

Jane Eliza Expansion Development

Hydraulic Modelling

Renmark Paringa Council

4 September 2025

Ref: 250950R002



Building exceptional
outcomes together



Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
0	Issue For Use	SE	ML	SE	29/08/2025
1	Minor amendments to Neilly's report	SE	ML	SE	04/09/2025

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Executive Summary

Tonkin was engaged by Renmark Paringa Council (Council) to assess the potential impacts of the proposed Jane Eliza Expansion development on riverine flooding risks in Renmark, Paringa and surrounding areas in light of the significant flooding events of 2022/2023. The purpose of this report is to understand the Jane Eliza Expansion development's potential effects on local flood behaviour. This investigation evaluates pre- and post-development flood levels and the changes in flood risks for various river flow events.

Preliminary investigation works evaluated the impacts of the Jane Eliza Expansion development on flood extents and depths. The key objectives of this report are to:

- Confirm how proposed further development of Jane Eliza affects how the floodplain responds with the Jane Eliza Expansion to identify the differences in the adjacent floodplain water levels.
- Acknowledge Council's 2022/23 flood response strategy, the proactive approach to managing impending flood risk, and how this forms part of the future flood management strategy for Renmark.
- Acknowledge that Council plans to commit to a flood response effort similar to how they responded to previous events and provide for an equivalent level of protection to the nominated flood levels presented in the modelling.

The modelling, which utilised a Digital Elevation Model (updated to 2024 LiDAR) and a range of river flow scenarios, demonstrates that for the flood events up to 186 GL/d, the Jane Eliza development does not alter flood extents as they are bound by Council's managed levee network. At higher flow events (250 GL/d and 341 GL/d), some localised minor increases in flood depth are observed.

In conclusion, modelling suggests that the impacts of the development for flows of 186 GL/d, 250GL/d and 341GL/d have no impact on properties contained within the Council maintained levees around town. The minor flood level increases demonstrated in the modelled data will be absorbed in the levees 600mm operational freeboard within the levee network.

The extents of flooding outside these areas show little change, with only minimal increases to flood extents upstream around Calperum station, and no observable differences downstream – including the areas to the south and southeast of Kulnine St.

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Client: Renmark Paringa Council
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Appendix A - Neilly Group Flood Modelling Report and Flood Maps

1 Introduction

Tonkin has been engaged by the Renmark Paringa Council (Council) to provide services and relevant documentation to support Council in understanding and communicating the potential effects of the proposed Jane Eliza Expansion development in Renmark, particularly as it relates to the risk of riverine flooding.

It is understood that there are some community concerns related to the proposed Jane Eliza Expansion development following the substantial flood event that occurred throughout 2022/23. This reporting follows modelling and preliminary investigation works.

The impacts of the proposed development on existing flooding behaviour and potential peak flood levels are currently unknown and will be assessed to understand the magnitude of change between pre-development and post-development conditions for a range of scenarios.

The purpose of this report is to:

- Confirm how the proposed Jane Eliza Expansion development affects how the floodplain responds to the volumetric changes in landmass due to the development's construction, identifying the changes in the adjacent floodplain water levels.
- Acknowledge Council's 2022/23 flood response strategy, the proactive approach to managing impending flood risk, and how this forms part of the future flood management strategy for Renmark.
- Confirm the existing levee alignment can protect for all investigated events noting that raising works need to be completed for larger events.

Council has included the assumption that flood events larger than 186 GL/d will be responded to in the same way as the 2022/23 event. This is on the basis that Federal Disaster Recover Funding Arrangements (DRFA) and State Local Government Disaster Recovery Assistance Arrangements (LGDRAA) are not expected to change and the funds and resource capacity will be accessible to achieve this.

2 Modelling

2.1 Approach

Neilly Group prepared a coarse TuFlow model in response to the 2022/2023 event and revisited this model for the purpose of understanding changes to flood risk for the proposed Jane Eliza Expansion development.

They incorporated the levee heights following the 22/23 flood, which were reconstructed in preparation for the flood event, with a 600mm freeboard above the live flood level (186 GL/d), in accordance with Council's standard practice. Gaps in the levees were identified (e.g. where there are roadways and accesses to properties), reviewed, and discussed with Council to confirm they will close the network as required in an event.

Neilly Group utilised their floodplain model of the area to assess the pre-development versus post-development flood extent, and a copy of Neilly Group's modelling report is included as Appendix A to this report, and revised flood maps as Appendix B.

All Council managed levees were then modelled at a predetermined level to ensure event scenarios did not overtop. This was undertaken to allow "clean" flood maps and so the resulting GIS layers can be later analysed by Council, if required, to understand the levels that levees will need to be raised to in order to provide immunity during larger events (outside scope of current project).

Private levees were retained in the model "as is" and do not account for any upgrades or raising that may be required during further events.

2.2 Appreciation of Model

It is important to note that hydraulic modelling takes a statistical approach based on predictions and calibrated from observations and measurements of real events, this is engineering standard practice and is widely recognised as the established method for investigating hydraulic behaviour. Observations presented (e.g. maps and graphs) may not exactly replicate what was experienced on the ground throughout the 2022/23 flood due to event scenario rerun patterns not perfectly aligning to the natural event behaviour, however outputs are generally similar. The model was calibrated with observations from the 2022/23 floods, but it should be noted that the model is a statistical analysis. It is anticipated that the relativity between pre and post-development results is sufficiently representative of the effect of the proposed Jane Eliza expansion development on the surrounding floodplains.

Flooding observed on the ground can differ from model predictions, due to a range of dynamic and unpredictable factors. These changes can alter runoff patterns and some of the factors that can cause observed flooding to differ from modelled flooding (or from similar sized events) include:

- Rainfall intensity and distribution may change, resulting in storms behaving differently to previous events, and to the assumptions made in constructing the model.
- Flows in the River Murray in South Australia are dependent on the River Murray through New South Wales and Victoria, and also major tributaries including the Lower Darling, Goulburn and Murrumbidgee systems. Neilly Group's model has assumed fixed "input" conditions at the SA border. The timing and quantity of water flowing from these systems is independent of the other systems, as each is dependent on what happens in each of their catchments (e.g. intensity and duration of a rainstorm). This is the accepted industry standard to predict flows, and although future similar events will behave differently, the approach taken by Neilly is the most effective and representative way of predicting flood flows. The flow presented in this report is the flow at the border into South Australia, and is a combined flow of all upstream rivers and tributaries.

- Soil saturation levels and pre-existing wet ground can increase runoff and slow recession of floodwater.
- Simplified hydrological processes around infiltration have been assumed and these may vary.

The factors noted above are likely to alter the hydraulic behaviour of the modelled system, however the resultant change in measured water level is expected to be negligible or minute due to these factors.

2.3 Observations

The modelling shows the following observations for the three investigated events, comparing pre- and post- development of Jane Eliza Expansion. Afflux is a change in flood level, usually an increase. Whilst there are some increases in water level, there are also some observed decreases in flood level.

The observed change in water levels given below (afflux) are the difference between the flooding observed pre-development, and the flooding observed post-development.

Flood modelling outcomes assume that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards.

2.3.1 Development impacts at 186 GL/d

In the 186 GL/d event, water level increases of 5mm are observed from Nelwart St in Bookmark Creek, increasing to approximately to 15 mm at the Sturt Highway bridge, 20 mm at Twentyfirst St bridge, 25 mm at Ral Ral bridge and then increases of up to 35 mm across the Jane Eliza floodplain. Beyond this, increases drop quickly to ~15 mm, then remain above 10 mm across the width of the floodplain all the way up to the southern boundary of Calperum Station and the northern extent of Ral Ral Wide Waters.

To the immediate east of the development, water levels are shown to decrease by 5 to 10 mm close to the development. Elsewhere, changes are less than +/- 5 mm.

The table below shows the location of afflux (change in water levels) due to the Jane Eliza Expansion Development at 186 GL/d.

	Location	Afflux at 186 GL/d (mm)
1	Goolwa St	21
2	David St 1	26
3	David St 2	33
4	David St 3	33
5	Ral Ral Ave Gun Club	31
6	Ral Ral Ave & Ontario St	27
7	Ral Ral Ave Bridge (East)	24
8	Marrara St (WWTP)	23
9	RIT Pump Station	-4
10	Visitor Centre	-5
11	Maximum Afflux	46

2.3.2 Development impacts at 250 GL/d

A similar pattern is observed for the 250 GL/d event, starting again at approximately a 5 mm increase just upstream of Nelwart St bridge across Bookmark Creek, ~15 mm, ~20 mm and ~25 mm increases at Sturt Highway, Twentyfirst St and Ral Ral Avenue bridges respectively, then up to 40 mm across the Jane Eliza floodplain. Closest to the western edge of the development, increases are observed to be approximately 50 mm, this increase relates to other locations seen in the afflux maps that exceed those observed in the reported locations in the table below.

The rest of the floodplain shows minor increases to afflux measurements upstream of the proposed development site. The areas measuring a reduced water level (negative afflux value) extends further down riverfront providing a positive benefit along the entire town waterfront area.

The table below shows the location of afflux (change in water levels) due to the Jane Eliza Expansion Development at 250 GL/d.

	Location	Afflux at 250 GL/d (mm)
1	Goolwa St	24
2	David St 1	35
3	David St 2	41
4	David St 3	40
5	Ral Ral Ave Gun Club	37
6	Ral Ral Ave & Ontario St	34
7	Ral Ral Ave Bridge (East)	29
8	Marrara St (WWTP)	27
9	RIT Pump Station	-6
10	Visitor Centre	-6
11	Maximum Afflux	55

2.3.3 Development impacts at 341 GL/d

The 341 GL/d event sees a continuation of the same trends. Key values along Bookmark Creek are largely unchanged downstream of Ral Ral Ave. At Ral Ral Avenue bridge the increase is now approximately 30 mm, and further increases are observed across the floodplain, with the maximum against the edge of the development approaching 60 mm. These relate to locations seen in the afflux maps which exceed those observed in the reported locations in the table below.

Water level reductions due to the development are now shown right to Sturt Highway towards the Paringa bridge.

The table below shows the location of afflux (change in water levels) due to the Jane Eliza Expansion Development at 341 GL/d.

	Location	Afflux at 250 GL/d (mm)
1	Goolwa St	27
2	David St 1	38
3	David St 2	44
4	David St 3	44
5	Ral Ral Ave Gun Club	39
6	Ral Ral Ave & Ontario St	37
7	Ral Ral Ave Bridge (East)	30
8	Marrara St (WWTP)	29
9	RIT Pump Station	-7
10	Visitor Centre	-7
11	Maximum Afflux	58

2.4 Afflux

Afflux refers to the predicted change, usually in flood levels, between two scenarios. It is frequently used as a measure of the change in flood levels between an existing scenario and a proposed scenario. Its measurement is used to observe the impacts of any potential new structure to the local community and environment.

It is observed above that a drop in water levels at the RIT Pump Station and the Visitor Centre for all three modelled events. In the absence of changes in the channel itself, reasons for this might include:

- A higher volume of flow is being diverted though Bookmark Creek due to the protrusion into the river formed by the development footprint,
- Creation of new flood storage areas by raising the levees and changing how increased flows in the river behave, and
- Any changes to the effective channel (e.g. roughness, widening or deepening), increasing its capacity to carry water, reducing flood levels.

2.5 Assumptions

The following assumptions have been made in preparing this report:

- We have reviewed results with Council to verify that gaps in the levees (e.g. roadways and access tracks etc.) were closed in the 2022/3 floods, so the model reflects the actual situation during the recent flood.
- Pre-development modelling used Neilly Group's existing floodplain model, which is based upon LiDAR (updated to 2024) digital elevation data available in the public domain. Some minor amendments to

the model were undertaken to ensure that features such as permanent levees at their current height are accurately represented within the model domain.

- The post-development model was based on an amended Digital Elevation Model (DEM) to reflect planned changes to the floodplain as a result of the development expansion. The total footprint of the proposed Jane Eliza Development was based on the Jane Eliza Land Development Concept Model (Ref 221524 Dwg 000 Rev A, dated 29 November 2022) developed for Council.
- Flood events larger than 186 GL/d will be responded to in the same way as the 2022/23 event. This is on the basis that Federal Disaster Recover Funding Arrangements (DRFA) and State Local Government Disaster Recovery Assistance Arrangements (LGDRAA) are not expected to change; and the funds and resource capacity will be accessible to achieve this.

3 Conclusion

The Renmark Paringa Council commissioned Tonkin to investigate and understand how the proposed Jane Eliza Expansion development might affect flooding risks in the Renmark area, especially after the significant floods of 2022–2023. The goal was to:

- Address community concerns about flood risks due to the development.
- Compare flood behaviour before and after the development.
- Confirm whether existing levees (flood barriers) can still protect the town under various flood scenarios.

Hydraulic modelling was carried out using updated topographic data (LiDAR from 2024) and a flood simulation tool called TUFLOW. The modelling looked at six different flood scenarios, ranging from 80 GL/day to 341 GL/day river flow rates.

The model analysis compared pre-development and post-development flood levels and extents, thus, providing a clear understanding of the likely changes in flood behaviour with the development in place. Key findings include:

- Measured increases in water level (afflux) are relatively minor across the three events tested (186 GL/d, 250 GL/d and 341 GL/d). The largest observed increase in flood level is approximately 60 mm, concentrated adjacent to the development footprint.
- Localised reductions in water level of up to 7 mm are observed downstream at the RIT Pump Station and the Renmark Visitor Centre. These are likely due to hydraulic redistribution of flows into Bookmark Creek.
- The existing Council-managed levee system provides effective protection for all modelled events up to the 186 GL/d event, provided it is maintained in accordance with Council's standards. For larger events, raising works will be required to maintain flood immunity.
- The changes in water level attributable to the Jane Eliza Expansion are small in comparison to natural variability in flood events, and do not materially alter regional flood behaviour.

The modelling confirms that the Jane Eliza Expansion will not create significant adverse impacts on floodplain behaviour or unacceptable increases in flood risk to the wider Renmark community. While minor increases in water levels are expected adjacent to the development site, these are within a tolerable range and are offset in part by reductions along the town riverfront.

Council's proactive management of the levee network during the 2022/23 flood event has been validated as an effective approach, and future responses to events larger than 186 GL/d will rely on the same strategy, supported by State and Federal disaster recovery funding.

