Disclaimer

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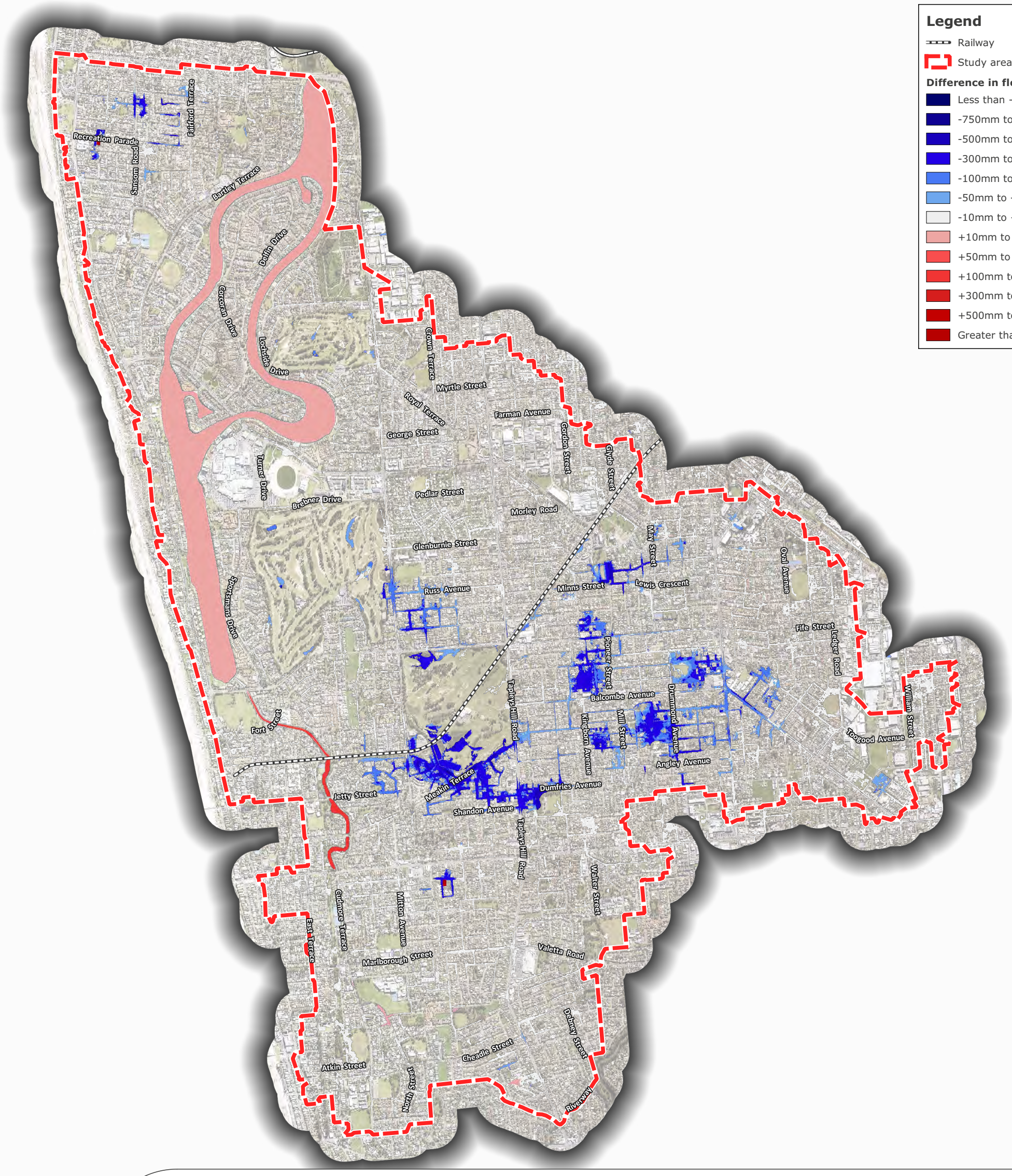

