towards SDGs	Similar to the past; unevenly distributed; slow progress towards SDGs	Slow and increasingly unequal	Rapid growth at the expense of the environment; resource intensive lifestyles and industries; high investment in health and education; dependence on technological solutions
WHAT THE FUTURE CLIMATE MAY LOOK LIKE UNDER EACH SSP					
Global warming by 2100	1.0-1.8°C	1.3-2.4°C	2.1-3.5°C	2.8-4.6°C	3.3-5.7°C
Resulting global warming levels*	Due to past emissions all SSPs reach 1.5°C in the 2030s and then diverge				
	Overshoots 1.5C slightly around 2050 then returns and stabilises near 1.5C by 2100	Reaches 2°C around 2050s and stabilises	Reach 2°C around 2050s 2.7°C by 2100	Reach 2°C around 2050s 3°C around 2070s 4°C possible by 2100	Reach 2°C around 2050s 3°C around 2060s 4°C by around 2080s

Diagram C2: Projected temperature increases associated with the 6th IPCC Report socioeconomic pathways relative to 1961-1990 and their associated uncertainty

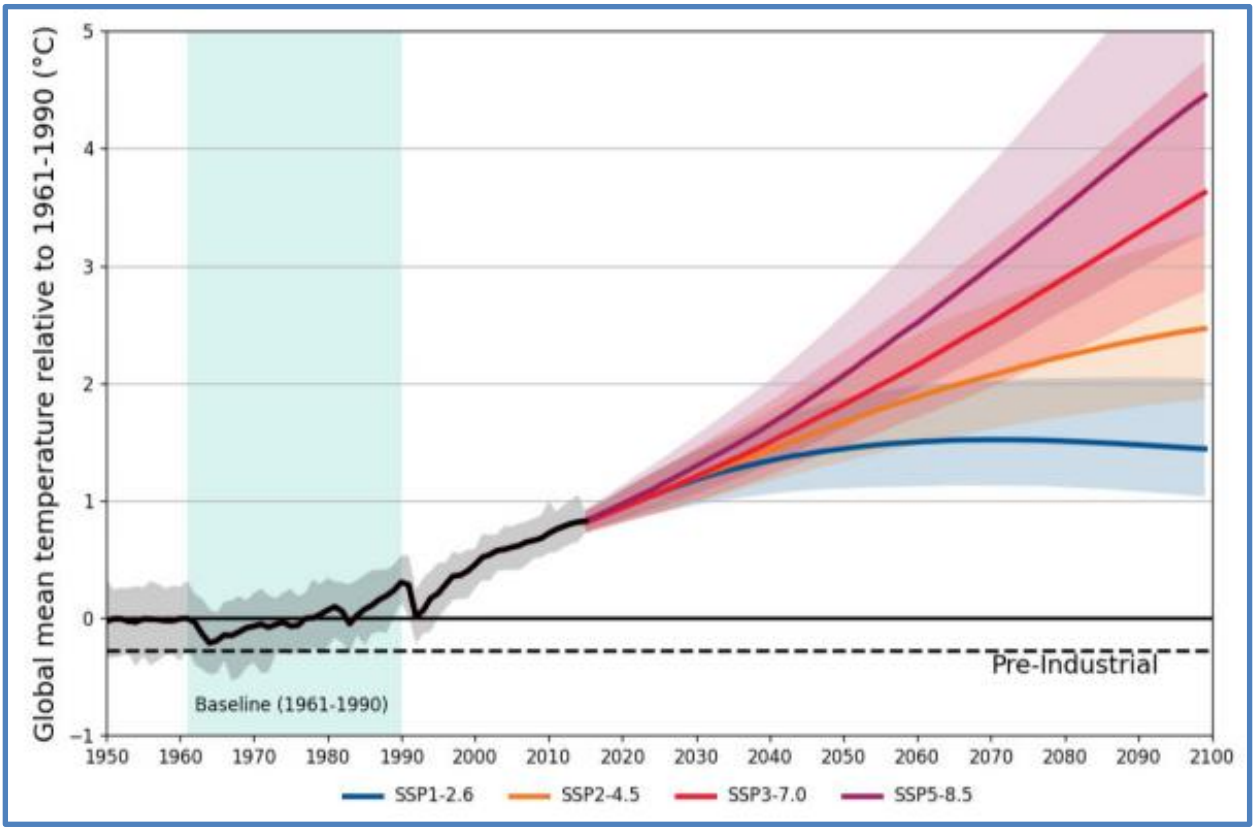
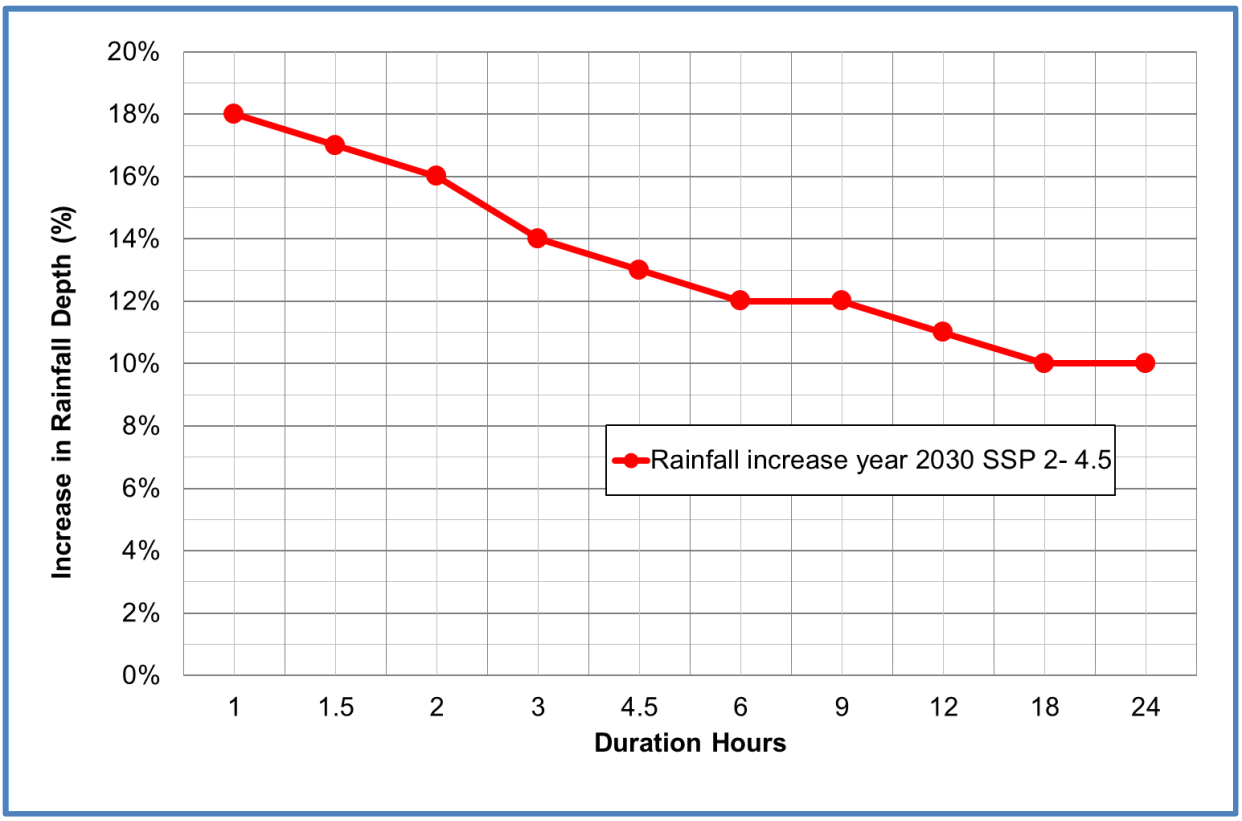


Diagram C3 indicates the percentage increase in rainfall depth from the data in ARR 2019 to the Year 2030 data provided in ARR V 4.2. Thus, for the durations of event producing flooding in the study area (say > 12 hours) the increase due to upgrading to the Year 2030 is around 10%.