Appendix A - Neilly Group Flood Modelling Report and Flood Maps



NEILLY GROUP ENGINEERING

TONKIN CONSULTING PTY LTD

JANE ELIZA MODELLING – STAGE 2
(PROJ. NO. 250950)

JUNE 2025

Document Control

Details and distribution

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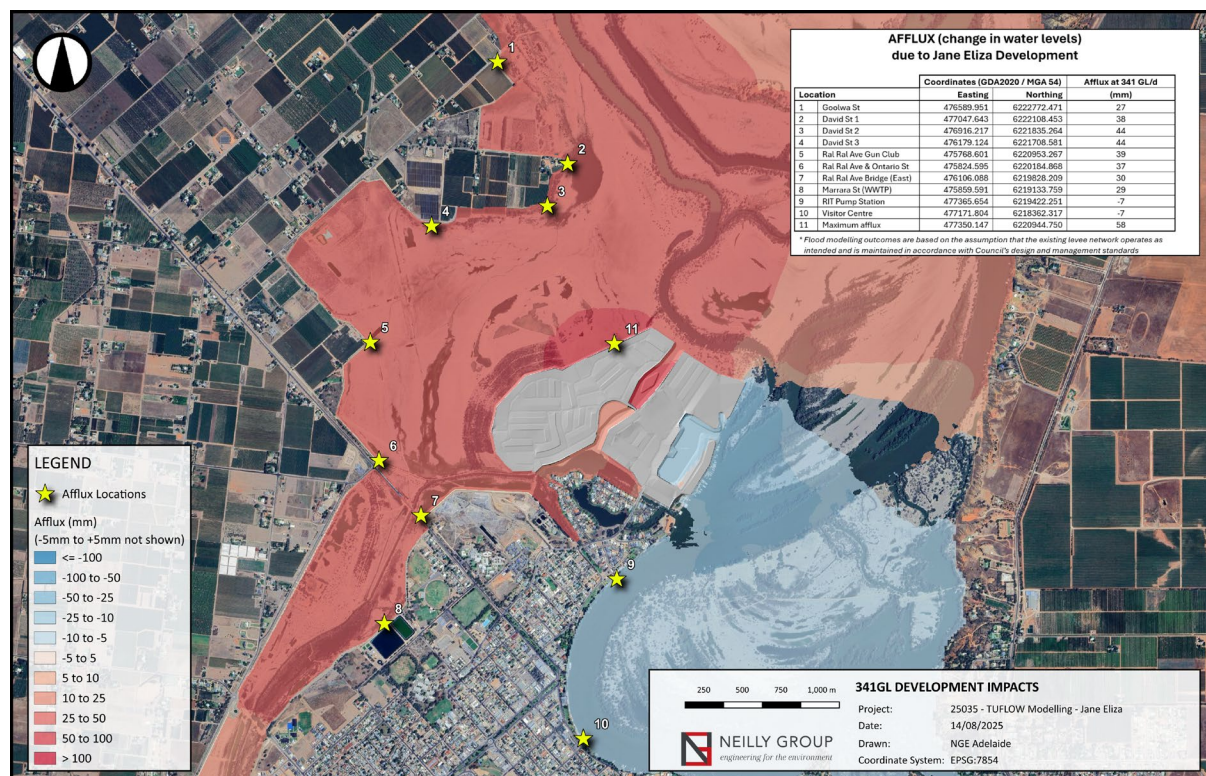
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1-2	11/10/2024	Brent Hennekam	Addressed feedback from Tonkin	Brett Twycross	Brett Twycross
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2-3	04/09/2025	Brent Hennekam	Addressed council feedback		

Executive Summary

During the 2022-23 River Murray flood event, in the lead up to the flood peak, Neilly Group developed a rapid response flood model - covering approximately 380km², from Chowilla Station to Lyrup – to aid Council in their response to the floods. This model has been amended as a cost-effective way for Council to estimate the change in water levels (afflux) in future floods due to the proposed development on the Jane Eliza floodplain, without the cost of developing a new model specifically for that purpose.

The model was updated (with post-flood topography [2024 LiDAR data]) and improved (increased model resolution; topographic amendments to improve accuracy) to a level sufficient to inform decisions relating to the development.

Modelling highlights that the volume of water displaced by the development is only approximately 2.5% of the volume of the floodplain areas surrounding the town. Estimated increases in water levels on the Jane Eliza floodplain and along Bookmark Creek are greatest against the edge of the development, where they reach approximately 60 mm. Highest levels were observed during the modelled 341 GL/d event; the afflux for this event is shown in the image below.



Afflux results for the 341 GL/d event.

These results provide Council with added confidence that the development will have minimal impacts to future flood levels, and that it will not impact their ability to protect the town through actions similar to those undertaken in the 23022-23 event.

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Note on this report

The original report submitted in 2024 used LiDAR data to determine the heights and extents for the flood mapping. This resulted in areas that were protected during the 2022/23 event, along with areas that would be protected in larger events, showing flooding occurring to properties and areas that would not flood under “true” conditions.

To address this, Council, through Tonkin, commissioned ‘Stage 2’ modelling, under the assumption that Council would have both funding and capacity to ensure the integrity of the Council’s flood levee network leading up to such an event, effectively confirming that Council’s future flood response would seek to replicate actions taken during the 2022-23 event.

This report is an update of the original report, highlighting changes in the Stage 2 modelling and updating the flood and afflux maps for the 186 GL/d, 250 GL/d and 341 GL/d events.

Sections that have been added or modified include:

- Section 2.6
- Section 3.1.4
- Sections 3.2
- Sections 3.3.4, 3.3.5 & 3.3.6
- Section 3.4

Sections that have been removed (as they are no longer relevant) are:

- Sections 3.2.1 and 3.2.2

Acronyms

Acronym	Meaning
AHD	Australian Height Datum
DEM	Digital Elevation Model
DEW	Department for Environment and Water
EPA	Environmental Protection Agency
GL	Gigalitres
LiDAR	Light Detection and Ranging
PO	Plot Output (in TUFLOW)
SA	Source Area (in TUFLOW)
SGS	Sub Grid Sampling (in TUFLOW)
WSE	Water Surface Elevation

1 Introduction

Neilly Group Pty Ltd (Neilly Group) were engaged by Tonkin Consulting (Tonkin) on behalf of Renmark Paringa Council to undertake pre- and post-development flood modelling for the Jane Eliza development in Renmark, SA, and to report on changes to flood impacts due to the proposed development (afflux). Neilly Group have an existing flood model that was developed during the 2022/23 River Murray flood event that was to be used for this purpose.

The location of the development is shown in Figure 1, and the extent of the flood model is shown in Figure 2.



Figure 1. Location of proposed Jane Eliza development.

1.1 Scope of works

The scope of works for this project is as follows:

- 'Pre-development' (existing/base case) modelling of 6 flow events.
- 'Post-development' modelling of above 6 events.
- Inundation extent maps for all modelled scenarios.
- Change (afflux) maps for all 6 events.
- Preparation of short, factual modelling report stating all data used - assumptions, model details, etc – and providing commentary on afflux.

The modelled events were specified as the 80 GL/d, 100 GL/d, 150 GL/d, 250 GL/d, 341 GL/d and the level of the 2022-23 flood which has been reported as 186 GL/d (DEW 2024; EPA 2023).

It was recognised that minor modifications to the model would be required for this task.



Figure 2. Extent of original model.

2 Model details

2.1 General approach

The model was developed in the TUFLOW (Two-dimensional Unsteady FLOW) simulation modelling software, specifically designed for hydraulic assessment. This tool provides a robust solution for simulating flood and tidal wave dynamics.

TUFLOW provides both 1D and 2D solutions, for accurately mapping flow patterns and inundation in complex environments. TUFLOW operates by representing the terrain surface as a set of uniformly sized square cells. Hydraulic calculations, which solve the Saint-Venant shallow water wave equation, are then undertaken on each cell with the water level determined at 4 locations per cell (i.e. to represent a sloping water surface), with volume and velocity calculations undertaken on the faces of each cell.

The cell size is set by the user, with larger cells reducing the overall representation of the terrain surface but decreasing computational runtime. This is important for large, complex areas of flow where a large area may need to be modelled to accurately represent flow patterns, and computational runtime can be in the tens of hours or days.

2.2 Original model

Model parameters for the original model are provided below in Table 1.

Table 1. Hydrologic and 2D modelling parameters.

Item	Description
Modelling method	TUFLOW 2d hydraulic model
Topography	Elevation - River Murray LiDAR 2021 Dataset (#2625) available through the ELVIS portal (https://elevation.fsdf.org.au/) resampled to a 5m x 5m grid
Model cell size	15m
Inflow boundary	Source Area (SA) polygon at upstream extent providing desired flow rate
Losses	Not modelled
Downstream boundary	Longitudinal gradient based on the slope of the creek. Note that this was also located far downstream to: i. Choose a suitable location where the floodplain is narrower ii. Ensure no impacts on the area of interest.

The model was developed as a rapid decision making tool in response to rising flood waters, and was designed to inform on very high flows. The model did not attempt to include bathymetry, nor culverts, and the LiDAR was used as is. This suited the original purpose.

2.3 Changes to the original model

Since developing the original model, new data has become available, and the specifics of this modelling task required a higher level of detail than the original use case. Changes to the original model include:

- The Digital Elevation Model (DEM) was updated to include the new 2024 LiDAR (Elevation - River Murray LiDAR 2024, Dataset #2760).
- The model was adapted to utilise Sub Grid Sampling (SGS) to allow for better representation of the actual surface. This allowed the model cell size to increase to 20m, while capturing storage detail from the raw 50cm LiDAR data.

- Bathymetry was added to the model using DEW model results that have previously been shared with Neilly Group for prior projects:
 - Bathymetry was estimated between Lock 5 and Lock 6 by subtracting the depth from the water surface elevation in the provided results. While this is a practical approach, the accuracy is dependent on the quality of the DEW model and any assumptions they have made.
 - Bathymetry could not be included downstream of Lock 5 using this method which may impact results, especially around Lock 5 where the sudden absence of bathymetry would have the greatest impact.
- Breaklines were added to the model using the updated shapefiles available via <https://data.sa.gov.au/>. This ensures that levees are still captured and enforced within the model after the ground surface is “smoothed” when converting high resolution LiDAR into larger resolution cells.
 - Breaklines were offset as required to not restrict flows through smaller channels.
 - Breaklines were connected where necessary (e.g. across roadways) to reproduce observed flood extents during the 2022-23 event.
- Topography modifications were used to attempt to improve flow connectivity through the following sections. This involved “cutting through” the modelled surface to connect areas where (i) waterways smaller than the model cell size are smoothed out, and (ii) where bridges, culverts or regulators may not be picked up in the LiDAR. This process is important to more accurately represent real flows.
 - Entry into Bookmark Creek
 - Passage through various channels in the vicinity of Lock 5, specifically:
 - Connections through Sturt Highway and Paringa Paddock Rd Sturt Highway
 - Margaret Dowling Creek (inc. regulator)
 - Deep Creek (inc. regulator).

These adaptations have been undertaken to reflect the current topography and improve model results to a level suitable for use in estimating afflux due to the development, and have followed industry best practice and standard flood engineering procedures.

2.4 Final (Stage 1) model parameters

Final model parameters are outlined in Table 2.

Table 2. Final model parameters.

Item	Description
Modelling method	TUFLOW 2d hydraulic model
Topography	Combination of: - Elevation - River Murray LiDAR 2024 Dataset (#2760), 0.5m resolution - Elevation - River Murray LiDAR 2021 Dataset (#2625), 0.5m resolution - Estimated Bathymetry – varied resolution (100m2 typical cell area; min. 25m2, max. 9,650m2)
Model cell size	20m, using SGS at full DEM resolution
Manning's n	Water (n = 0.015) Low vegetation (n = 0.04) Medium vegetation (n = 0.05) Dense vegetation (n = 0.06) Urban Areas (n = 0.30)
Inflow boundary	Source Area (SA) polygon at upstream extent providing desired flow rates: 80 GL/d (925.93 L/s) 100 GL/d (1,157.41 L/s) 150 GL/d (1,736.11 L/s) 186 GL/d (2,152.78 L/s) 250 GL/d (2,893.52 L/s) 341 GL/d (3,946.76 L/s)
Losses	Not modelled
Downstream boundary	Longitudinal gradient based on the slope of the creek. Note that this was also located far downstream to: - Choose a suitable location where the floodplain is narrower - Ensure no impacts on the area of interest

The model setup is shown in Figure 3. Manning's Roughness is shown in Figure 4.

2.5 Proposed development landform

The final landform was provided to Neilly Group from Tonkin on 4 September 2024 in the form of an AutoCAD file (*x221524_DESIGN TIN.dwg*). This was converted to a 0.5m DEM to match the existing LiDAR.

Topography modifications that were required to assist flows to enter Bookmark Creek for the pre-development modelling were removed were they would have otherwise cut through the design surface.

The edge of the Jane Eliza development was not picked up cleanly within the model, so a raised levee "glass wall" was added around the top perimeter, which will allow Tonkin to ensure the design provides sufficient height (inc. freeboard) without requiring iterative modelling.