Legend

- Railway
- Study area boundary

Difference in flood depth

- Less than -750mm
- -750mm to -500mm
- -500mm to -300mm
- -300mm to -100mm
- -100mm to -50mm
- -50mm to -10mm
- -10mm to +10mm
- +10mm to +50mm
- +50mm to +100mm
- +100mm to +300mm
- +300mm to +500mm
- +500mm to +750mm
- Greater than +750mm

0 1,000 2,000 3,000 m

tonkin

Job Number: 20190818
Filename: 20190818GQ003A
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Date: 2021-06-22
Drawn: MM

Data Acknowledgement:
Aerial imagery from City of Charles Sturt, 2019
Roads and railways from Data SA, 2018

N

CITY OF CHARLES STURT

WEST LAKES STORMWATER MANAGEMENT PLAN
10% AEP FLOOD DEPTH DIFFERENCE MAP

Map 22

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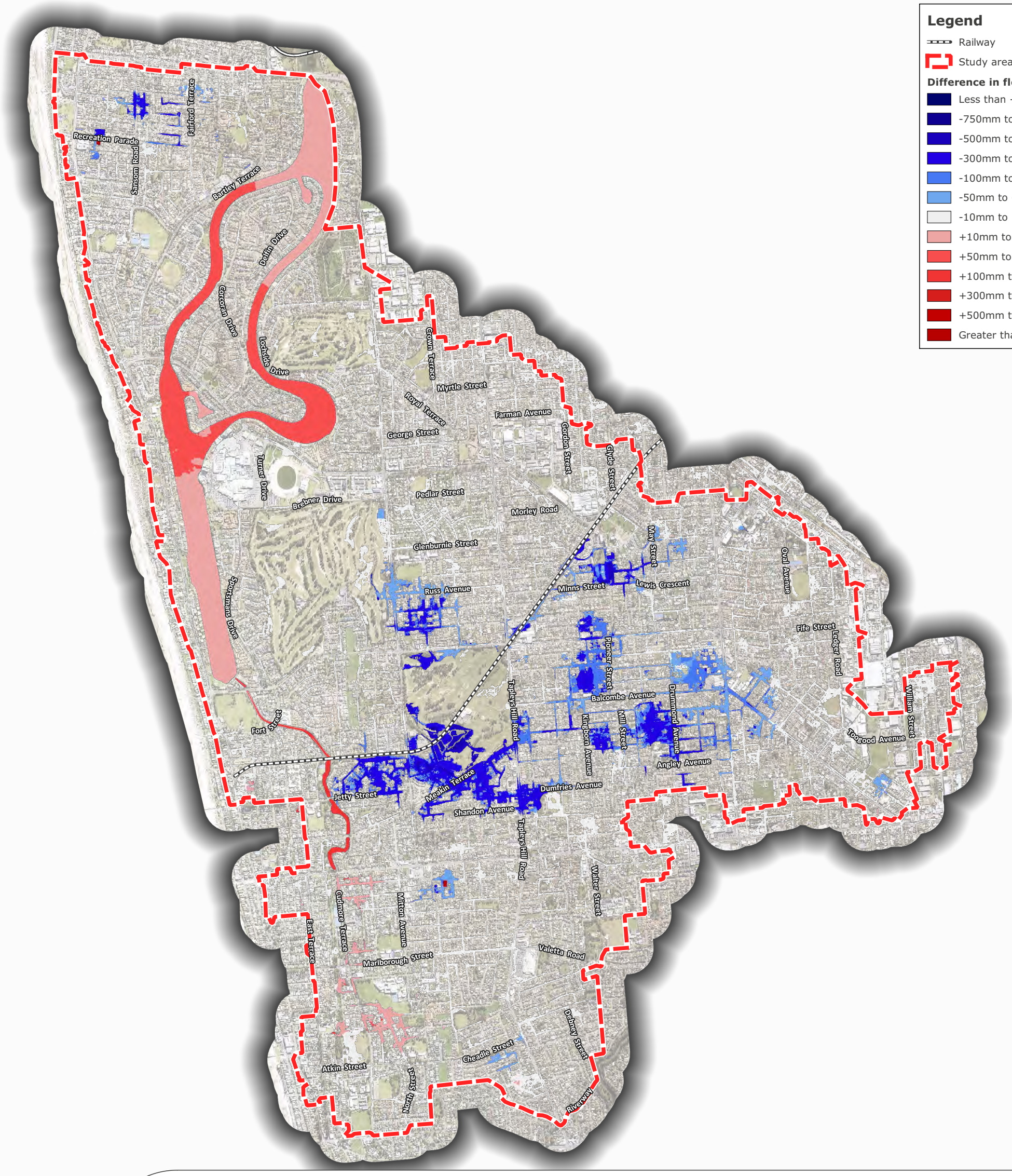

