Gawler River Floodplain Management Authority

GAWLER RIVER FLOODPLAIN MAPPING REPORT

FINAL

September 2015

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Notice To Users Of These Data Sets and Report

This data and report map must be read in conjunction with the following information and the main study report "Gawler River Floodplain Mapping Report" dated September 2015.

Background

This map has been prepared using the best technology currently available to a standard of accuracy sufficient for broad scale flood risk management and planning. All maps in the series will help promote awareness of flooding associated with the Light River. It is expected that it will be of use to persons undertaking development and by the authorities that assess land capability and development proposal. It will also assist in planning essential services and emergency response.

Flood behaviour

A flood occurs when a pipe, channel or creek cannot carry the volume of water entering from a catchment. When this occurs, floodwaters travel across the surface of the land potentially damaging property built upon the floodplain and potentially threatening the safety of people in the floodplain. Flooding is a natural event.

Annual Exceedance Probability (AEP)

The AEP is the likelihood of occurrence of a flood of given size or larger in any one year. This is expressed as a ratio, for example 1:100 or 1%. There is a 1% chance that the 1:100 AEP flood will be equalled or exceed in any one year. Similarly, there is a 5% chance that a 1:20 AEP flood will be exceeded in any one year.

Alternatively, flood risk can be considered in terms or average recurrence interval (ARI). This is the number of years on average, within which a given flood will be equalled or exceeded. A 1:100 ARI flood will be equalled or exceeded once in 100 years on average. A 1:20 ARI flood will be equalled or exceeded once in 20 years on average, and so on.

Due to the random nature of floods, however, a 1:100 year flood need not occur in every 100 years and conversely, several floods which exceed the 1:100 year flood could occur within any one period of 100 years.

Storm durations

The flooding response of a catchment is dependent on the duration of any storm event. Generally shorter, more intense storms produce the greatest flows from urban areas. Longer duration, but less intense storms, produce the greatest flows from undeveloped hills areas. The storm duration assessed as being the most realistic, worst case scenario for the Gawler River is the 24 hour storm. It is this storm duration that has been used to produce the data sets and maps contained herein.

Impact on buildings

The flood extents shown are a prediction of land affected for the specific level of risk and do not necessarily indicate a threat to buildings located on that land. Flood assessment for particular sites will require more detailed interpretation, survey and analysis by qualified and experienced persons.

Basis of mapping

The data sets contained the maps included herein are based on survey, hydraulic and hydrological modelling to an accuracy sufficient for broad scale flood risk management and planning. The modelling reflects current practice, but it must be realised that there are uncertainties and assumptions associated with the data and the processes on which the models are based, and the flood extents shown in the maps cannot be regarded as exact predictions. Modelling assumptions and survey data descriptions are provided in the floodplain mapping report.

The flood extents are not based on actual historical floods.

Scope of the mapping

The limit of flooding shown on this map is not a boundary between flood prone and flood free land. Land outside the flood extent shown on this map could be affected by:

- flooding from the mapped flood that extends beyond the area that has been mapped;
- larger storms;
- flooding from local drainage systems which can occur as a result of localised heavy rainfall or drain blockage;
- storms with a different Annual Exceedance Probability.

The modelling and mapping does not deal with the influence of local underground drainage systems. The effect of these systems will increasingly affect the flood extent as distance from the main watercourse increases and the depth of flooding reduces.

Areas of very shallow flooding

In areas shown as being affected by flood depths of less than 0.1m (100mm) fences, walls, landscaping and buildings will affect the flow of floodwaters. Similarly, vegetation and other debris may be carried by flood flows which may cause blockages and changes in flood flow paths. Resolution to this level of detail is beyond the capabilities of the modelling process and consequently the level of certainty in relation to flood depths in these areas is reduced.

Changes to the catchment

The flood extent shown on the maps is based on conditions thought to be current at 2014. Further development, earthworks and other changes to the catchment may affect the actual flood extents.