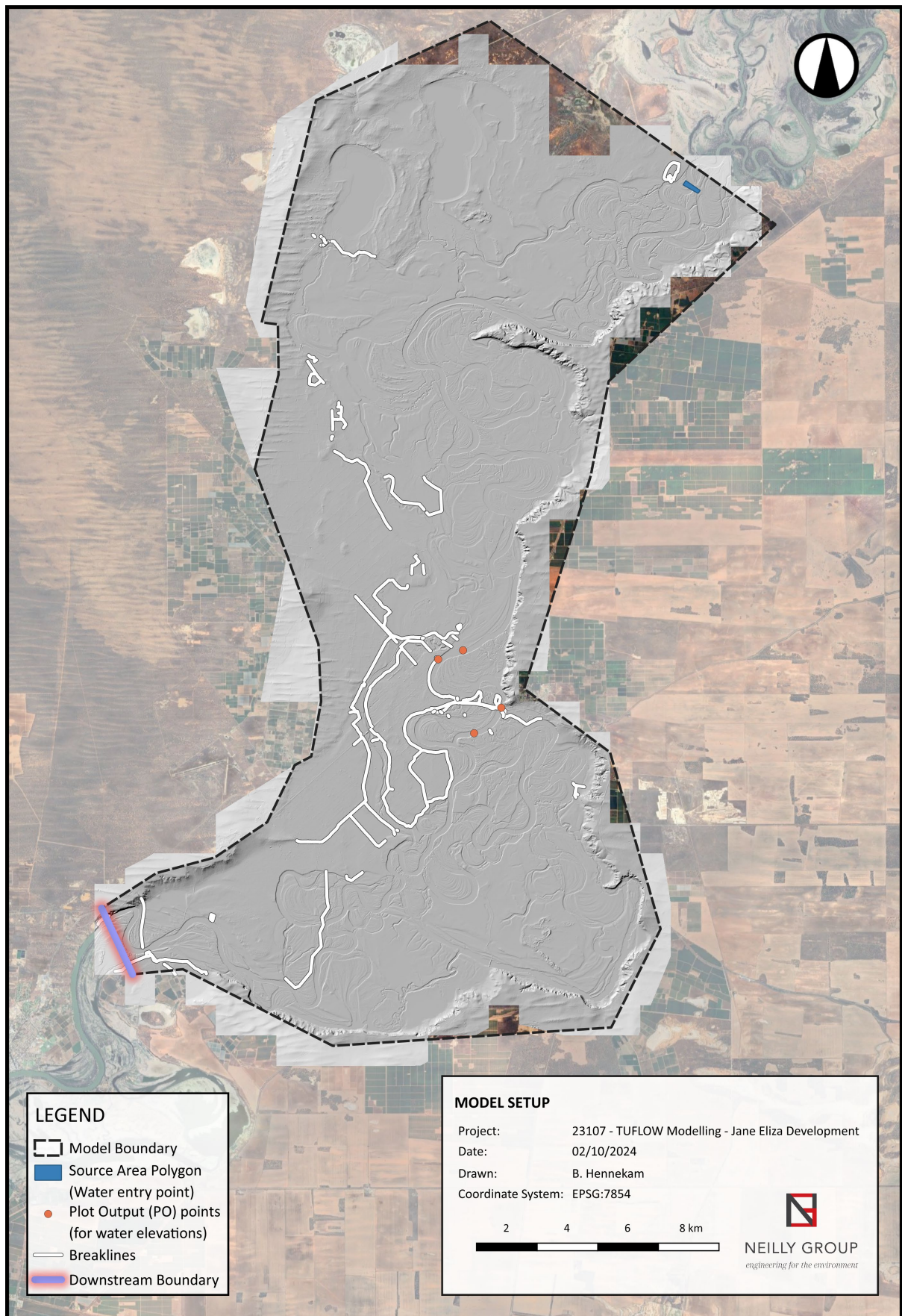


Figure 3. Model setup.

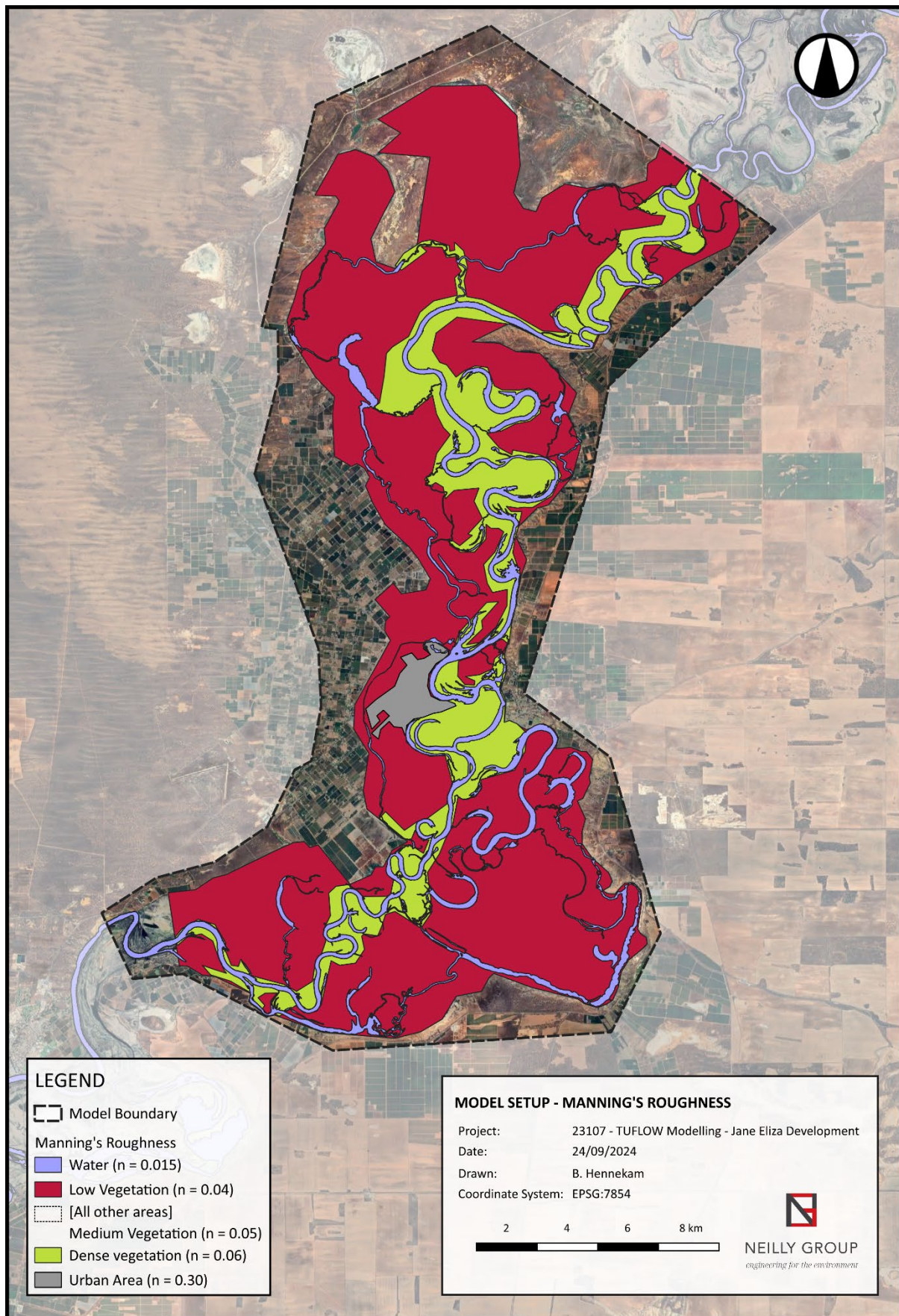


Figure 4. Manning's roughness values.

2.6 Stage 2 changes to model

2.6.1 Model resolution

Model cell size was increased throughout the model (using Quadtree) to improve run times, focussing the smallest cells / highest resolution along the levee networks only, and not the entire town area.

2.6.2 Levee network changes

Changes to the levee network were undertaken following advice from Tonkin representatives, per their conversations with Council as to what would and would not be protected by the Council in future flood events. This included raising levee heights plus patching gaps at the following locations, where Council have advised they will close the network per the response to the 2022-23 flood event:

- Adding a continuous levee from the northernmost house on Pelican St to the easternmost house on David St.
- Extending the north-eastern extent of the levee around the Jane Eliza floodplain along the existing track until it reached sufficient elevation to prevent flooding.
- Closing off both sides of the Twentyfirst St bridge by joining the levees on either side of the road (in Stage 1 only the eastern [town] side was closed).
- Closing off the levee across Patey Rd to join Sturt Hwy in the east of town.
- Extending the western end of the at Tolarno St / Sturt Hwy to reach the crown of the road.
- Extending the levee at the south-western end of Kulnine St further up the road.
- Digitising the levee north of Sturt Hwy on the eastern (Paringa) side of Paringa Bridge.
- Extending both ends of the levee that runs adjacent Margaret-Dowling Creek:
 - Along Lock 5 Rd up to the Sturt Hwy
 - Beyond the Mundic Creek boat ramp and up to higher ground

A map of the levee network used in the Stage 2 modelling is provided in Figure 5.

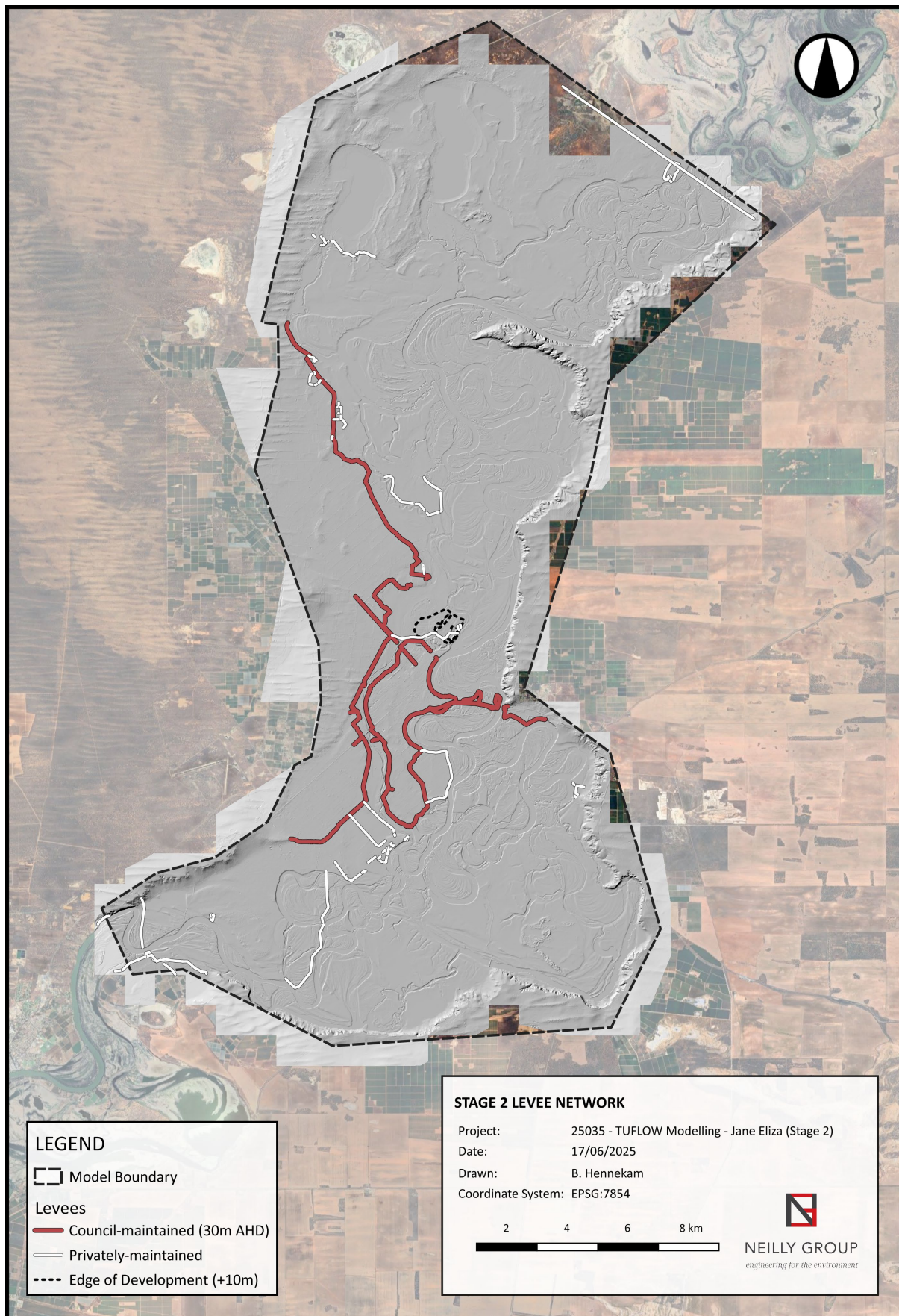


Figure 5. Levee network used for Stage 2 modelling.

2.7 Assumptions and limitations

2.7.1 Scope of the model (limitations)

The model was originally developed as a large scale flood model, and has been fine-tuned for use as an Afflux Model, to inform on differences between modelled water levels before and after the development. At its highest resolution, it has a cell size of 5m by 5m, and is accurate to a level sufficient for this use.

The model does not contain detailed topography, constrictions and impediments such as narrow channel, bridge openings or culverts. Where these are required for connectivity, simpler methods for topographic adjustments have been applied to prevent model instabilities while retaining reasonable run times on the available resources. Roughness values are broad stroke, as is common for a study of this size (380 km²), soil interactions have not been modelled and no adjustments have been made to flow rates - which are provided at the SA border, approximately 30 km upstream along the main channel. This ignores impacts (such as flow reductions) that may occur due to the Chowilla floodplain and Lock 6.

2.7.2 Assumptions

No assumptions or changes to the model have been made relating to other works currently occurring along Bookmark Creek, including the regulator and the replacement bridge.

Changes to the modelling for Stage 2 is under the assumption that the Council will have both funding and capacity to prepare the levee network in the lead-up to any future flood events, and therefore need to assume the Council-maintained levee network is not overtopped under any flood scenario.

2.7.3 Confidence

An Afflux Model predicts afflux (water level changes) at a location due to a change that affects local hydraulics (e.g. a new development). An afflux model is not a detailed flood model designed to inform water levels at precise locations. All assumptions and limitations of the model are captured in both the pre- and post-change scenario, hence it is considered that afflux reported from an afflux model has zero error.

Given the above, and the general agreement with past modelling and previously recorded events, especially outside the Lock 5 area where the change from using bathymetry to no bathymetry appear to affect local water levels, the model provides added assurance that the proposed development will not negatively impact the town, nor increase flood risk in future events.

3 Results

3.1 Model validation

3.1.1 Datasets used

Model validation was undertaken by comparing to the following datasets:

- Results provided by Tonkin in the spreadsheet '2022 12 15 - Renmark Levee Bank Long Sections - MSA Update (2).xlsx'.
- Historical flood records.
- River Murray Flow Reports – for the period of the 2022-23 floods, available via [Water Connect](#).
- DEW flood mapping shapefiles – flood extents for DEW modelling, plus the actual extents of the 2022-23 and 1956 floods, available via [data.sa.gov.au](#).

Notes about the datasets:

1. The provided results contained water surface elevations (WSE) for multiple locations along the river, at multiple flow rates.
 - a. No WSE were provided for 80 GL/d.
 - b. No WSE were available for 150 GL/d, so the average of the provided 140GL/d and 160 GL/d WSE was used.
 - c. No results are provided for the 186 GL/d flow rate, assumed as the 2022-23 peak flow rate, so the 180 GL/d value has been used.
2. Reported WSE during the 2022-23 flood correlate to the reported flow to SA value at the same time. While there is in fact a lag before that flow rate reaches Renmark, which Neilly Group estimate to be approximately 1 week, the results shown in Section 3.1.3 do not account for this lag.
3. The following locations were used, with values from other sources as shown in Table 3.