Legend

- Railway
- Study area boundary

Difference in flood depth

- Less than -750mm
- -750mm to -500mm
- -500mm to -300mm
- -300mm to -100mm
- -100mm to -50mm
- -50mm to -10mm
- -10mm to +10mm
- +10mm to +50mm
- +50mm to +100mm
- +100mm to +300mm
- +300mm to +500mm
- +500mm to +750mm
- Greater than +750mm

0 1,000 2,000 3,000 m

CITY OF CHARLES STURT

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WEST LAKES STORMWATER MANAGEMENT PLAN
5% AEP FLOOD DEPTH DIFFERENCE MAP

Map 23

Disclaimer

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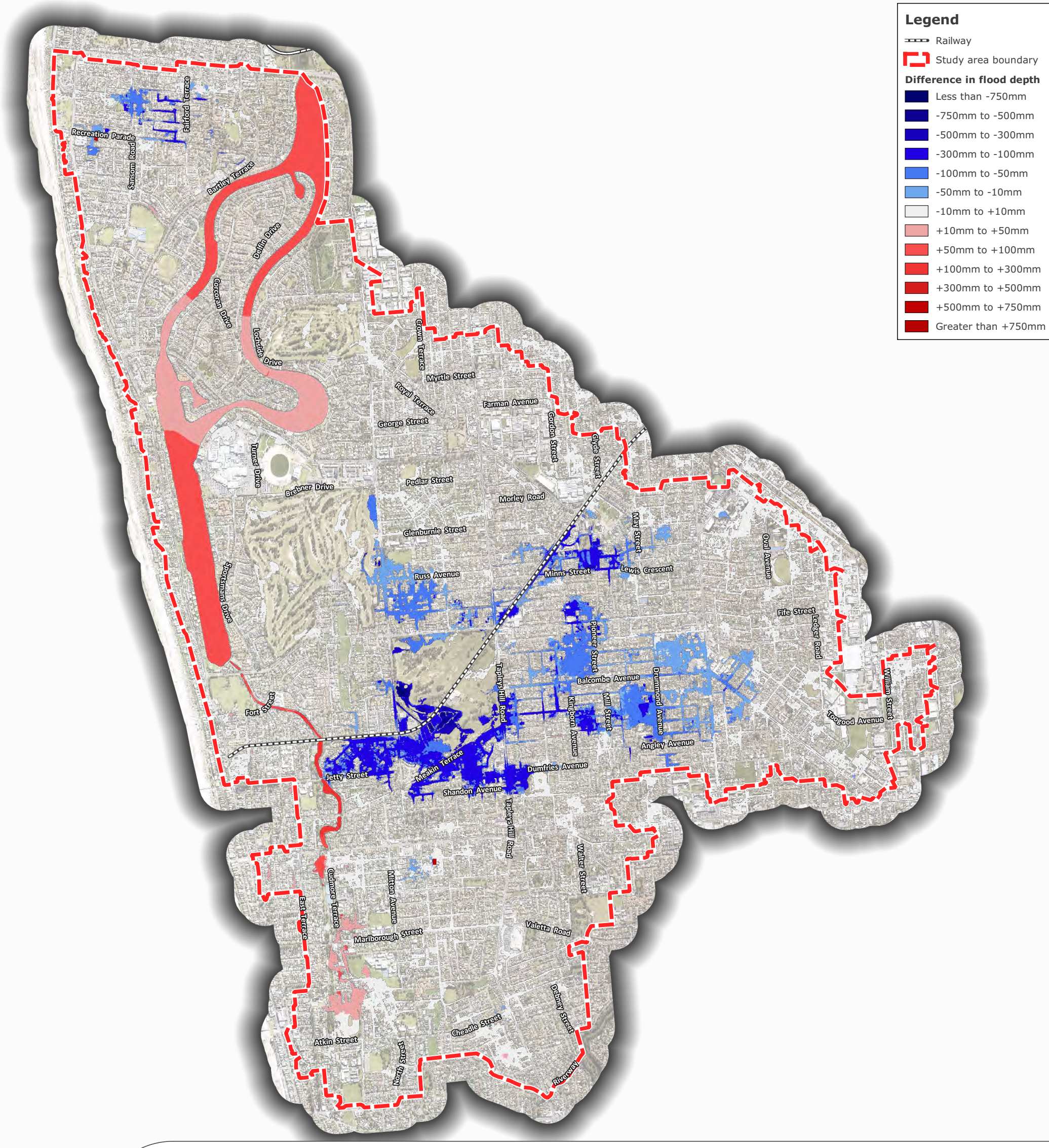