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Gawler River Floodplain Mapping

1 Introduction

Flooding of the Northern Adelaide Plains associated with the Gawler River is a significant constraint for further development within the region and an ongoing risk to existing development.

The Gawler River Floodplain Management Authority (GRFMA) commissioned Australian Water Environments (AWE) to update floodplain mapping (2007) to help develop a better understanding of the extent, depth and hazard of flooding in the Gawler River floodplain.

This report provides a description of the flood behaviour of the Gawler River, a review of the hydrological analysis for the 2007 floodplain mapping, and provides updated flood maps for the current conditions for the 1 in 50 ARI[1], 1 in 100 ARI and 1 in 200 ARI. Flood depth and hazard maps have been included in Appendix A.

[1] Average Recurrence Interval (ARI) is a statistical approximation of the average number of years between flood events of a particular size (e.g. a 1 in 100 ARI is a one in 100 chance that a flood of that size will occur in any given year)

2 Overview of Flooding Issues

2.1 Flooding Behaviour

Floods in the Gawler River are driven by flows from the upstream rural catchments of both the North Para and the South Para. These two river systems join immediately downstream of the town of Gawler. The catchment upstream of Gawler is a little over 1000 km^2 with the North Para catchment being the larger of the two main inflows comprising nearly 600 km^2.

The Gawler River is a perched river system and hence receives very little inflow from the land through which it flows on its way to the sea near Pt Gawler.

The capacity of the Gawler River channel falls from east to west and varies also with the dynamics of the flood hydrograph[2]. This characteristic is consistent with a naturally perched river system. Near Gawler the capacity of the river is around 400 m^3s^{-1}. This rapidly diminishes to the west. Near Boundary Road it is 200 m^3s^{-1}; Baker Road Ford 100 m^3s^{-1}; and down to 10 m^3s^{-1} immediately upstream of Buckland Park Lake.

Major overtopping in large floods occurs along much of the river length. Significant flooding commences within Gawler township from both the North Para River and South Para River. Mitigation works within Gawler and works associated with Mark 1 of the Gawler River Flood Management Project (which involved constructing the Bruce Eastick Flood Mitigation Dam on the North Para and modifications to the South Para Reservoir) have reduced the extent of this flooding for a 1 in 50 ARI event whilst greatly reducing flood extents for events around the 1 in 20 ARI and less. Flooding from the 1 in 20 ARI still occurs in the lower reaches of the Gawler River (west of Virginia) due to the limited capacity in this area. The flood extent of the 1 in 100 ARI event is largely unaltered by the works undertaken to date.

In a 1 in 100 ARI event, flooding within the township of Gawler can be expected but this would be contained within the main river valley. Downstream of Gawler flood waters can be expected to break out of the river channel shortly downstream of the Northern Expressway river crossing. Floodwaters upstream of the river crossing are contained within the river channel and levee system recently installed as part of the Northern Expressway bridge crossing.

Downstream of the Northern Expressway river crossing, a series of major breakouts can be expected to Boundary Road. The majority of the floodwaters would spill to the north from this area (approximately two thirds of the flood) and result in flooding of Lewiston before reaching Two Wells. Floodwaters approaching Two Wells would enter Salt Creek and cause flooding in the Two Wells township.

Smaller breakouts would occur downstream of Boundary Road. The worst of these would be adjacent to Pederick Road where floodwaters would spill to the north and south of the river. Spills to the north would flow westwards (approximately parallel to the river) towards Port Gawler. Over bank flow to the south would flow towards and through Virginia township and surrounding horticultural areas, then flow further west, overtopping Port Wakefield Road before flowing around the Buckland Park housing development (once it has been established).

[2] Flood hydrograph - Hydrological modelling provides the flow information for the hydraulic modelling process to enable flood mapping to be conducted. A flood hydrograph is based on the hydrological modelling and describes the way flow rates change during a flood event. A design flood hydrograph describes the flow expected as a result of a statistically derived rainfall, such as the 1 in 100 Average Recurrence Interval (ARI) flood event. Flood hydrographs can also be developed for historical flood events using historical rainfall records. Historical flood events are often used to calibrate a hydrological model before developing design flood hydrographs.