Table 3. Locations and sources of comparison values

Location	Tab in spreadsheet	DEW values
Lock 5	Old N'2 PS Grower Dist Bank	Lock 5 upstream
Paringa	Paringa	-
Renmark Pump Station	Hale St Bank	Renmark PS
Site	Hospital Bank	-

3.1.2 Methodology

For all model runs, both the resulting flood extents and WSE at the above locations were compared. The model was then iteratively refined by adjusting model cell size, breaklines and topography until further adjustments were no longer deemed viable in relation to the time spent versus the magnitude of the improvements achieved.

3.1.3 Assessment of final model

The final model shows a large degree of agreement with past modelling and historical events, with two exceptions.

1. Results at Lock 5 are generally higher than expected. This is assumed to be a result in bathymetry (below water surface details) changes in the model at Lock 5: bathymetry is assumed upstream of Lock 5, but no bathymetry is assumed downstream – a jump of 6-7m on the modelled surface.

2. The 341 GL/d results are higher than expected based on the recorded level of the 1956 flood and the provided model results. The reason for this has not been investigated since (i) so much has changed since 1956 that it is no longer considered a valid indicator, and (ii) no information (e.g. date of study, assumptions and limitations, etc) has been provided for the provided model results.

Figure 6 shows the water elevation for the different data sources at the Renmark Pump Station – the closest location to the site with multiple data points for validation.

Results show good agreement with historical levels at this location, including the peak of the recent 2022-23 flood event. Results for Lock 5, plus the results for each flow rate, across all sites, are provided in Appendix A.

Comparison flood extents are provided with the pre-development results in Appendix B.

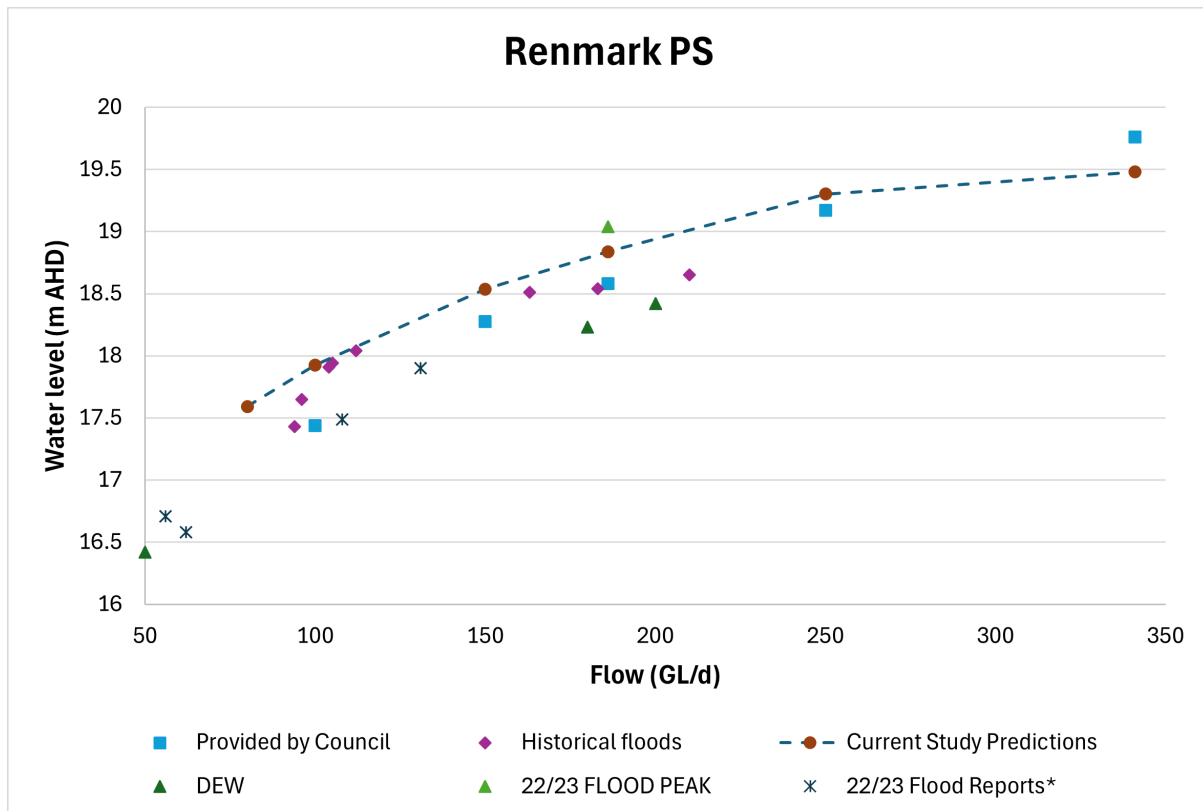


Figure 6. Model validation results at Renmark PS.

** Flood reports not adjusted for lag time from crossing border to Renmark*

3.1.4 Re-assessment of Stage 2 Results

The method used to model Council's commitment to maintain the levee system in future flood events included extending the height of the Council-maintained levee network to 30m high "glass walls". As these amend the topography of the model surface, they restrict flows in the model that were neither restricted in past actual events (except for 2022-23) nor previous modelling, hence it did not make sense to re-assess the new results against past events or modelling.

3.2 Results

3.2.1 Pre-development results (Stage 1)

The pre-development results are generally consistent with DEW flood extents, with the following comments:

- The Neilly Group model shows slightly greater flood extents, which is expected due to the higher water levels mentioned previously. This may also be due to the model resolution in these areas.
- The performance of the pre-development model is considered sufficient for use in analysis of the impacts by the proposed Jane Eliza development.

3.2.2 Pre-development results (Stage 2)

With the changes to the council-maintained levee network, the pre-development results for the 186 GL/d event are very similar to the 22/23 flood extent, with only minor differences due to levees not digitised (e.g. the new levee at Angove's) and model resolution (cell size).

Even with the additional levees that were digitised south-east of Kulnine St, flooding still occurs greater than what was observed during the actual flood. This is again likely due to model resolution, and is greatly reduced compared to Stage 1 results for the same flood event.

For the 250 GL/d and 341 GL/d events, as would be expected, the flood extents are significantly smaller than the DEW model results, due to the "glass walls" along the council-maintained levee network.

3.2.3 Post-development (Stage 1)

Post-development results show no noticeable increase in flood extents for events below the 186 GL/d event.

3.2.4 Post-development (Stage 2)

Due to the way Stage 2 modelling was undertaken, using a glass wall approach for Council maintained levees, no changes in flood extents are observed between pre- and post-development flood extents.

3.3 Afflux

3.3.1 Development impacts at 80 GL/d

In the 80 GL/d pre-development scenario, overland flows into Bookmark Creek are less than the larger modelled events, and due to the position of the proposed development, some of the flows that would have reached Bookmark Creek are now cut-off.

In this scenario, flows into Bookmark Creek are reduced, and therefore water levels reduce by up to 25mm, and water levels in the main channel and floodplain increase slightly (~6-7 mm near Renmark; ~10 mm in the Pike floodplain).

As with all scenarios, water levels on the Jane Eliza floodplain increase. The largest increase occurs adjacent to the development where maximum afflux of +50-60 mm occurs. Impacts are only seen on the floodplain, the proposed Jane Eliza development is **not** impacted and there are no adverse impacts or additional flood risks to developed areas (e.g. Renmark Township).

3.3.2 Development impacts at 100 GL/d

The 100 GL/d scenario is similar to the 80 GL/d scenario except that more water is able to enter Bookmark Creek, such that very little impact is observed to flows through that channel. With greater volumes on the floodplain, flows adjacent to the proposed development do not get restricted as in the 80 GL/d scenario and thus maximum afflux is reduced to just under 50 mm.

Impacts are essentially restricted to the Jane Eliza floodplain, with almost no impacts observed in the main channel or wider system. The proposed Jane Eliza development is **not** impacted and there are no adverse impacts or additional flood risks to developed areas (e.g. Renmark Township).

3.3.3 Development impacts at 150 GL/d

At 150 GL/d, the situation regarding Bookmark Creek vs the main channel and floodplain starts to reverse. With greater connectivity, more water is pushed through Bookmark Creek, resulting in elevated water levels, typically 10-20 mm, and slightly lower increases in water levels in the main channel, typically less than 10 mm.

Maximum water level increase adjacent to the development itself is approximately 45 mm. Impacts are restricted to floodplain areas, the proposed Jane Eliza development is **not** impacted and there are no adverse impacts or additional flood risks to developed areas (e.g. Renmark Township).

3.3.4 Development impacts at 186 GL/d

In the 186 GL/d event, water level increases in excess of 5 mm are observed from the downstream are observed from approximately Nelwart St in Bookmark Creek, increasing to approximately 15 mm at the Sturt Highway bridge, 20 mm at Twentyfirst St bridge, 25 mm at Ral Ral bridge and then in excess of 25 mm across the Jane Eliza floodplain. Maximum modelled afflux adjacent to the development is 46 mm.

Beyond this, increases drop quickly to ~15 mm, then remain above 10 mm across the width of the floodplain all the way up to the southern boundary of Calperum Station and the northern extent of Ral Ral Wide Waters.

To the immediate east of the development, water levels show to decrease by 5 to 10 mm close to the development. Elsewhere, changes are less than +/- 5 mm.

3.3.5 Development impacts at 250 GL/d

A similar pattern is observed for the 250 GL/d event, starting again at approximately a 5 mm increase just upstream of Nelwart St bridge across Bookmark Creek, ~15 mm, ~20 mm and ~25 mm increases at Sturt Highway, Twentyfirst St and Ral Ral Ave bridges respectively, then in excess of 30 mm across the Jane Eliza floodplain. Maximum modelled afflux adjacent to the development is 55 mm.

In the rest of the floodplain, the increases extend further upstream, and the area with reduced water levels is larger and shows a positive benefit (slight water level reduction) along the entire town waterfront area. This is due to changes in the split of flows between the main river channel and Bookmark Creek which will be further impacted by works currently occurring and not incorporated into this modelling.

3.3.6 Development impacts at 341 GL/d

The 341 GL/d event sees a continuation of the same trends. Key values along Bookmark Creek are largely unchanged downstream of Ral Ral Ave. At Ral Ral Ave bridge the increase is now approximately 30 mm, and further increases are observed across the floodplain, with the maximum against the edge of the development of 58 mm.

Water level reductions are now shown right to Sturt Highway towards the Paringa bridge, although it should be noted that modelling of the pathways through the bridge are simplified and results should be viewed as indicative only.

3.4 Discussion

The upstream sections of the SA River Murray, from the SA border to Lock 3, are characterised by large floodplains that disperse floodwaters across vast areas for minimal increases in flood depth compared to areas downstream of Lock 3 where the floodplains are more constricted.

Within the model boundary alone there are the Calperum / Ral Ral floodplain (~12,500 ha), the floodplains in the vicinity of the town (~4,200 ha) and the Pike floodplain (~8,000 ha) – see Figure 7. Combined this is almost 25,000 hectares over which the volume of water displaced by the development can spread.

The effects of the development are more pronounced closer to the site. Focussing on just the floodplain area around the town itself, the flood volume in the 341 GL/d event is over 815,000 megalitres (ML), while the volume of water displaced by the development is just over 21,500 ML, or 2.6%

Modelling suggests that the impacts of the development for flows up to the 186 GL/d flow rate have little impact on properties. While larger events are contained within the Council maintained levees around town, the extents of flooding outside these areas show little changes, with only minimal increases to flood extents upstream around Calperum station, and no observable differences downstream – including the areas to the south and southeast of Kulnine St.

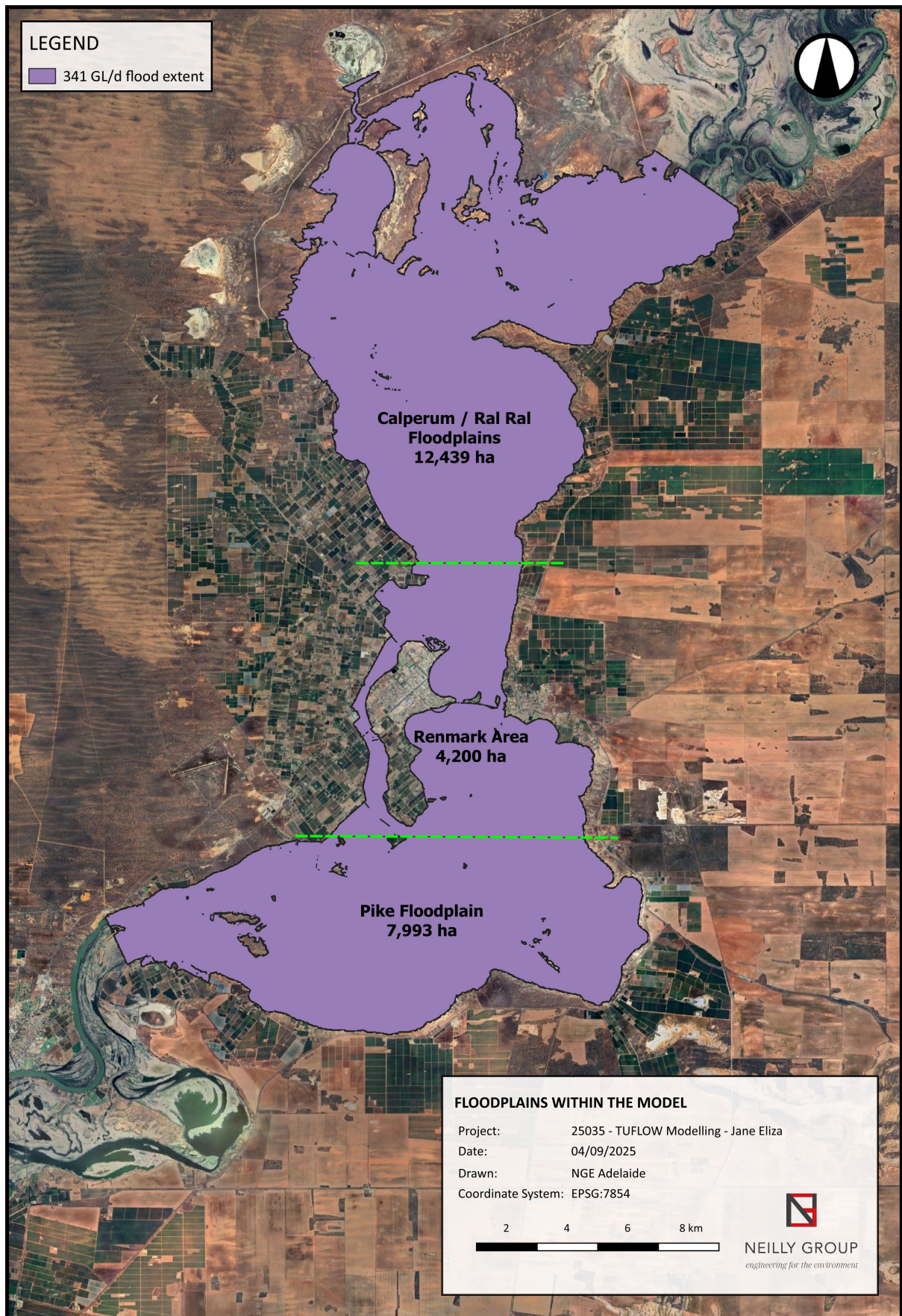


Figure 7. Floodplains within the model boundary.