Diagram C3: Change in Rainfall Depth for ARR 2019 IFD data Updated to the Year 2030 (SSP 2-4.5)



C4 Methodology for Inclusion of August 2024 ARR Climate Change Approach in this Report

Shoalhaven City Council advised that the August 2024 ARR Climate Change approach should be adopted as part of this Flood Compliance Report and this required updating the 2022 Flood Study hydrologic modelling. Initially, Council provided a WBNM hydrologic model that was developed by Rhelm Consulting to apply in the upcoming Lower Shoalhaven River Flood Risk Management Study (due in 2026). The WBNM approach was determined to not be practical as it would require extensive work to develop the critical storm durations and to justify why the WBNM results are compatible with the 2022 Flood Study results.

Council advised that WMAwater could use either the WBNM approach or the XPRafts hydrologic model approach which was adopted in the 2022 Flood Study. Council then provided a copy of the XPRafts hydrologic model together with input data. For various software reasons WMAwater could not directly use the supplied XPRafts model / input data and therefore developed their own approach using the data provided. It should be noted that XPRafts has been discontinued and thus there are no software updates to address changes in methodology (such as climate change).

The same critical duration storms and associated rainfall data (loss rates) adopted in the 2022 Flood Study were adopted in the current analysis and these are shown in Diagram C4.

Table 9-1 Design events and durations

AEP	Critical Durations Simulated
50%	6hr, 18hr
20%	90min, 6hr, 18hr
10%	90min, 3hr, 18hr
5%	90min, 3hr, 18hr
2%	12hr, 18hr
1%	12hr, 18hr
0.2%	2hr, 6hr, 36hr
PMF	24hr, 72hr

Diagram C4: Critical Duration Storms Adopted in the 2022 Flood Study (Reference 1)

C5 Results

To be confident that the WMAwater modelling approach produced the same (or very similar) results to 2022 Flood Study results, Figures C1 (5% AEP), C2 (1% AEP) and C3 (PMF) provide a comparison between the two approaches. These show that the differences between the two sets of results for the three design events are within +0.05m & -0.05m and thus the WMAwater XPRafts hydrologic modelling approach can be adopted.

Figures C4 (5% AEP), C5 (1% AEP) and C6 (PMF) indicate the increase in peak flood level due to adoption of the 2030 SSP3 planning horizon including a 0.1m sea level rise with no change to the topography (i.e these results reflect solely the impact of climate change). Within the floodplain areas downstream of Nowra in the 5% AEP there are increases of greater than 0.4m, up to 0.3m in the 1% AEP and up to 0.4m in the PMF.

Figures C7 (5% AEP), C8 (1% AEP) and C9 (PMF) indicate the increase in peak flood level due to adoption of the 2100 SSP3 planning horizon including a 0.9m sea level rise with no change to the topography (i.e these results reflect solely the impact of climate change). Within the floodplain areas downstream of Nowra there are increases greater than 0.4m in all three design events.

Figure C10 shows the difference in incremental effect (1% AEP event) of the Mod31 works from the July 2025 Existing conditions if climate change (Year 2030 SSP3 including a 0.1m sea level rise) is adopted for the Existing and Mod31 conditions. Figure C10 indicates that the incremental effect of the Mod31 works for the 1% AEP event is similar whether climate change (Year 2030 SSP3 including a 0.1m sea level rise) is included or not in the Existing and Design conditions.

Figure C11 and C12 indicate the design flood depths and contours for the 1% AEP event, post Mod31 works, for the Year 2030 and Year 2100, SSP3 respectively.

FIGURE C1
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
CHANGE IN PEAK FLOOD LEVEL
2022 FLOOD STUDY V WMAWATER XPRAFTS
5% AEP EVENT

N

Study Area

Impact (m)

- < -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- > 0.4
- No Longer Flooded
- Newly Flooded

0 0.5 1 2 3 4 Kilometers

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FIGURE C2
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
CHANGE IN PEAK FLOOD LEVEL
2022 FLOOD STUDY V WMAWATER XPRAFTS
1% AEP EVENT