Legend

- Railway
- Study area boundary

Difference in flood depth

- Less than -750mm
- -750mm to -500mm
- -500mm to -300mm
- -300mm to -100mm
- -100mm to -50mm
- -50mm to -10mm
- -10mm to +10mm
- +10mm to +50mm
- +50mm to +100mm
- +100mm to +300mm
- +300mm to +500mm
- +500mm to +750mm
- Greater than +750mm

0 1,000 2,000 3,000 m

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CITY OF CHARLES STURT

WEST LAKES STORMWATER MANAGEMENT PLAN
2% AEP FLOOD DEPTH DIFFERENCE MAP

Map 24

Disclaimer

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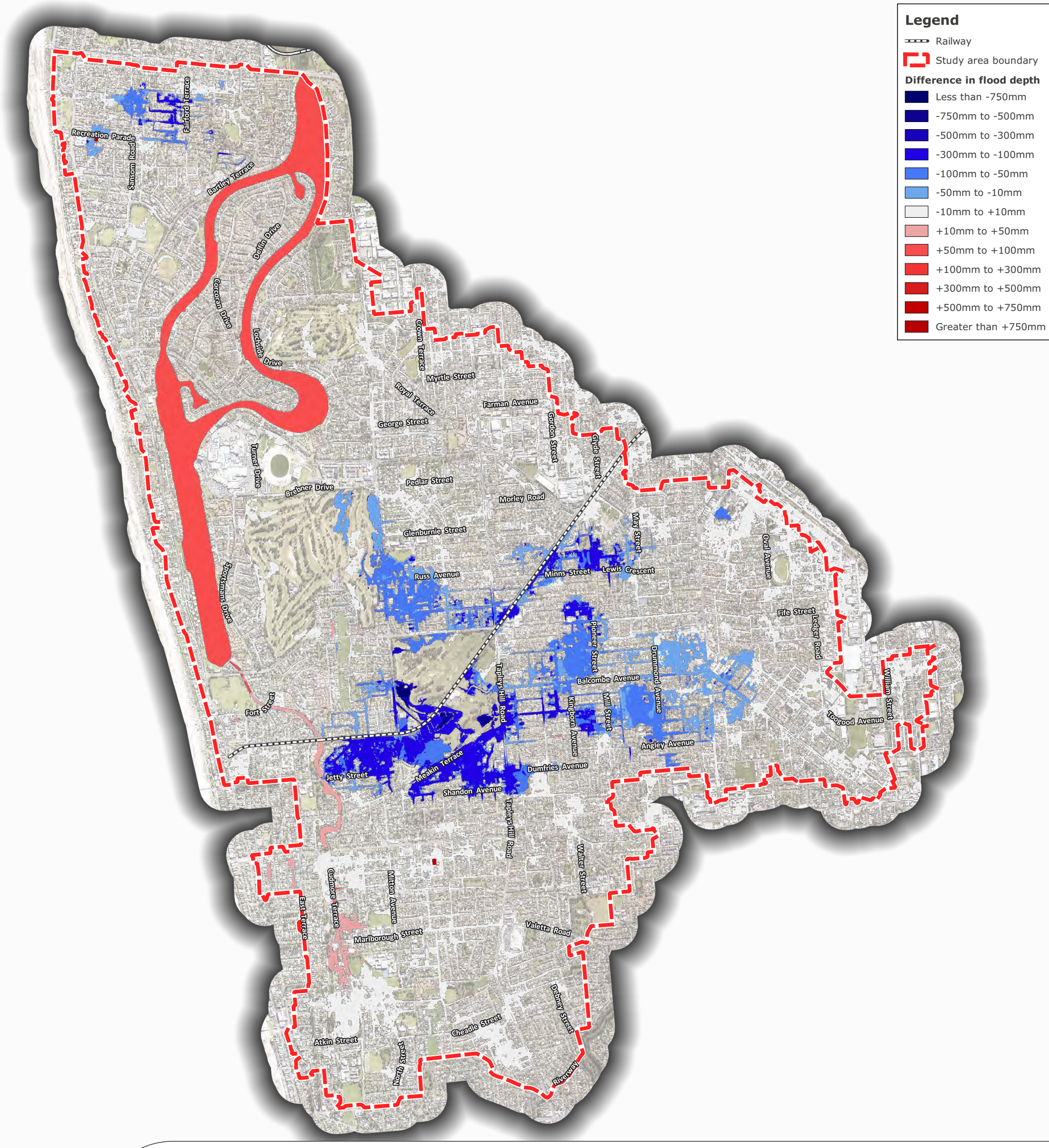