4 References

Department for Environment and Water (DEW), 2024. *2022-23 River Murray flood event*.
<https://www.environment.sa.gov.au/topics/river-murray-floods/2022-23-river-murray-flood-event>.

Environmental Protection Agency (EPA), 2023. *2022–23 River Murray Flood*.
<https://soe.epa.sa.gov.au/environmental-themes/river-murray/state-of-the-murray/2022-23-river-murray-flood>.

Appendix A: Model validation graphs (from Stage 1)

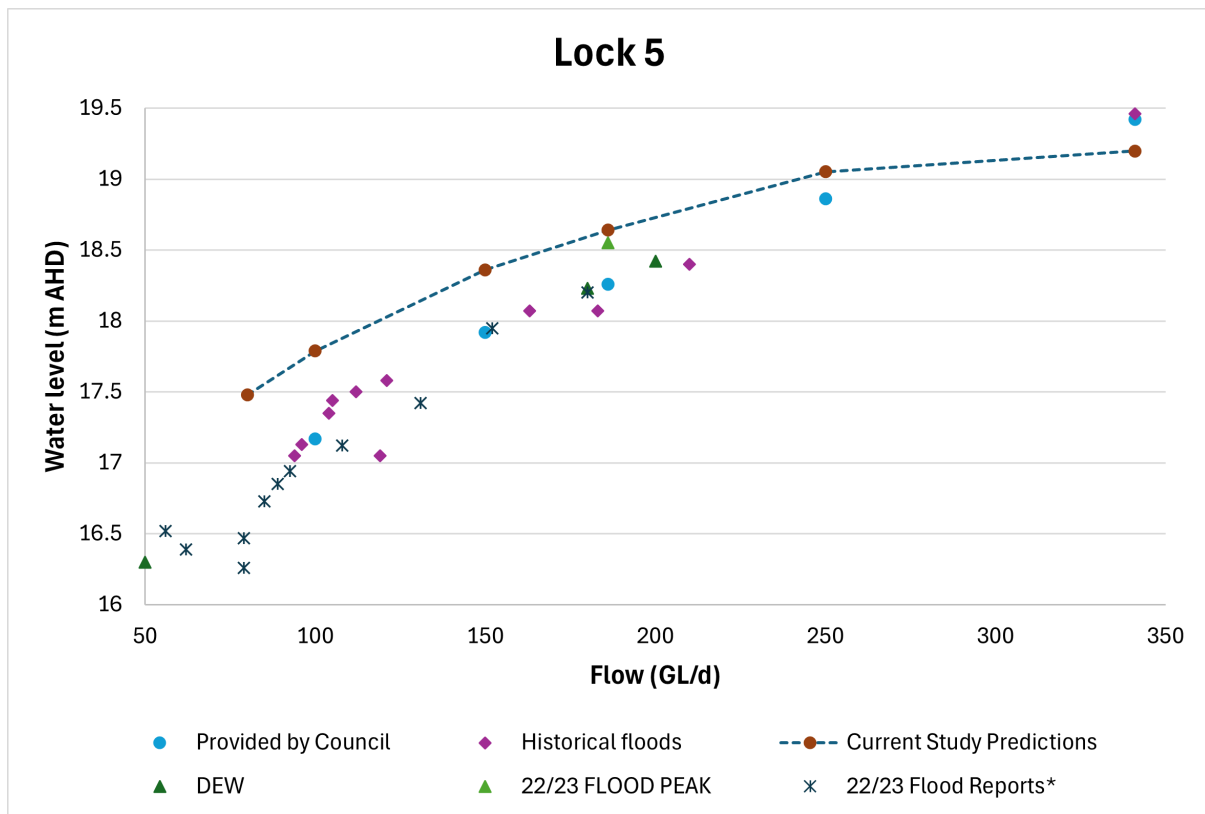


Figure 8. Model validation at Lock 5.

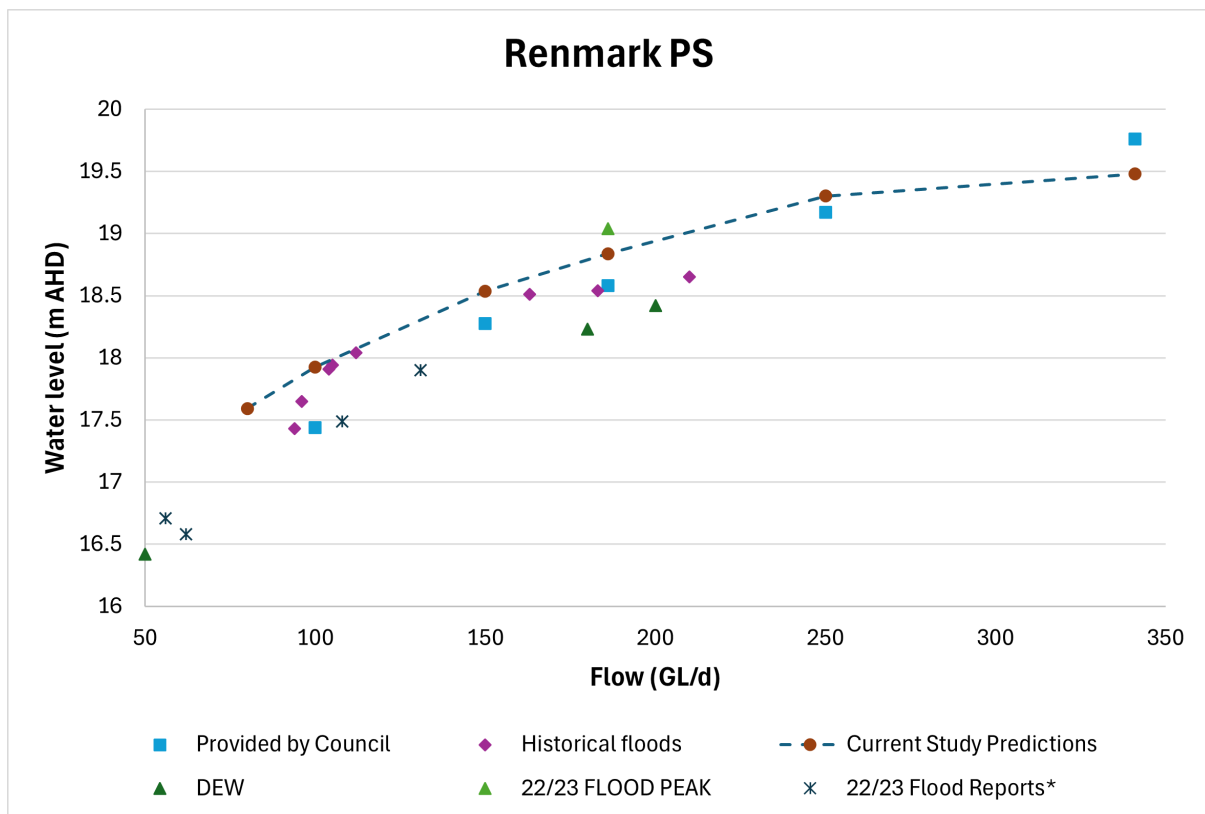


Figure 9. Model validation at Renmark Pump Station.

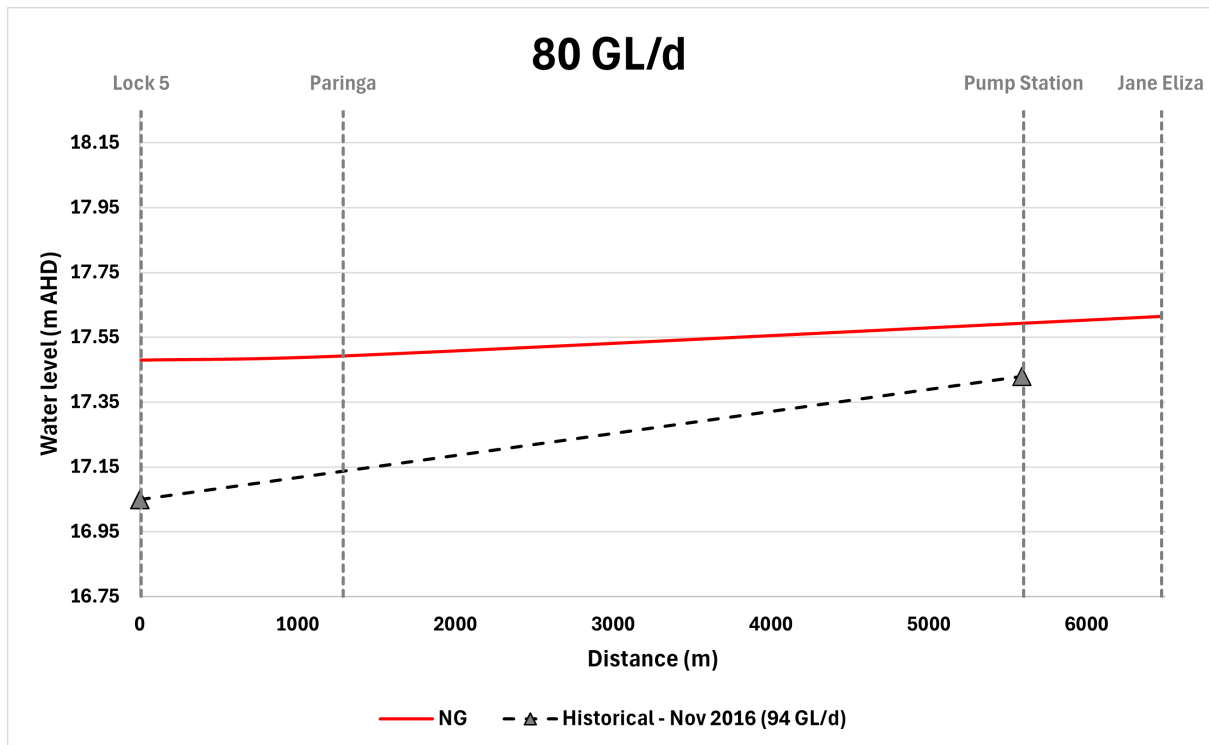


Figure 10. Model validation for 80 GL/d.

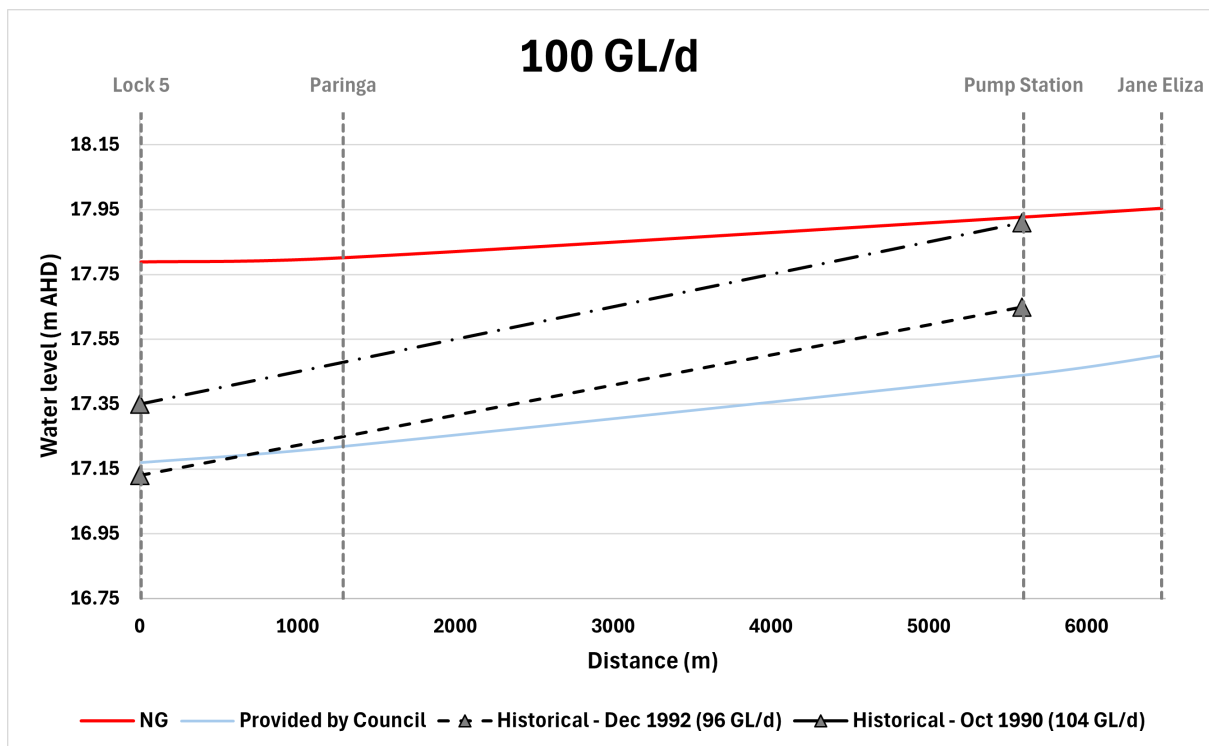


Figure 11. Model validation for 100 GL/d.