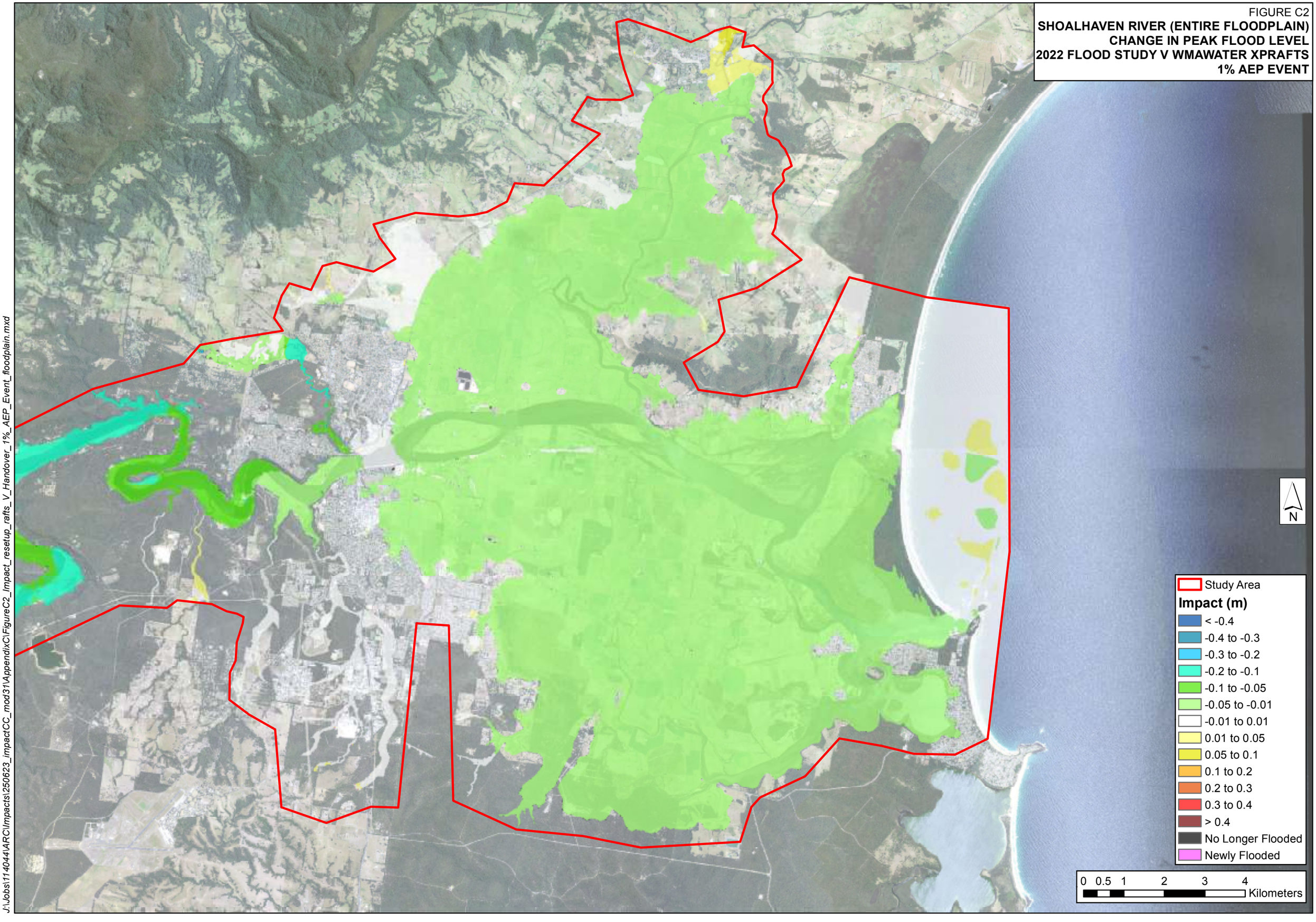

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FIGURE C3
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
CHANGE IN PEAK FLOOD LEVEL
2022 FLOOD STUDY V WMAWATER XPRAFTS
PMF EVENT

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N

Study Area

Impact (m)

- < -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- > 0.4
- No Longer Flooded
- Newly Flooded

0 0.5 1 2 3 4 Kilometers

FIGURE C4
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
INCREASE IN PEAK FLOOD LEVELS
YEAR 2030, SSP3
5% AEP EVENT

N

Study Area

Impact (m)

- < -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- > 0.4
- No Longer Flooded
- Newly Flooded

0 0.5 1 2 3 4 Kilometers

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FIGURE C5
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
INCREASE IN PEAK FLOOD LEVELS
YEAR 2030, SSP3
1% AEP EVENT

N

Study Area

Impact (m)

- < -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- > 0.4
- No Longer Flooded
- Newly Flooded

0 0.5 1 2 3 4 Kilometers

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FIGURE C6

SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
INCREASE IN PEAK FLOOD LEVELS
YEAR 2030, SSP3
PMF EVENT

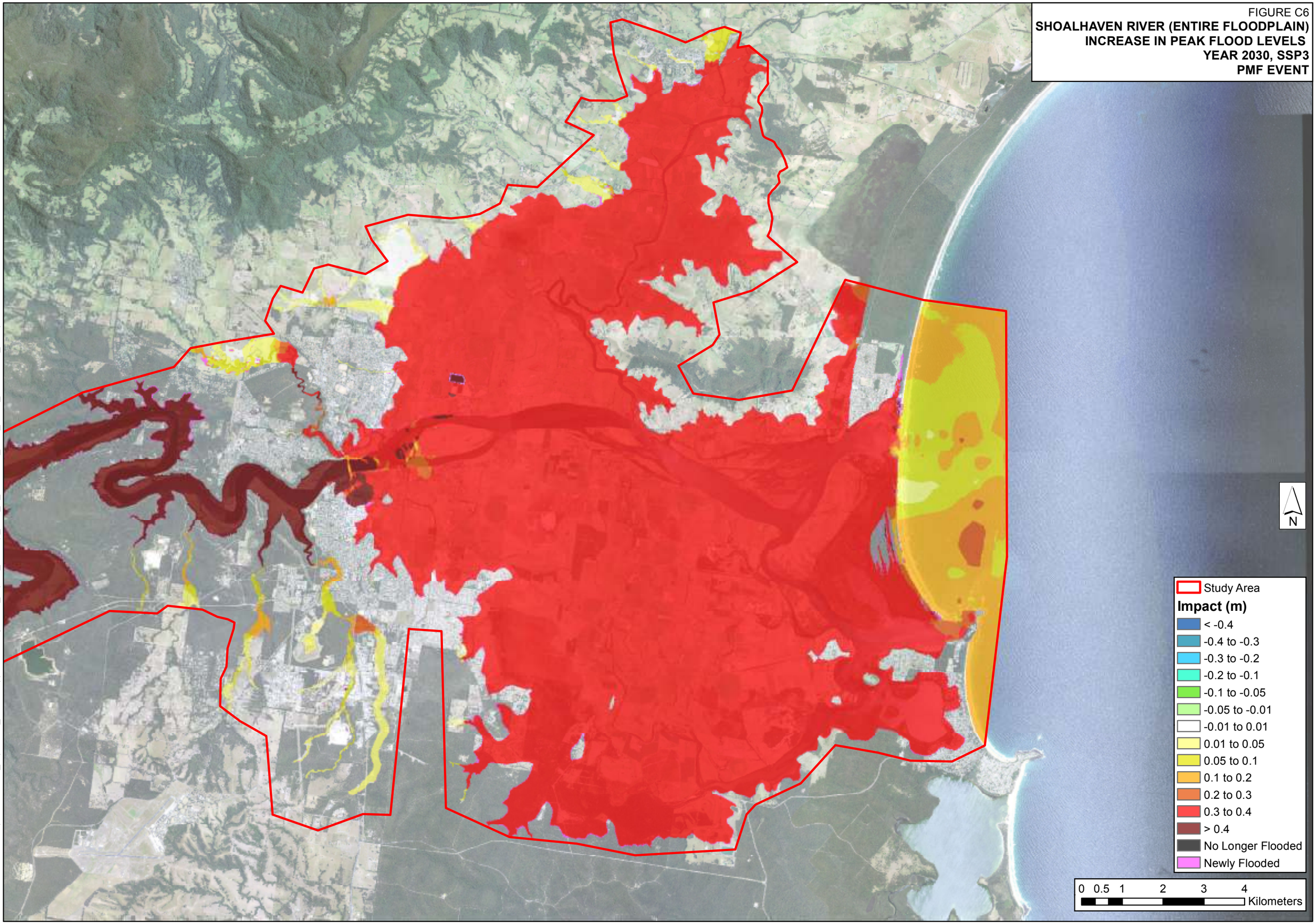

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FIGURE C7
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
INCREASE IN PEAK FLOOD LEVELS
YEAR 2100, SSP3
5% AEP EVENT