Legend

- Railway
- Study area boundary

Difference in flood depth

- Less than -750mm
- -750mm to -500mm
- -500mm to -300mm
- -300mm to -100mm
- -100mm to -50mm
- -50mm to -10mm
- -10mm to +10mm
- +10mm to +50mm
- +50mm to +100mm
- +100mm to +300mm
- +300mm to +500mm
- +500mm to +750mm
- Greater than +750mm

0 1,000 2,000 3,000 m

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WEST LAKES STORMWATER MANAGEMENT PLAN
1% AEP FLOOD DEPTH DIFFERENCE MAP

Map 25

Disclaimer

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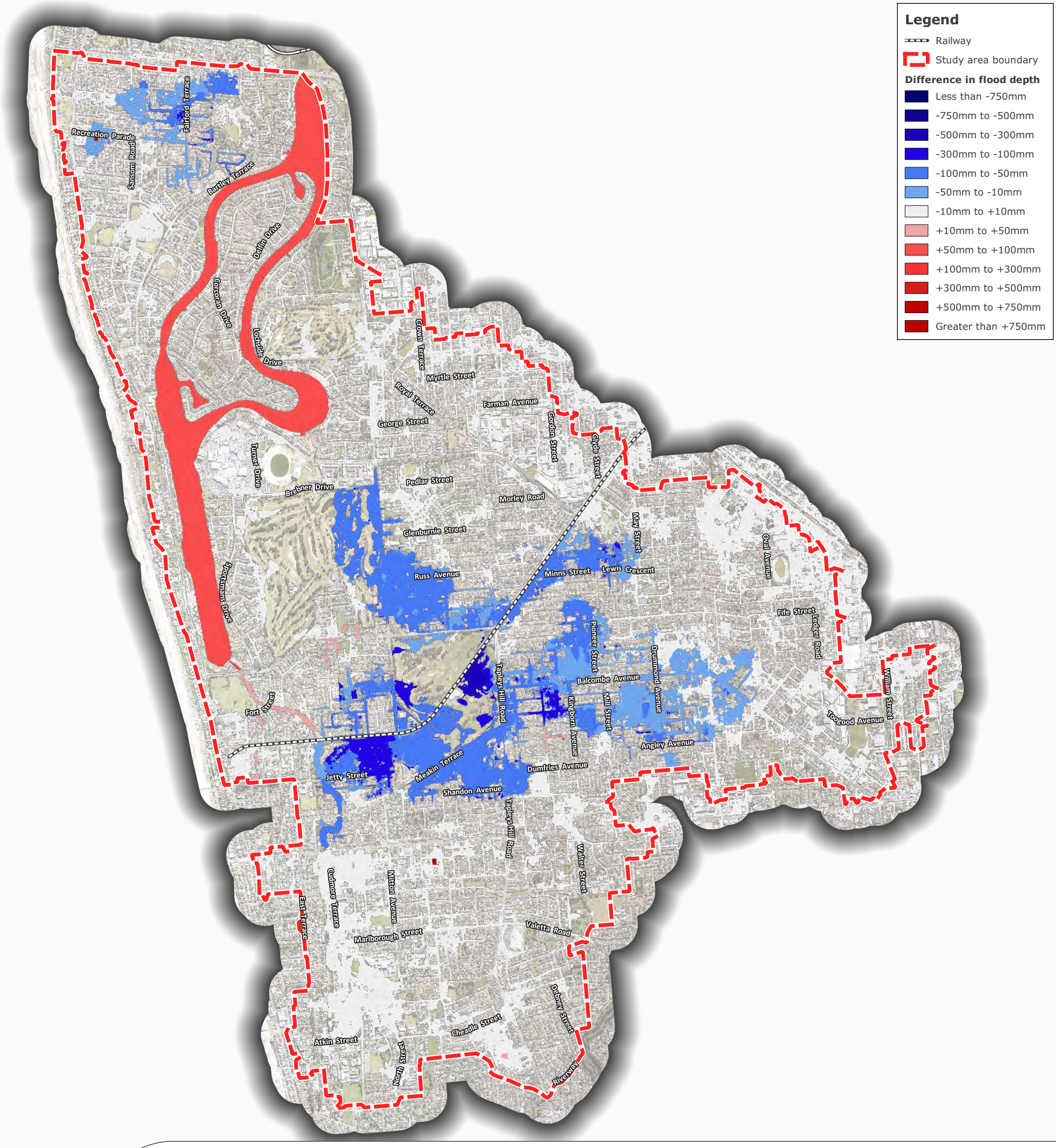

0 1,000 2,000 3,000 m

CITY OF CHARLES STURT

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Date:	2021-06-22
Drawn:	MM

Data Acknowledgement:
Aerial imagery from City of Charles Sturt, 2019
Roads and railways from Data SA, 2018

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WEST LAKES STORMWATER MANAGEMENT PLAN
0.2% AEP FLOOD DEPTH DIFFERENCE MAP

Map 26

Appendix D – Flood damages methodology

Flood damages have been estimated using the Rapid Appraisal Method (RAM) developed by the Victorian Department of Natural Resources and Environment (DNRE, 2000). This approach allows for a rapid and consistent evaluation of floodplain management measures in a cost-benefit analysis framework.

1.1 Methodology

The RAM relies primarily on geographic datasets, including the flood depth maps, cadastral data, land use types and property valuations. The general procedure for calculating the flood damages is detailed below:

- Process the cadastral dataset within the study area to include or exclude specific parcels, assign a category for calculations (residential or low, medium, high non-residential), and include valuation data for every parcel.
- Identify areas subject to inundation in a range of design flood events (63%, 39%, 20%, 10%, 5%, 2%, 1% and 0.2% AEP events).
- Use the flood depth maps to determine whether the building within a parcel is flooded for each of the design flood events. A building was considered flooded if the flood depth was above the adopted floor level for that type of building.
- Calculate the depth of flooding above floor level for residential buildings.
- Calculate the potential direct damage using stage-damage curves (for residential buildings) and areal damage rates for non-residential buildings.
- Factor in the community's preparedness to respond to a flood risk to convert potential direct damages to actual direct damages.
- Calculate the indirect damages as a percentage of the direct damages.
- Sum the actual direct and indirect damages to get the total damages for each design storm event and to produce a damage-probability relationship.
- Calculate the annual average damage (AAD) using the damage-probability relationship.