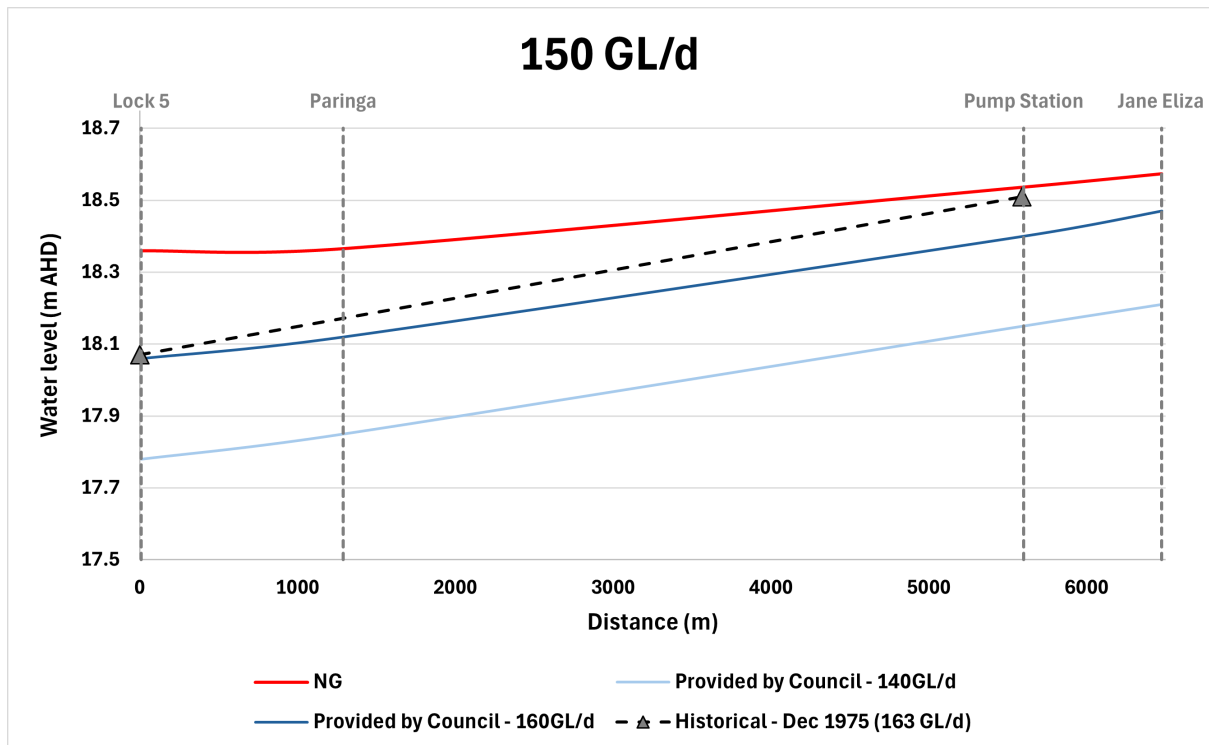


Figure 12. Model validation for 150 GL/d.

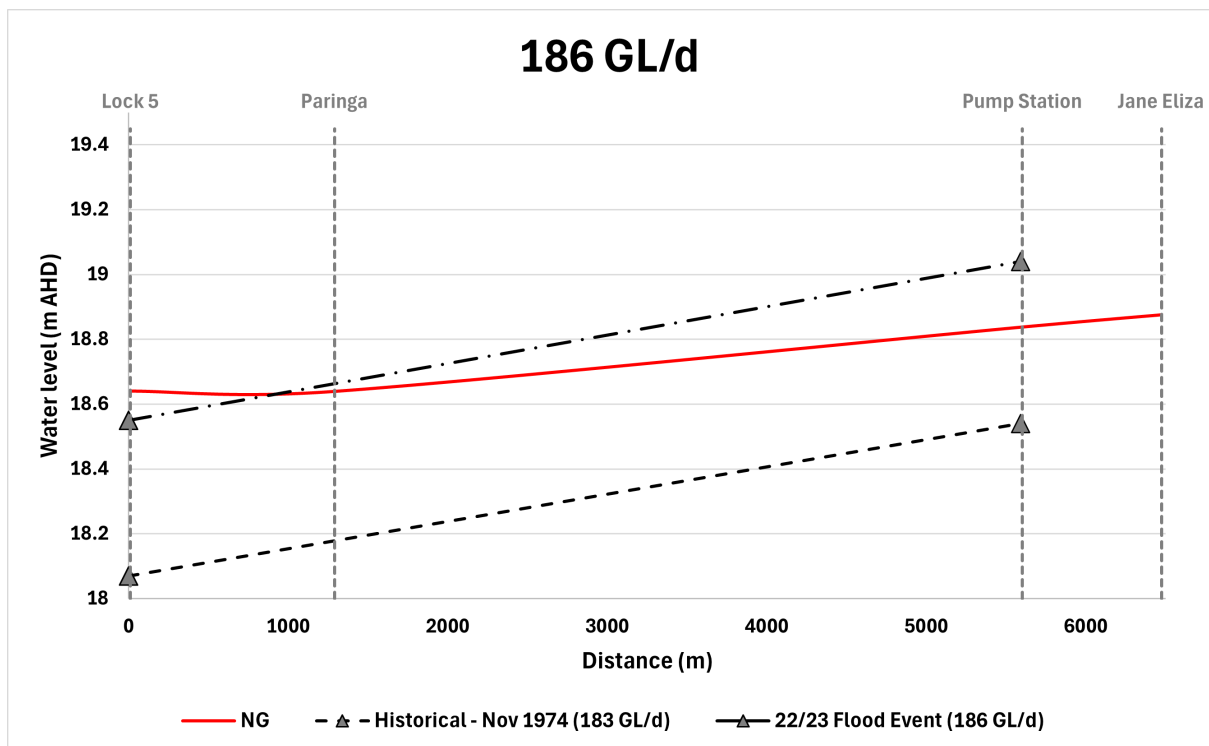


Figure 13. Model validation for 186 GL/d.

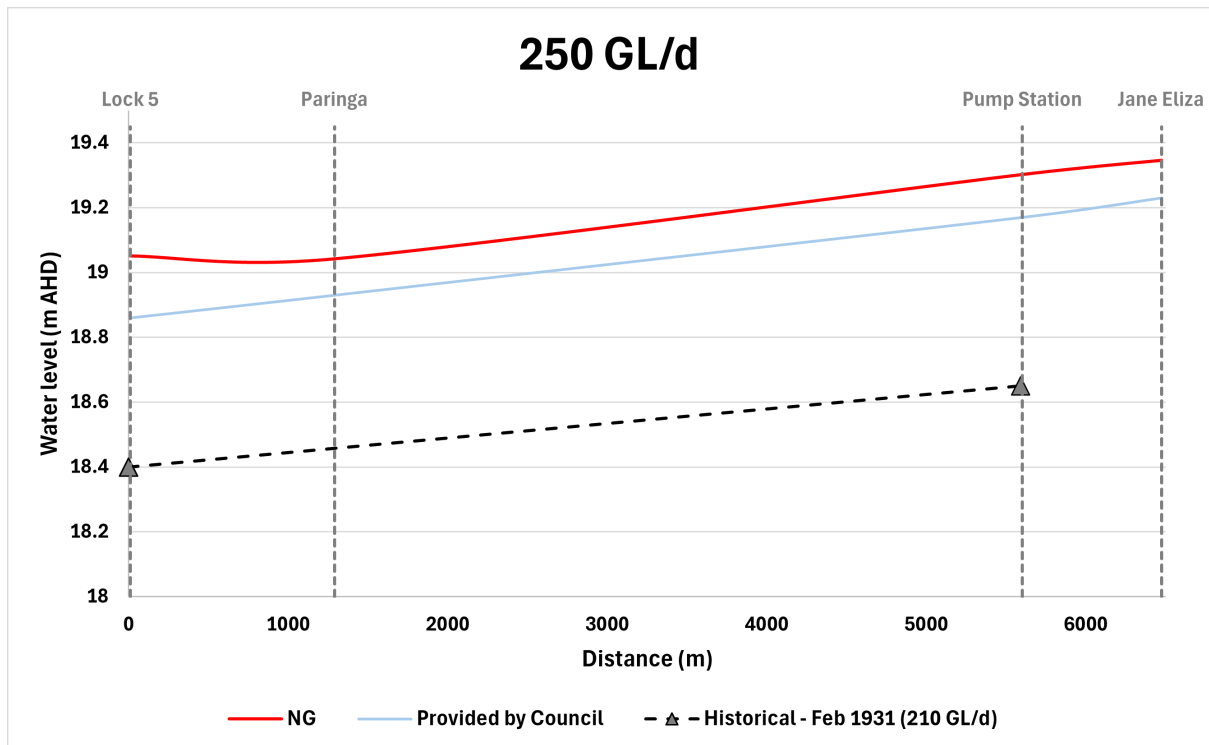


Figure 14. Model validation for 250 GL/d.

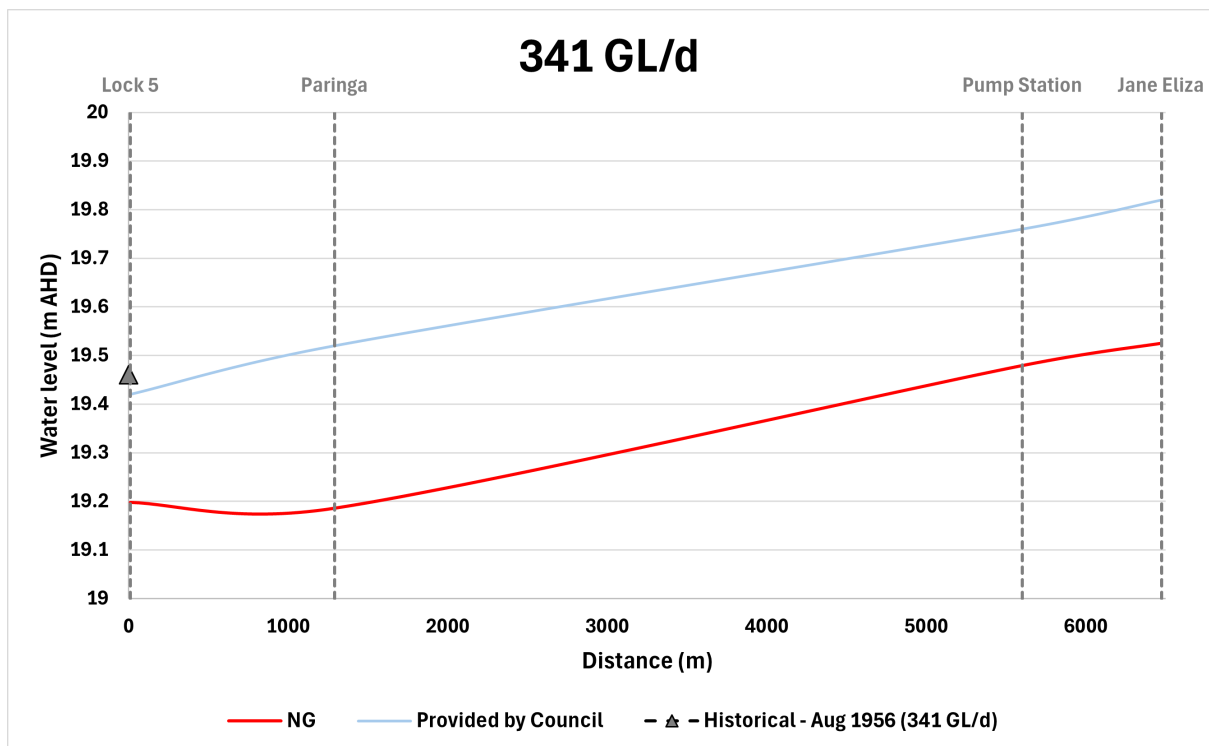
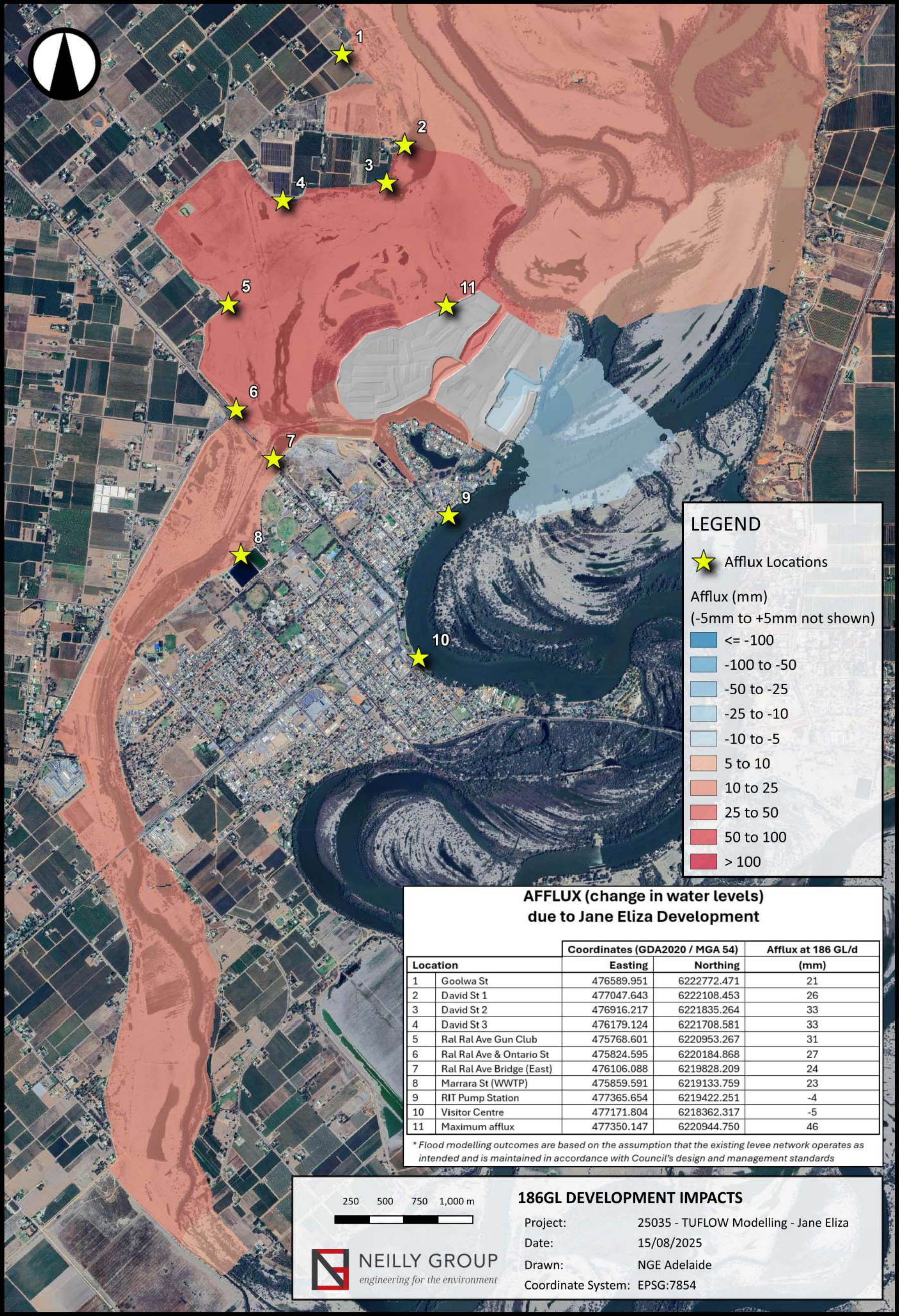


Figure 15. Model validation for 341 GL/d.