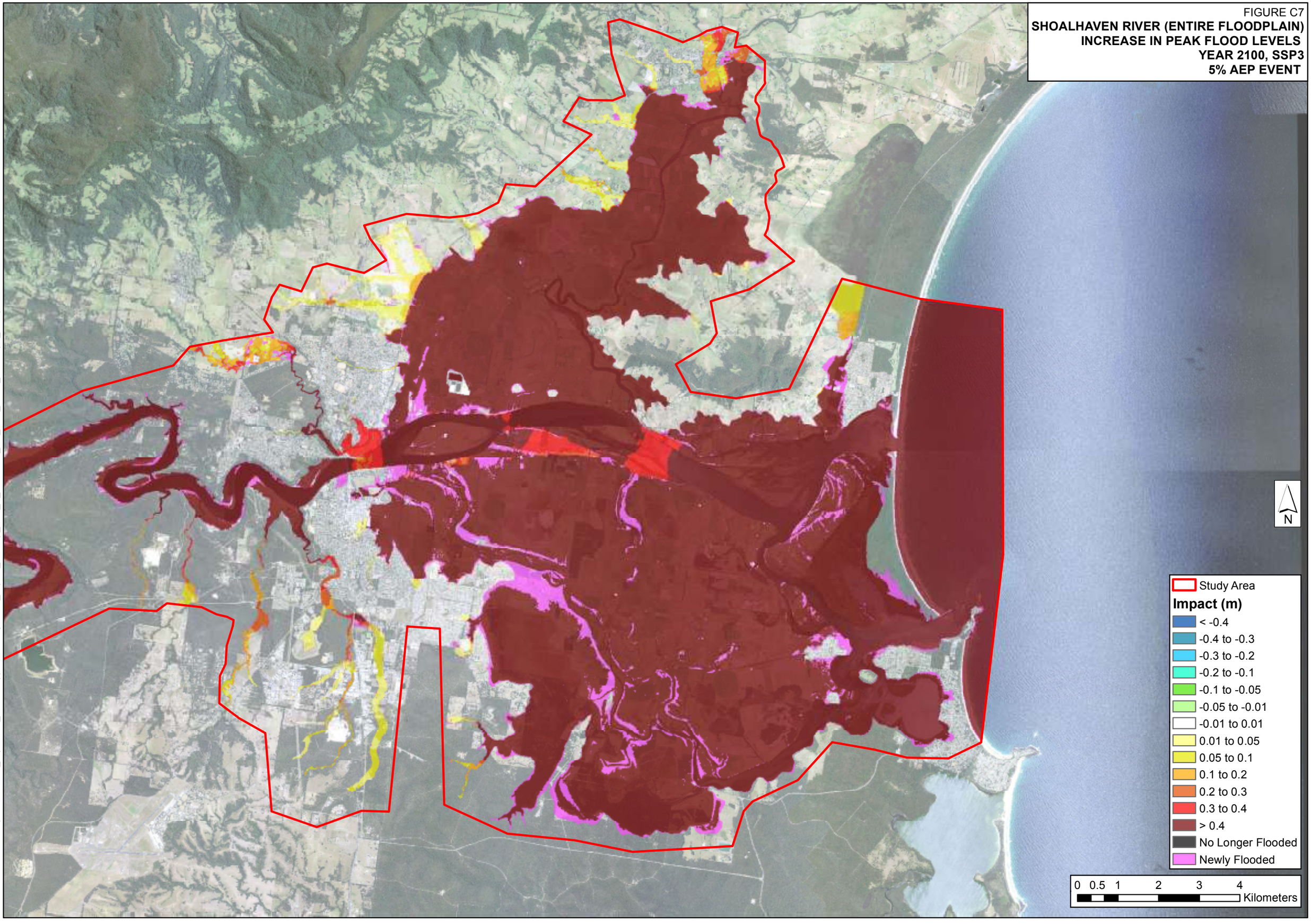

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FIGURE C8
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
INCREASE IN PEAK FLOOD LEVELS
YEAR 2100, SSP3
1% AEP EVENT

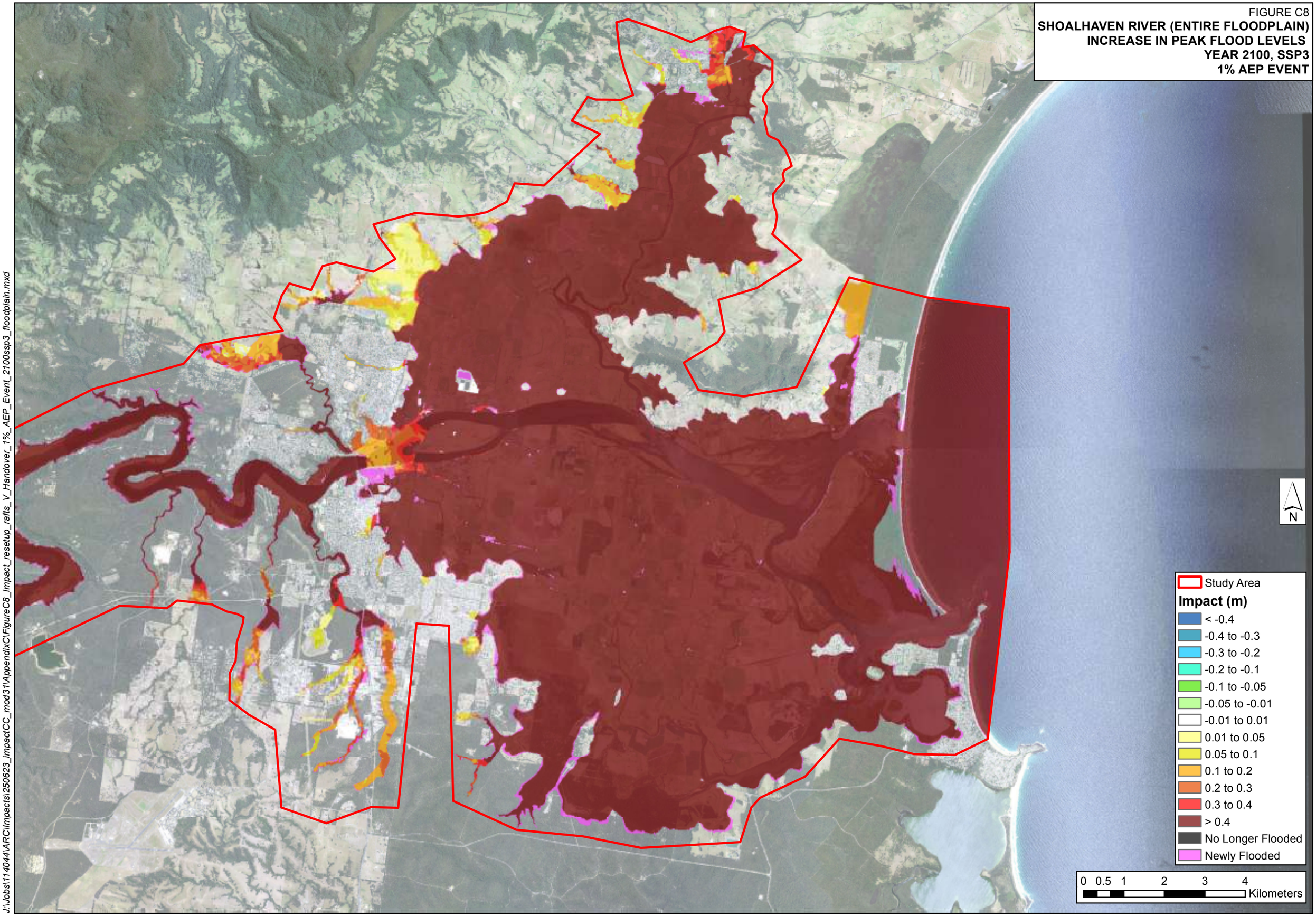

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FIGURE C9
SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
INCREASE IN PEAK FLOOD LEVELS
YEAR 2100, SSP3
PMF EVENT