Damage to public infrastructure, such as roads, has not been included in the analysis as it has been assumed that these damages would be small.

1.2 Pre-processing the cadastral data

The cadastral dataset provided by Council was pre-processed to provide the property information on which the damage calculations were based. Some of the adjustments that were made to the cadastral datasets include:

- Above ground floors of multi-storey properties were removed.
- Private carparks and common areas within strata title properties were removed to avoid double counting clean-up costs for these areas.
- Parcels only containing areas unaffected by floodwaters, including private roads, reserves or watercourses, were removed.

1.3 Calculations

1.3.1 Potential direct damages

Residential allotments

In the absence of surveyed floor levels, it has been assumed that the floor level of residential buildings is 150 mm above ground level at the centroid of the allotment.

Where flood depths are above the floor level, the damages were calculated using a relationship between flood depth and residential property damage, developed by URS in 2002 as part of work undertaken for the City of Charles Sturt. This relationship has been adjusted to bring costs in line with present values and modified to adjust damages (either up or down) based on capital value. An additional $4,000 of damage has been included for damage to outbuildings and general external clean-up costs. The adopted relationship is shown in Equation 1.

$$\textbf{\textit{Potential direct damage}}\ (\$) = \mathbf{34{,}000} + \mathbf{30{,}000} \times \boldsymbol{d} \times \frac{\boldsymbol{CV}}{\boldsymbol{CV}_{\boldsymbol{ave}}} \qquad \text{Equation 1}$$

Where, d = $flood\ depth\ above\ floor\ level\ (m)$

CV = $property\ valuation$

CV_{ave} = $average\ residential\ property\ valuation$

In the absence of valuation data, an average value of $750,000 has been adopted for all residential properties.

Where there is flooding at the centroid of the allotment less than 150 mm, a direct damage value of $2,000 has been applied.

Non-residential allotments

In the absence of surveyed floor levels, it has been assumed that the floor level of non-residential buildings is 100 mm above ground level. This is slightly lower than the adopted floor level for residential buildings as a portion of non-residential buildings are typically set lower, to allow for vehicular access.

The RAM describes the calculation of damages for non-residential buildings based on floor area. Small non-residential allotments (less than 1,500 m^2 in size) were considered flood-affected when the flood depth was above the floor level (100 mm). In the absence of building footprints, the affected floor area was calculated as 70% of the site area for smaller allotments and equal to the flooded area for larger allotments (greater than 1,500 m^2 in size).

The buildings were divided into either low, medium or high categories based on their likely value of contents. The damage rates for the floor area of flood-affected buildings were extracted from the RAM guidelines. Table 1 provides estimates of the mean potential damage and gives an indication of the typical land use types associated with each category.

Table 1 Adopted damages for non-residential buildings

Value of contents	Typical land use	Mean direct potential damage ($/m^2)
Low	Offices, sporting pavilions, churches	71
Medium	Libraries, clothing retailers, caravan parks	126
High	Electronic retailers, printing	316

1.3.2 Actual direct damages

Damages that actually occur to a property (actual direct damages) are generally less than those that could occur if the landowners took no action to reduce damages during a flood (potential direct damage). Ratios to convert potential to actual damages were used as per the recommendations of RAM. For this study, a factor of 0.9 was used. This is representative of a community that is generally unaware of their flood risk and who have a warning time of less than 2 hours.

1.3.3 Indirect damages

Indirect damages refer to the costs incurred by a community during and after a flood occurs, including emergency response costs, disruptions to employment, commerce, transport and communication. These damages are in addition to the direct damages described above.

The RAM report suggests that these costs are approximately 30% of the actual direct damages and this was adopted to estimate the indirect damages for this study.

1.3.4 Annual average damage

The annual average damage (AAD) is an estimate of the average annual cost of flood damages (direct and indirect) over a long period of time. It balances small frequent flood damages with large but less frequent flood damages and provides a convenient way to compare different floodplain management measures. It is a probability-weighted mean of the actual flood damages and is equivalent to the area beneath the flood damage-probability curve.