Appendix B: Maps



LEGEND

★ Afflux Locations

Afflux (mm)
(-5mm to +5mm not shown)

- ≤ -100
- 100 to -50
- 50 to -25
- 25 to -10
- 10 to -5
- 5 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- > 100

AFFLUX (change in water levels) due to Jane Eliza Development

Location		Coordinates (GDA2020 / MGA 54)		Afflux at 186 GL/d
		Easting	Northing	(mm)
1	Goolwa St	476589.951	6222772.471	21
2	David St 1	477047.643	6222108.453	26
3	David St 2	476916.217	6221835.264	33
4	David St 3	476179.124	6221708.581	33
5	Ral Ral Ave Gun Club	475768.601	6220953.267	31
6	Ral Ral Ave & Ontario St	475824.595	6220184.868	27
7	Ral Ral Ave Bridge (East)	476106.088	6219828.209	24
8	Marrara St (WWTP)	475859.591	6219133.759	23
9	RIT Pump Station	477365.654	6219422.251	-4
10	Visitor Centre	477171.804	6218362.317	-5
11	Maximum afflux	477350.147	6220944.750	46

* Flood modelling outcomes are based on the assumption that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards

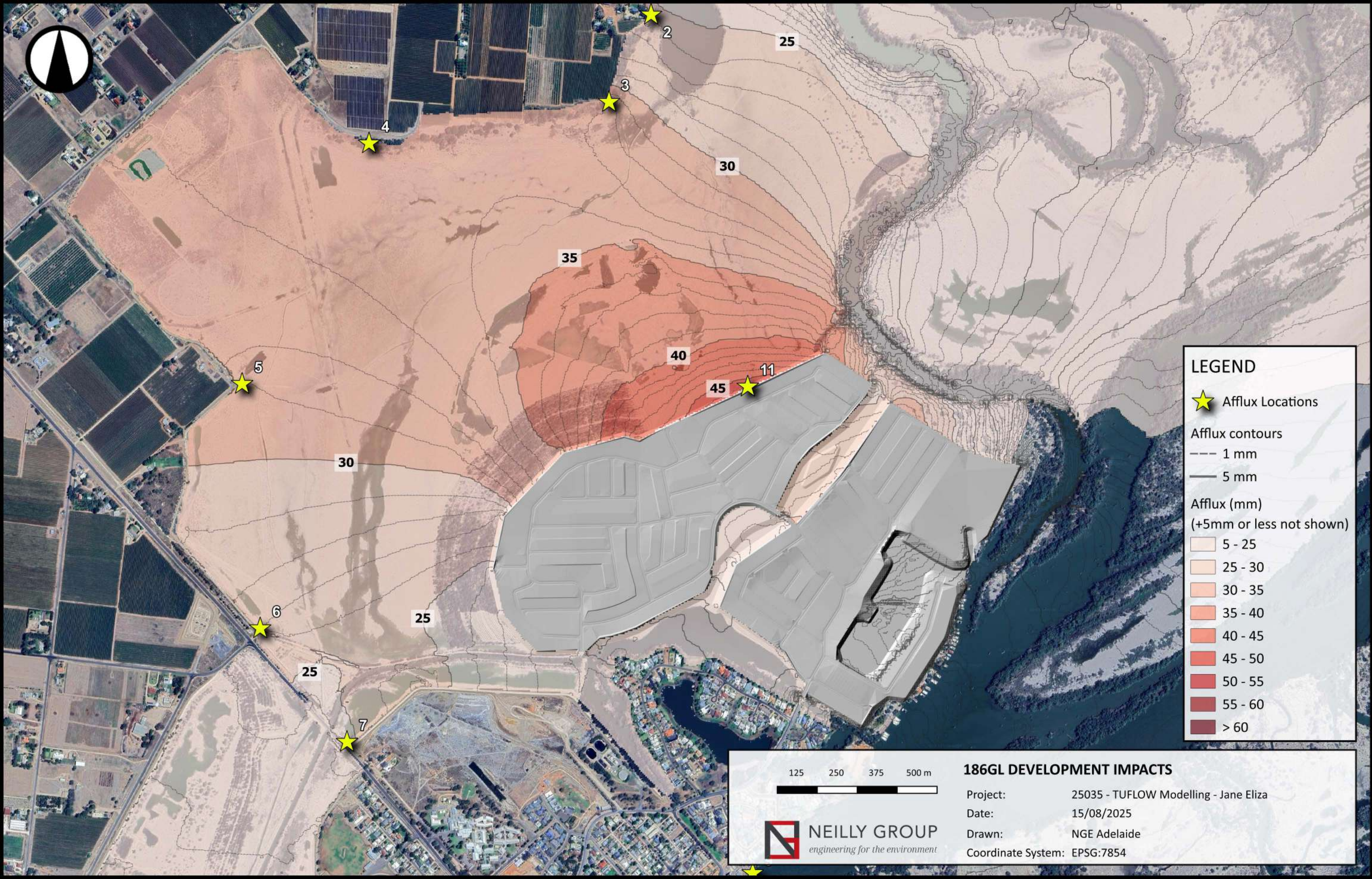
250 500 750 1,000 m



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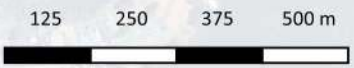
186GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza
Date: 15/08/2025
Drawn: NGE Adelaide
Coordinate System: EPSG:7854



LEGEND

- Afflux Locations
- Afflux contours
 - 1 mm
 - 5 mm
- Afflux (mm)
(+5mm or less not shown)
 - 5 - 25
 - 25 - 30
 - 30 - 35
 - 35 - 40
 - 40 - 45
 - 45 - 50
 - 50 - 55
 - 55 - 60
 - > 60



186GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza
Date: 15/08/2025
Drawn: NGE Adelaide
Coordinate System: EPSG:7854



**AFFLUX (change in water levels)
due to Jane Eliza Development**

Location		Coordinates (GDA2020 / MGA 54)		Afflux at 186 GL/d (mm)
		Easting	Northing	
1	Goolwa St	476589.951	6222772.471	21
2	David St 1	477047.643	6222108.453	26
3	David St 2	476916.217	6221835.264	33
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7	Ral Ral Ave Bridge (East)	476106.088	6219828.209	24
8	Marrara St (WWTP)	475859.591	6219133.759	23
9	RIT Pump Station	477365.654	6219422.251	-4
10	Visitor Centre	477171.804	6218362.317	-5
11	Maximum afflux	477350.147	6220944.750	46

** Flood modelling outcomes are based on the assumption that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards*

LEGEND

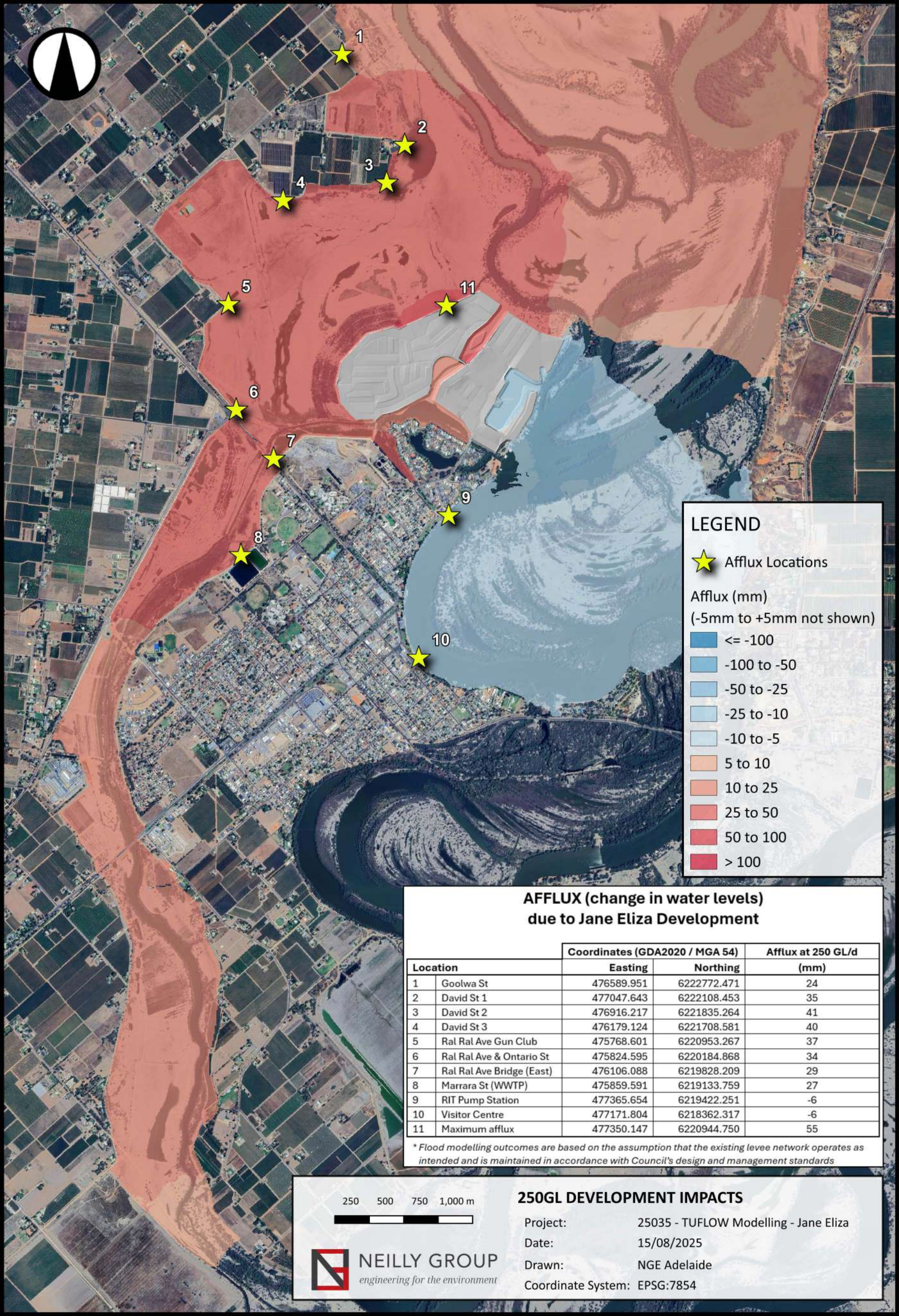
- ★ Afflux Locations
- Afflux (mm)
(-5mm to +5mm not shown)
- ≤ -100
 - 100 to -50
 - 50 to -25
 - 25 to -10
 - 10 to -5
 - 5 to 10
 - 10 to 25
 - 25 to 50
 - 50 to 100
 - > 100

250 500 750 1,000 m



186GL DEVELOPMENT IMPACTS

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Date: 14/08/2025
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Coordinate System: EPSG:7854



LEGEND

★ Afflux Locations

Afflux (mm)
(-5mm to +5mm not shown)

- ≤ -100
- 100 to -50
- 50 to -25
- 25 to -10
- 10 to -5
- 5 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- > 100

AFFLUX (change in water levels) due to Jane Eliza Development

		Coordinates (GDA2020 / MGA 54)		Afflux at 250 GL/d
Location		Easting	Northing	(mm)
1	Goolwa St	476589.951	6222772.471	24
2	David St 1	477047.643	6222108.453	35
3	David St 2	476916.217	6221835.264	41
4	David St 3	476179.124	6221708.581	40
5	Ral Ral Ave Gun Club	475768.601	6220953.267	37
6	Ral Ral Ave & Ontario St	475824.595	6220184.868	34
7	Ral Ral Ave Bridge (East)	476106.088	6219828.209	29
8	Marrara St (WWTP)	475859.591	6219133.759	27
9	RIT Pump Station	477365.654	6219422.251	-6
10	Visitor Centre	477171.804	6218362.317	-6
11	Maximum afflux	477350.147	6220944.750	55

* Flood modelling outcomes are based on the assumption that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards

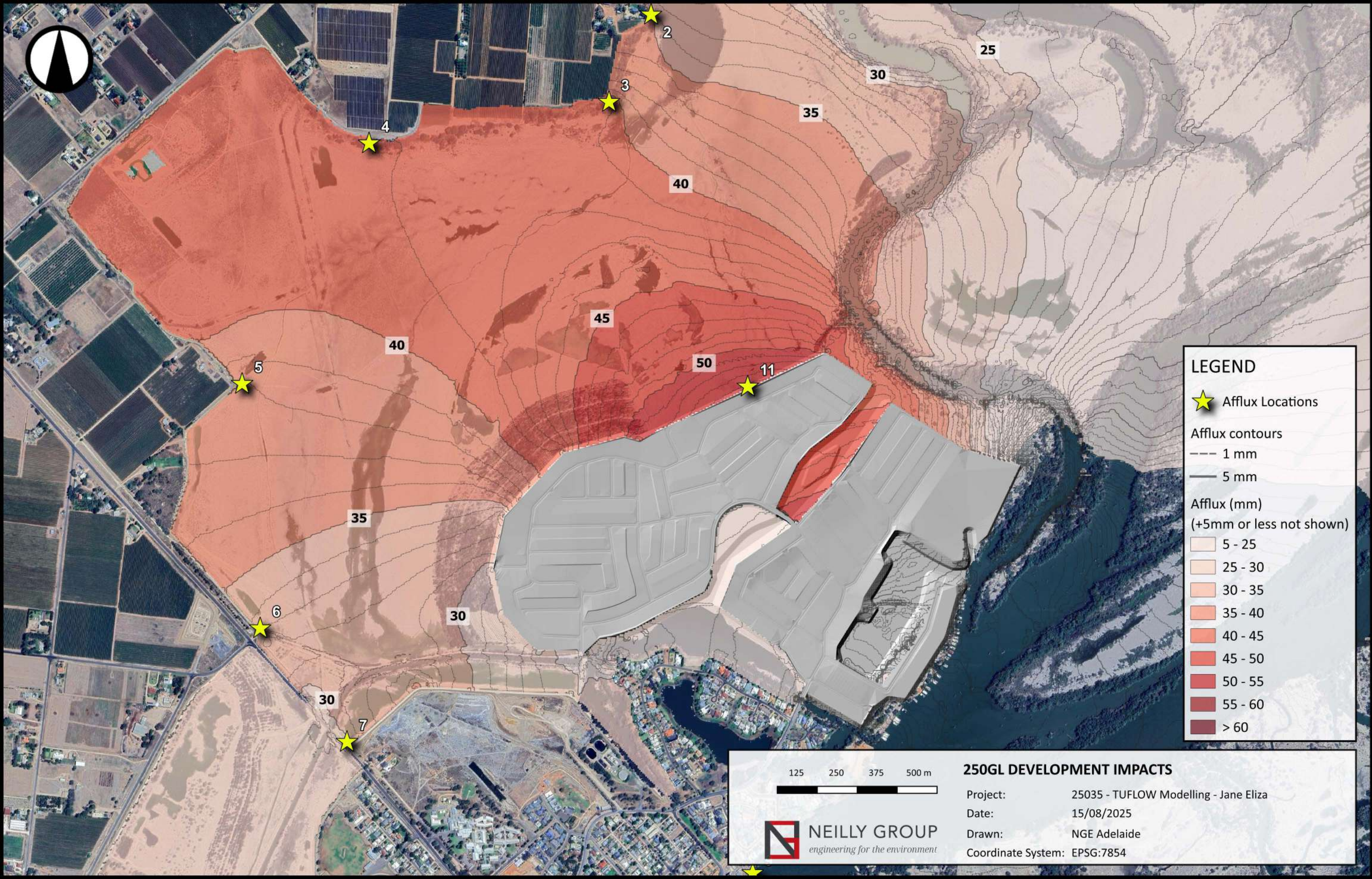
250 500 750 1,000 m



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250GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza
Date: 15/08/2025
Drawn: NGE Adelaide
Coordinate System: EPSG:7854