N

Study Area
Impact (m)
< -0.4
-0.4 to -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
> 0.4
No Longer Flooded
Newly Flooded

0 0.5 1 2 3 4
Kilometers

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FIGURE C10

SHOALHAVEN RIVER (ENTIRE FLOODPLAIN)
COMPARISON OF CHANGE IN PEAK FLOOD LEVELS
YEAR 2030, SSP3
1% AEP EVENT

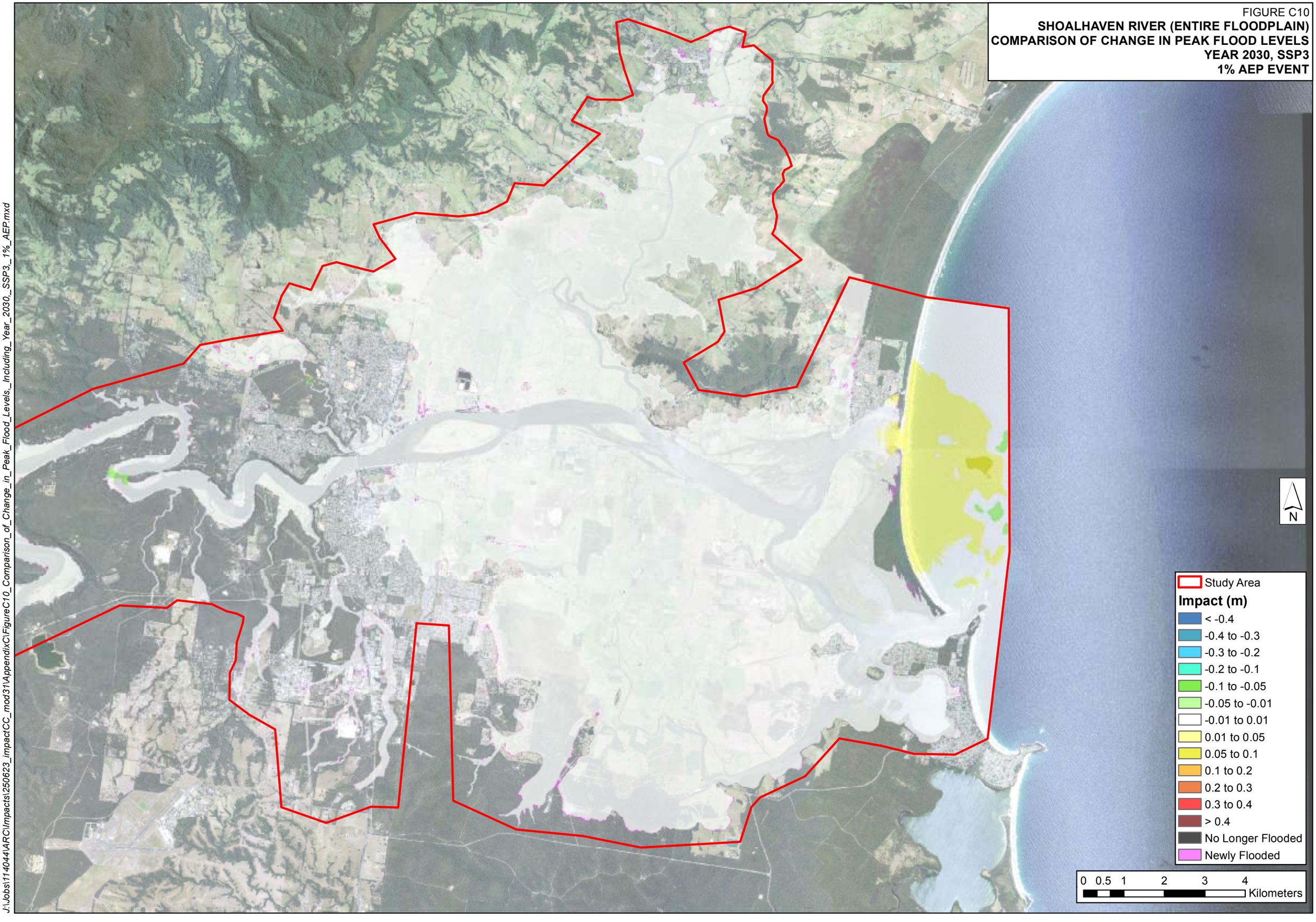

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FIGURE C11
SHOALHAVEN RIVER (LOCAL AREA)
DESIGN FLOOD DEPTH AND CONTOURS
MOD 31, YEAR 2030 SSP3
1% AEP EVENT

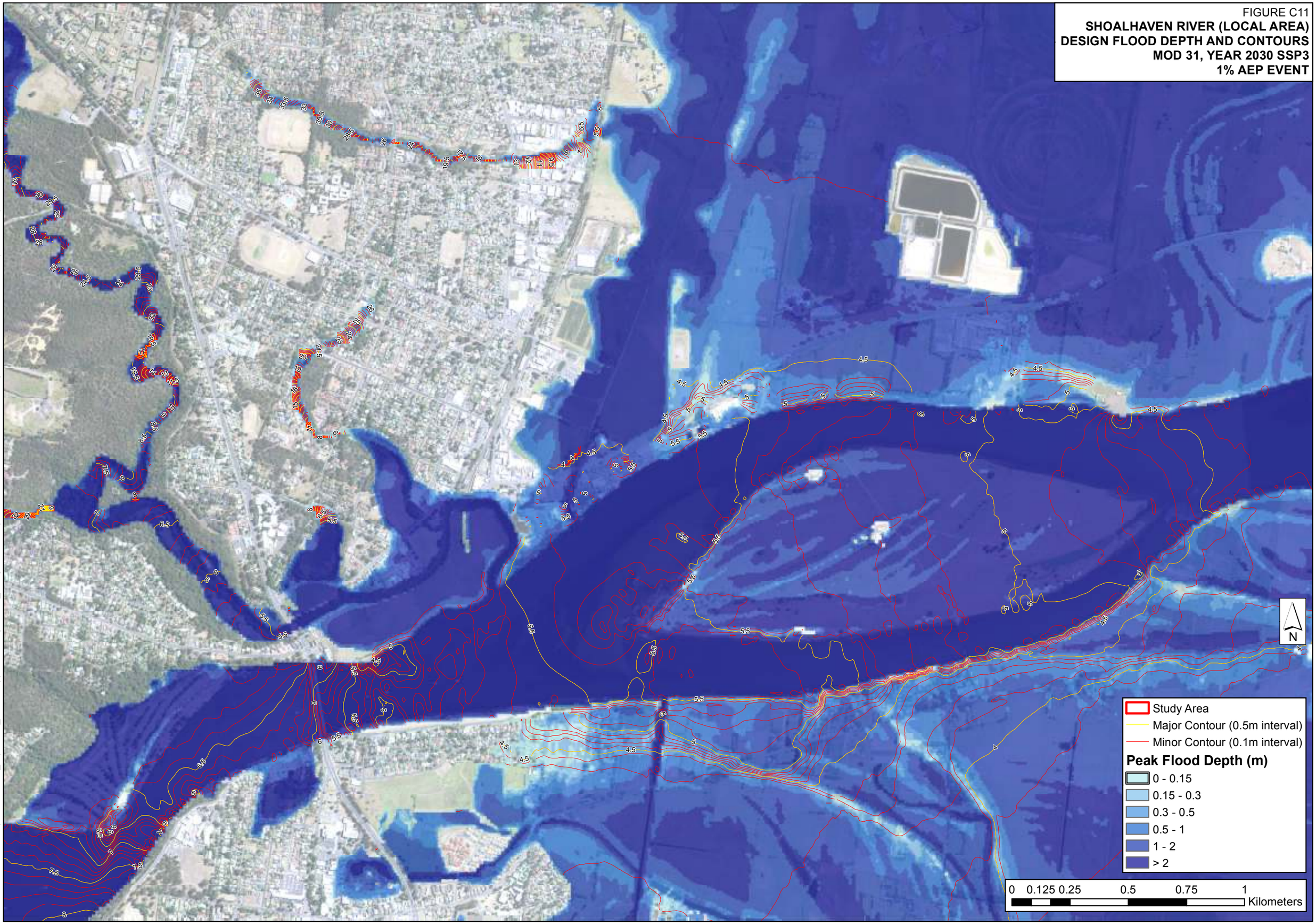

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FIGURE C12
SHOALHAVEN RIVER (LOCAL AREA)
DESIGN FLOOD DEPTH AND CONTOURS
MOD 31, YEAR 2100 SSP3
1% AEP EVENT

Study Area
Major Contour (0.5m interval)
Minor Contour (0.1m interval)

Peak Flood Depth (m)
- 0 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- > 2

0 0.125 0.25 0.5 0.75 1 Kilometers

N

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Flood Certificate for 32 Bolong Rd, BOMADERRY – LOT 34 DP 1222627

Appendix D

Shoalhaven City Council

Bridge Rd, Nowra NSW 2541 | 02 4429 3111
Deering St, Ulladulla NSW 2539 | 02 4429 8999

Address all correspondence to
The General Manager, PO Box 42, Nowra NSW 2541 Australia
council@shoalhaven.nsw.gov.au | DX5323 Nowra | Fax 02 4422 1816

shoalhaven.nsw.gov.au

COUNCIL REFERENCE: 28112E (D23/322278)
DATE: 10 Aug 2023

Thank you for your recent inquiry in relation to flood data held by Shoalhaven City Council.

Please find below some general information on flooding, as well as the requested property specific Flood Certificate.

GENERAL FLOOD INFORMATION

Shoalhaven City Council in conjunction with the NSW State Emergency Service has produced site specific flood brochures for Shoalhaven Heads, Nowra / Bomaderry / Terara, Greenwell Point / Orient Point, St Georges Basin, and Sussex Inlet.

These site-specific FloodSafe brochures, as well as general FloodSafe brochures, can be accessed at the below link:

https://www.ses.nsw.gov.au/local-region-information/isr/flood-storm-and-tsunami-guides/

General Flood Information, such as “What to do before, during & after a flood”, prepared by Emergency Management Australia is also available online at the below link:

http://www.bom.gov.au/water/floods/document/What_todo_floods.pdf

FLOOD PLANNING LEVELS FOR THE LOWER SHOALHAVEN RIVER FLOODPLAIN

In the Ordinary Council meeting held on 23 January 2023, the *Lower Shoalhaven River Flood Study (2022)* and the amended *Flood Planning Levels for the Lower Shoalhaven River Floodplain Policy (2023)* was adopted. The Flood Planning Levels in this Flood Certificate have been determined in accordance with this Policy, available online at the below link:

https://doc.shoalhaven.nsw.gov.au/displaydoc.aspx?record=POL23/7

FLOOD CERTIFICATE

According to the *Lower Shoalhaven River Floodplain Risk Management Plan – Climate Change Assessment (2011) and Lower Shoalhaven River Flood Study (2022)* this property, 32 Bolong Rd, BOMADERRY – LOT 34 DP 1222627, Land ID – 119700, comprises Flood Prone Land. This property is located below the Flood Planning Level and is affected by the 1% AEP flood event**.**

FLOOD INFORMATION

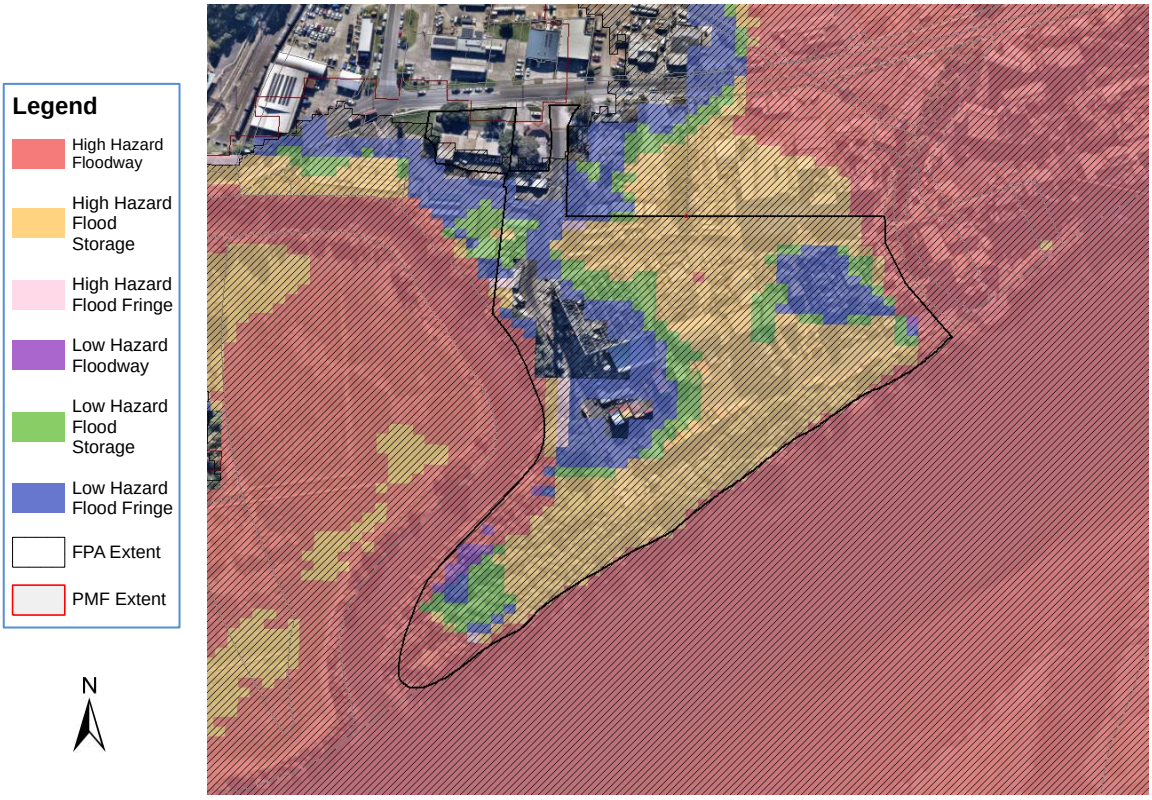
Year	Existing	Projected 2050	Projected 2100
Flood Planning Level (m AHD)	Not Applicable	6.3**	6.3**
Hazard and Hydraulic Category*	High Hazard Floodway	High Hazard Floodway	High Hazard Floodway
Probable Max Flood Level (m AHD)	7.0	7.0	7.1
0.2% AEP Flood Level (m AHD)	5.7	5.7	5.7
1% AEP Flood Level (m AHD)	5.4	5.4	5.5
2% AEP Flood Level (m AHD)	5.2	5.2	5.2
5% AEP Flood Level (m AHD)	5.0	5.0	5.0
10% AEP Flood Level (m AHD)	4.5	4.5	4.5
Velocity (0.2% AEP flood event) (m/s)	1.6	1.5	1.5
Velocity (1% AEP flood event) (m/s)	1.5	1.5	1.5