LEGEND

★ Afflux Locations

Afflux contours

--- 1 mm

— 5 mm

Afflux (mm)

(+5mm or less not shown)

5 - 25

25 - 30

30 - 35

35 - 40

40 - 45

45 - 50

50 - 55

55 - 60

> 60

125 250 375 500 m



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250GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza

Date: 15/08/2025

Drawn: NGE Adelaide

Coordinate System: EPSG:7854



**AFFLUX (change in water levels)
due to Jane Eliza Development**

Location		Coordinates (GDA2020 / MGA 54)		Afflux at 250 GL/d (mm)
		Easting	Northing	
1	Goolwa St	476589.951	6222772.471	24
2	David St 1	477047.643	6222108.453	35
3	David St 2	476916.217	6221835.264	41
4	David St 3	476179.124	6221708.581	40
5	Ral Ral Ave Gun Club	475768.601	6220953.267	37
6	Ral Ral Ave & Ontario St	475824.595	6220184.868	34
7	Ral Ral Ave Bridge (East)	476106.088	6219828.209	29
8	Marrara St (WWTP)	475859.591	6219133.759	27
9	RIT Pump Station	477365.654	6219422.251	-6
10	Visitor Centre	477171.804	6218362.317	-6
11	Maximum afflux	477350.147	6220944.750	55

** Flood modelling outcomes are based on the assumption that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards*

LEGEND

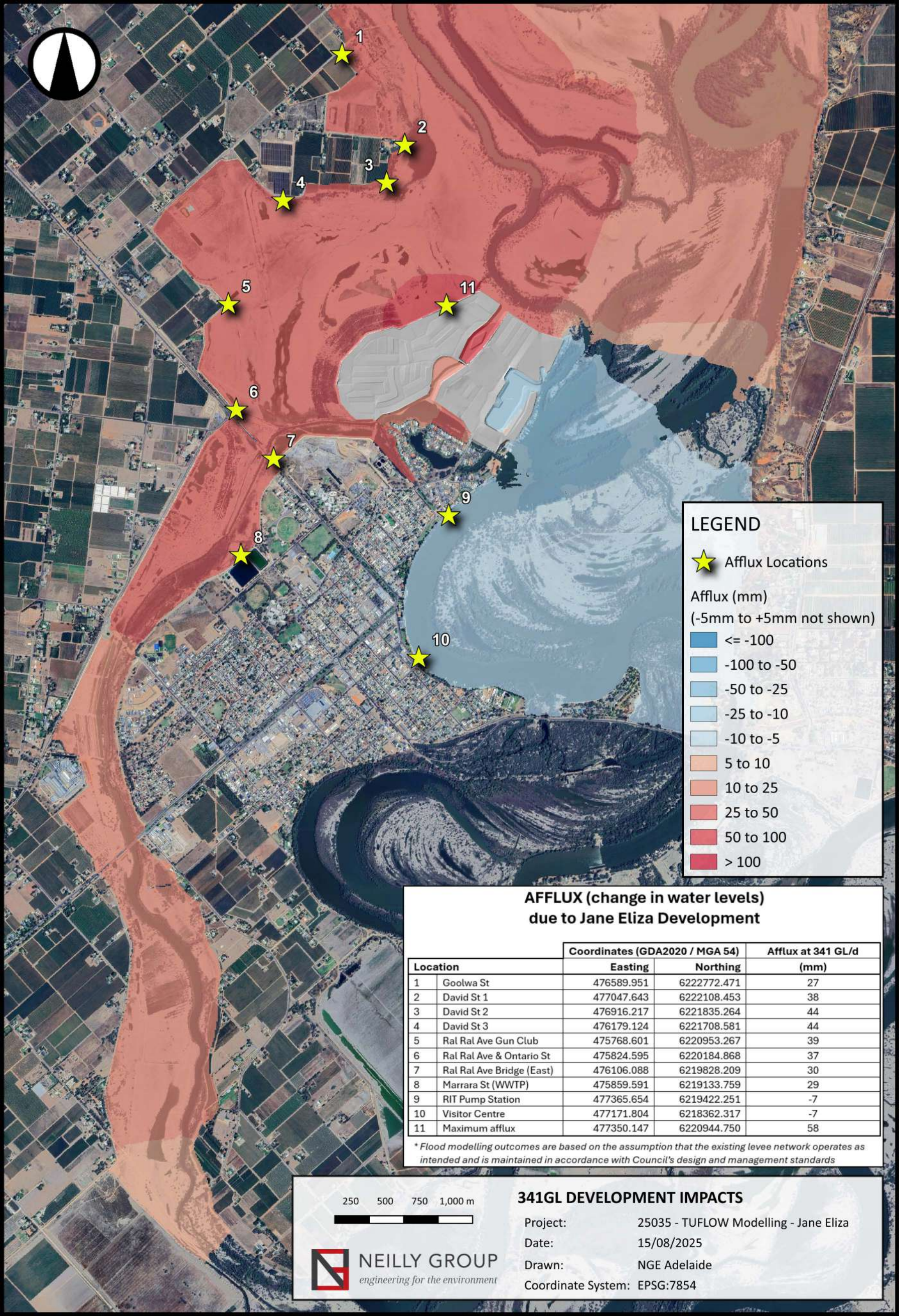
- ★ Afflux Locations
- Afflux (mm)
(-5mm to +5mm not shown)
- ≤ -100
 - 100 to -50
 - 50 to -25
 - 25 to -10
 - 10 to -5
 - 5 to 5
 - 5 to 10
 - 10 to 25
 - 25 to 50
 - 50 to 100
 - > 100

250 500 750 1,000 m



250GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza
Date: 14/08/2025
Drawn: NGE Adelaide
Coordinate System: EPSG:7854



LEGEND

★ Afflux Locations

Afflux (mm)
(-5mm to +5mm not shown)

- ≤ -100
- 100 to -50
- 50 to -25
- 25 to -10
- 10 to -5
- 5 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- > 100

AFFLUX (change in water levels) due to Jane Eliza Development

		Coordinates (GDA2020 / MGA 54)		Afflux at 341 GL/d
Location		Easting	Northing	(mm)
1	Goolwa St	476589.951	6222772.471	27
2	David St 1	477047.643	6222108.453	38
3	David St 2	476916.217	6221835.264	44
4	David St 3	476179.124	6221708.581	44
5	Ral Ral Ave Gun Club	475768.601	6220953.267	39
6	Ral Ral Ave & Ontario St	475824.595	6220184.868	37
7	Ral Ral Ave Bridge (East)	476106.088	6219828.209	30
8	Marrara St (WWTP)	475859.591	6219133.759	29
9	RIT Pump Station	477365.654	6219422.251	-7
10	Visitor Centre	477171.804	6218362.317	-7
11	Maximum afflux	477350.147	6220944.750	58

* Flood modelling outcomes are based on the assumption that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards

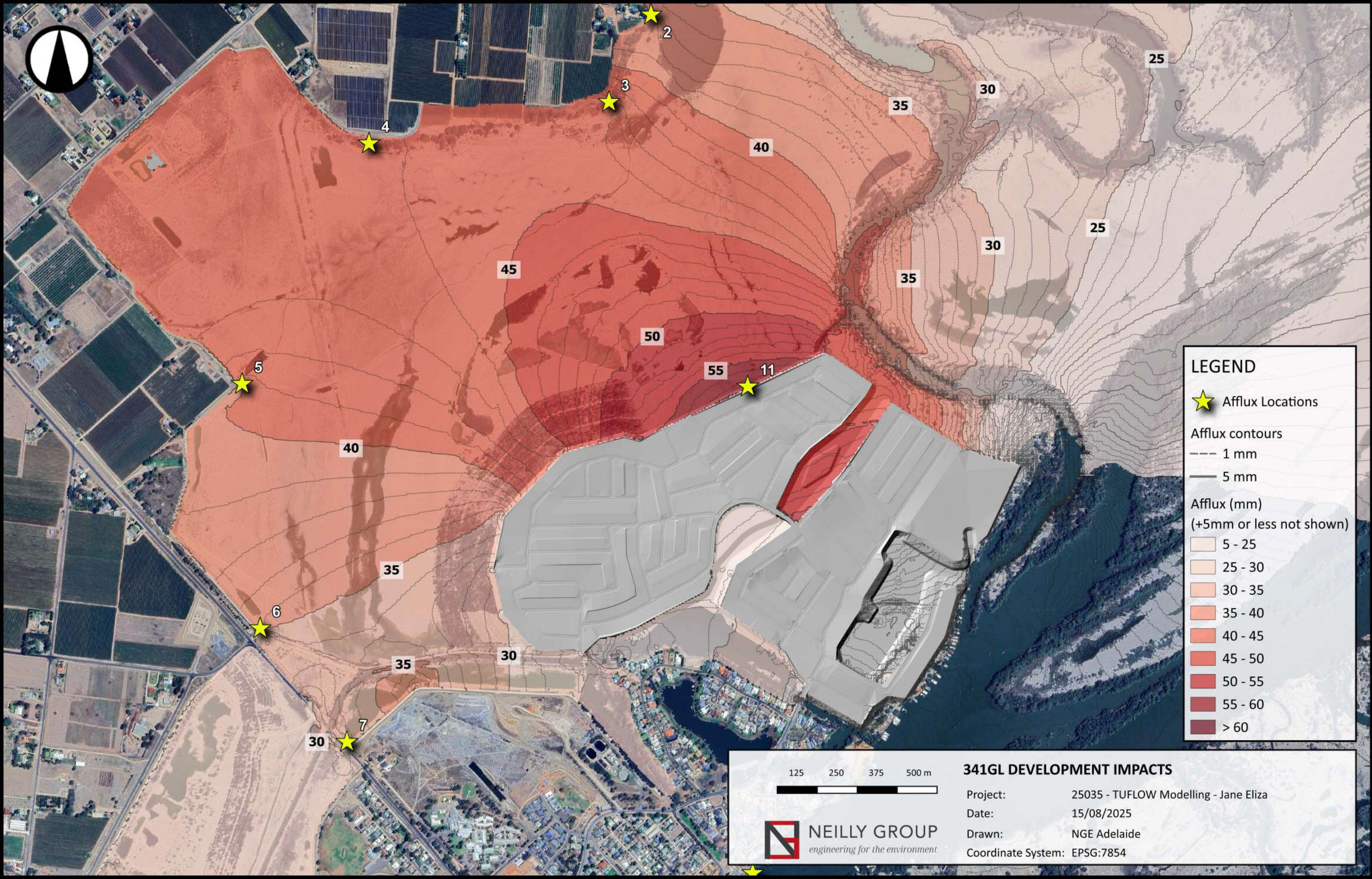
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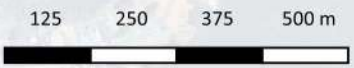
341GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza
Date: 15/08/2025
Drawn: NGE Adelaide
Coordinate System: EPSG:7854



LEGEND

- Afflux Locations
- Afflux contours
 - 1 mm
 - 5 mm
- Afflux (mm)
(+5mm or less not shown)
 - 5 - 25
 - 25 - 30
 - 30 - 35
 - 35 - 40
 - 40 - 45
 - 45 - 50
 - 50 - 55
 - 55 - 60
 - > 60



341GL DEVELOPMENT IMPACTS

Project: 25035 - TUFLOW Modelling - Jane Eliza
Date: 15/08/2025
Drawn: NGE Adelaide
Coordinate System: EPSG:7854



**AFFLUX (change in water levels)
due to Jane Eliza Development**

Location		Coordinates (GDA2020 / MGA 54)		Afflux at 341 GL/d (mm)
		Easting	Northing	
1	Goolwa St	476589.951	6222772.471	27
2	David St 1	477047.643	6222108.453	38
3	David St 2	476916.217	6221835.264	44
4	David St 3	476179.124	6221708.581	44
5	Ral Ral Ave Gun Club	475768.601	6220953.267	39
6	Ral Ral Ave & Ontario St	475824.595	6220184.868	37
7	Ral Ral Ave Bridge (East)	476106.088	6219828.209	30
8	Marrara St (WWTP)	475859.591	6219133.759	29
9	RIT Pump Station	477365.654	6219422.251	-7
10	Visitor Centre	477171.804	6218362.317	-7
11	Maximum afflux	477350.147	6220944.750	58

* Flood modelling outcomes are based on the assumption that the existing levee network operates as intended and is maintained in accordance with Council's design and management standards

LEGEND

- ★ Afflux Locations
- Afflux (mm)
(-5mm to +5mm not shown)
- ≤ -100
 - 100 to -50
 - 50 to -25
 - 25 to -10
 - 10 to -5
 - 5 to 5
 - 5 to 10
 - 10 to 25
 - 25 to 50
 - 50 to 100
 - > 100

250 500 750 1,000 m



341GL DEVELOPMENT IMPACTS

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