* Refer to Standard Considerations in this Flood Certificate for further details.

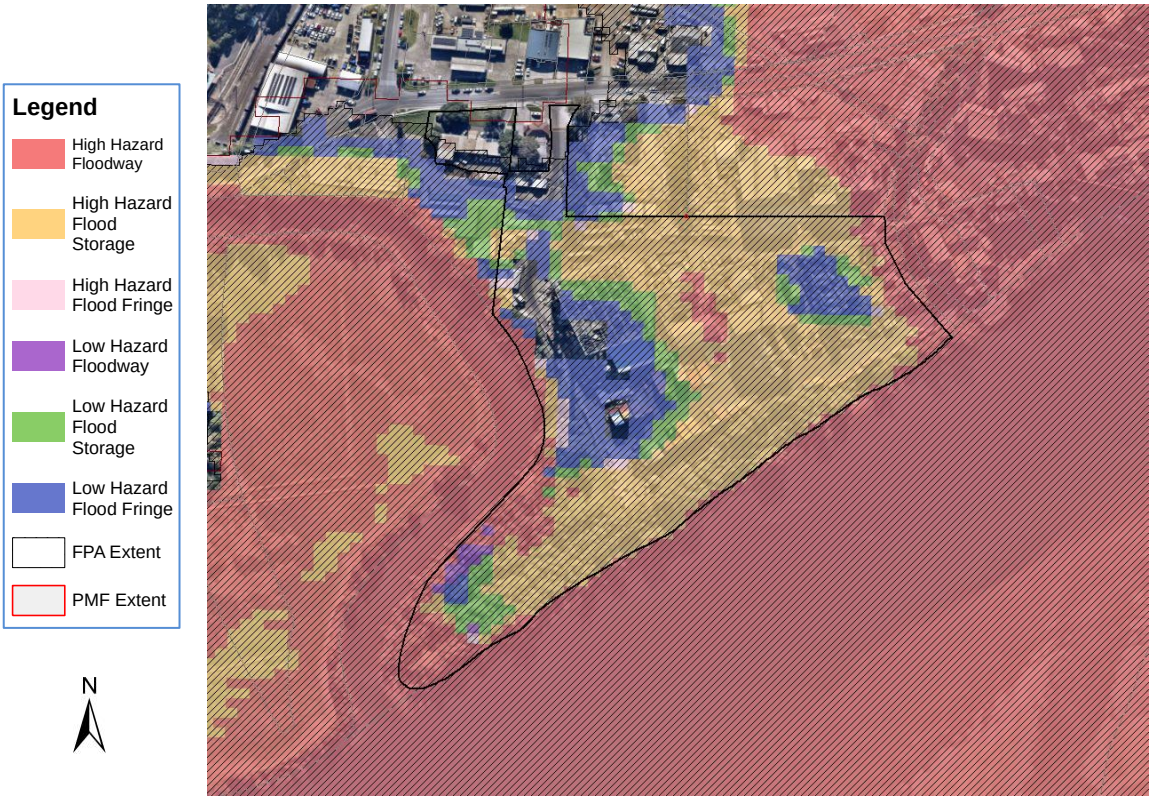
** Flood Planning Levels obtained from the *Lower Shoalhaven River Floodplain Risk Management Plan – Climate Change Assessment (2011)* in accordance with the *Flood Planning Level for the Lower Shoalhaven River Floodplain Policy (2023)*. The hazard and hydraulic category, flood levels and flood velocities have been obtained from the *Lower Shoalhaven River Flood Study (2022).*

SITE SPECIFIC CONSIDERATIONS

1. Current NSW Government legislation requires climate change to be considered as part of this Floodplain Risk Management Study and Plan. Climate change related information evolves with time and it is expected that existing flood behaviour and levels may change in the future.
2. All applications for buildings, and the like, must take into account the projected 2050 flood information. All subdivision and other long-term planning must take into account the projected 2100 flood information.
3. Other hazard and hydraulic categories may affect the property. For more specific information regarding the different hazard and hydraulic categorisations affecting this property please refer to Map 1 and Map 2 below or contact Council on 1300 293 111.



Map 1: Hazard and Hydraulic Categories for the Projected 2050 Scenario



Map 2: Hazard and Hydraulic Categories for the Projected 2100 Scenario

STANDARD CONSIDERATIONS

Properties below the Flood Planning Level:

Council considers the land in question to be below the Flood Planning Level and therefore subject to flood related development controls. The conditions as set out below will reduce flood risk in flood events up to the Flood Planning Level, however the property may still be subject to flooding at higher levels during rare flood events.

Development controls apply to flood affected properties.

Development conditions will vary depending on flood hazard, hydraulic category as well as the type of development that is proposed. Please refer to the following documents for information on Council's flood related development controls and the NSW State Government's Flood Prone Land Policy. For properties that comprise multiple hazard and hydraulic categories, the development conditions will apply for the highest category that exists within the development footprint.

- Shoalhaven Development Control Plan – Chapter 9: Development on Flood Prone Land http://dcp2014.shoalhaven.nsw.gov.au/main-category/whole-document
- Flood Risk Management Manual 2023: Flood Risk Management Manual | NSW Environment and Heritage

DISCLAIMER

Your enquiry relating to the likelihood of the land specified in the application being flooded has been referred to the Council's Floodplain Engineer.

In responding to your application, the Council seeks to bring to your attention the fact that pursuant to s.733 of the Local Government Act a council does not incur liability in respect of the giving of any advice furnished in good faith by the Council relating to the likelihood of any land being flooded or the nature or extent of any such flooding.

The Council does not have a legal obligation to provide advice to you and to the extent that this reply is giving advice, the Council provides that advice in good faith with the intention of preserving, so far as is legally possible, the Council's immunity from liability pursuant to s.733 of the Local Government Act.

While all reasonable care has been taken to ensure the accuracy of the information given in this reply, its purpose is to provide a general indication of flood risk in the area. Flood lines shown on Council maps indicate the approximate extent of flooding only in relation to the abovementioned land.

The information provided may contain errors or omissions and the accuracy may not suit the purposes of all users. A site survey and further investigation are strongly recommended before commencement of any project based on this data.

The information given is the most current information at the time of the request. It is to be noted, however, that flood information is constantly reviewed and updated and as such, the information contained in this regard is current only on the day of issue.

Before acting upon the information provided in this reply, the Council urges you to obtain separate and independent advice as Council, in giving this information, does not intend it to be relied upon in such a fashion as to impose liability upon the Council.

Should you not be prepared to accept the information contained in this reply upon that basis then you should immediately notify Council.

GLOSSARY

AEP (Annual Exceedance Probability) means the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage – for example a 1% AEP flood event has a 1% chance of occurring in any one calendar year.

AHD (Australian Height Datum) is a common national surface level datum corresponding approximately to mean sea level.

Flood Fringe is the part of the floodplain remaining after the floodway and flood storage areas have been defined.

Flood Planning Area is any land identified as being flood affected in the 1% AEP flood event plus freeboard.

Flood Planning Level (FPL) is the 1% AEP flood level plus freeboard. The FPL is used for planning purposes, as determined in Floodplain Risk Management Studies and incorporated in Floodplain Risk Management Plans.

Flood Prone Land means any land susceptible to flooding up to the Probable Maximum Flood event (that is, land within the floodplain) as identified in an adopted Council Flood Study or Floodplain Risk Management Study and Plan.

Flood Storage areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.

Flood Study is a technical investigation of flood behaviour. It defines the nature of flood risk by establishing the extent, level and velocity of floodwaters. The study also provides information on the distribution of flood flows across various sections of the flood plain for the full range of flood events up to and including the PMF.

Floodplain Risk Management Plan is a plan developed in accordance with the principles and guidelines contained in the NSW Government Floodplain Management Manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.

Floodplain Risk Management Study is a study that identifies and compares various risk management options. This includes an assessment of their social, economic, ecological and cultural impacts, together with opportunities to maintain and enhance river and floodplain environments.

Floodway means those parts of the floodplain where a significant discharge of water occurs during floods. They are often aligned with natural defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.

Freeboard is currently 0.5m for riverine flooding for all catchments in the Shoalhaven LGA. Freeboard is a factor of safety used to set the FPL (i.e. FPL = 1% AEP flood level plus freeboard (0.5m)). Freeboard takes into account uncertainties in flood modelling and climate change predictions, local factors that cannot be included in the flood model or wave action caused by wind, boats or vehicles driving through flood waters.

Hazard Category represents the risk or danger to personal safety, evacuation movements and buildings and structures within the Flood Planning Area during the 1% AEP flood. There are only two possible hazard categories – high or low.

Hydraulic Category describes the function of a specific part of the Flood Planning Area in conveying flood waters during a 1% AEP flood. There are three possible hydraulic categories – floodway, flood storage or flood fringe.

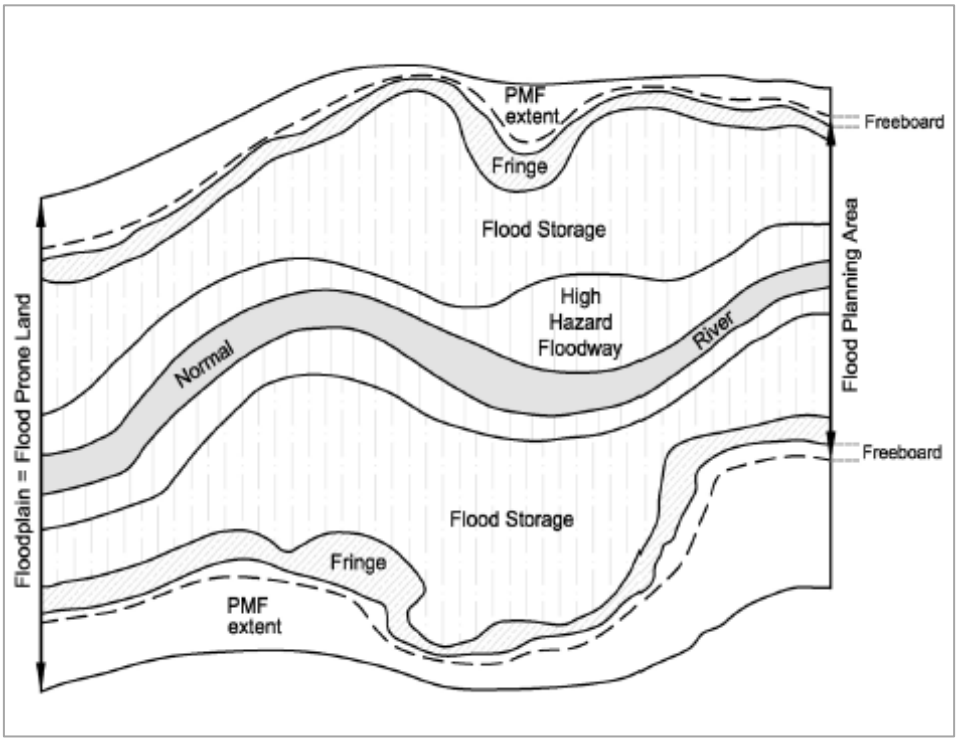


Figure: Floodplain Aerial View

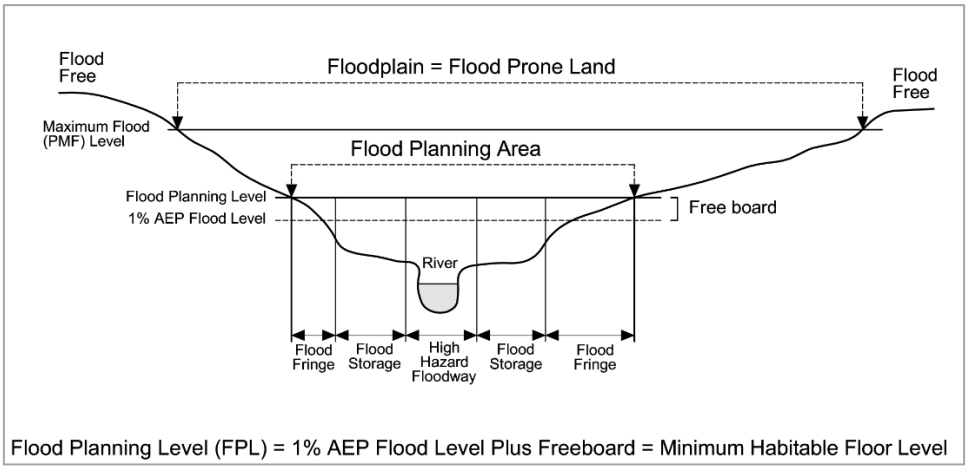


Figure: Cross Section through Floodplain

Probable Maximum Flood (PMF) is the largest flood that could conceivably occur at a particular location, usually estimated from Probable Maximum Precipitation. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.

Provisional is used for hazard categories that have been determined in a Flood Study. Hazard categories are provisional until the Floodplain Risk Management Study and Plan has been completed and adopted by Council, as this document considers additions risks, not considered during the Flood Study.