2.2 Results of Hydrology Review

A review of the hydrological analysis of the Gawler River for the 2007 floodplain mapping was undertaken.

There were four key areas that were considered as offering potential for improving the 2007 hydrological assessment. These were:

1. Update the flood frequency relationship using the extra years of streamflow and rainfall data available since the 2007 hydrology review.
2. Assess the impact of the Bureau of Meteorology update of the statistical rainfall data, also known as Intensity – Frequency – Duration (IFD) information.
3. Compare the predicted flow volumes from the Rainfall Runoff Routing (RRR) model with historical flow volumes. In the 2007 hydrological assessment the 72 hour storm was adopted as the critical design storm. This storm duration would have the greatest volume, and was thus seen to be critical when the effect of the dams was assessed.
4. Examine evidence that supports the variable loss model used on the Yaldara catchment. This loss model reduced the losses as the Average Recurrence Interval of the rainfall increased.

The result of these investigations are summarised below.

- There was an additional eight years of flow data (2006-2013) available for the Gawler River system. However, due to system augmentations (Bruce Eastick Flood Control Dam and South Para Spillway modification) only Yaldara, Penrice and South Para flow monitoring stations were able to have the data record extended to review the flood frequency analysis.
- The flood frequency analysis showed little change from the 2007 peak flow results for the North Para with both Penrice and Yaldara seeing a minor reduction in the estimated 1 in 100 ARI flow (approximately 7% at Penrice and <1% at Yaldara).
- The flood frequency analysis for the South Para indicated a significant reduction from the 2007 peak flow results. The 1 in 100 ARI flow is now estimated to be 158 m^3s^{-1} in comparison to the previous estimate of 215 m^3s^{-1}. This is simply because additional flow recordings over the last ten years have enabled a more reliable flood frequency analysis to be undertaken.
- It was not possible to update the flood frequency relationships at Gawler Junction because the gauge has been decommissioned. However, given the reduction in peak flow estimates for both the North and South Para upstream it is likely that the 2007 peak flow estimate at Gawler Junction is conservative.
- Comparison of flood volumes from historical data was compared against the RRR model hydrograph volumes. This indicated that the 24 hour design storm provided the best match for flood volumes at Yaldara and Gawler Junction with volumes within 15% at Gawler Junction and 20% at Yaldara. Longer duration storms would result in substantially higher volumes and increase the discrepancy between modelled results and the flood frequency analysis.
- A fixed loss model (constant loss parameters for all ARI events modelled) for Yaldara catchments resulted in a reasonable match in runoff volumes between the partial series analysis and the RRR model for the 72 hour storm event. The peak flows however substantially decreased (40% reduction at Gawler Junction for the 1 in 100 ARI flow).

- The 24 hour design storm provides a good match (within 17%) with the flood frequency analysis peak flows for a range of ARI events and is considered to provide the best overall match to observed floods. Hence it should be adopted as the design storm.
- The new IFD data from the update to Australian Rainfall and Runoff was checked against the intensity values adopted in the 2007 hydrology. Generally the differences were within 5%, except for Mount Adam where there was a maximum difference of 13.8% for the 1 in 100 ARI event. There is no need to update the intensity values in for the design storms as the parameter selection was based on flood frequency analysis. Any increase to intensity would be counteracted by a change to the loss model parameters.
- Soil properties for the Greenock Creek catchment were reviewed and the findings generally supported two different flood producing mechanisms (medium intensity on wet winter catchments, or more intense summer rainfall on a dry catchment). This supported the variable loss model for the part of the catchment covered by the Yaldara loss model, including the Greenock Creek catchment.

Hydrographs are graphs that show the variation in flow over time. Flood hydrographs for the North Para, South Para and the Gawler River near Gawler are provided in Figure 2-1.

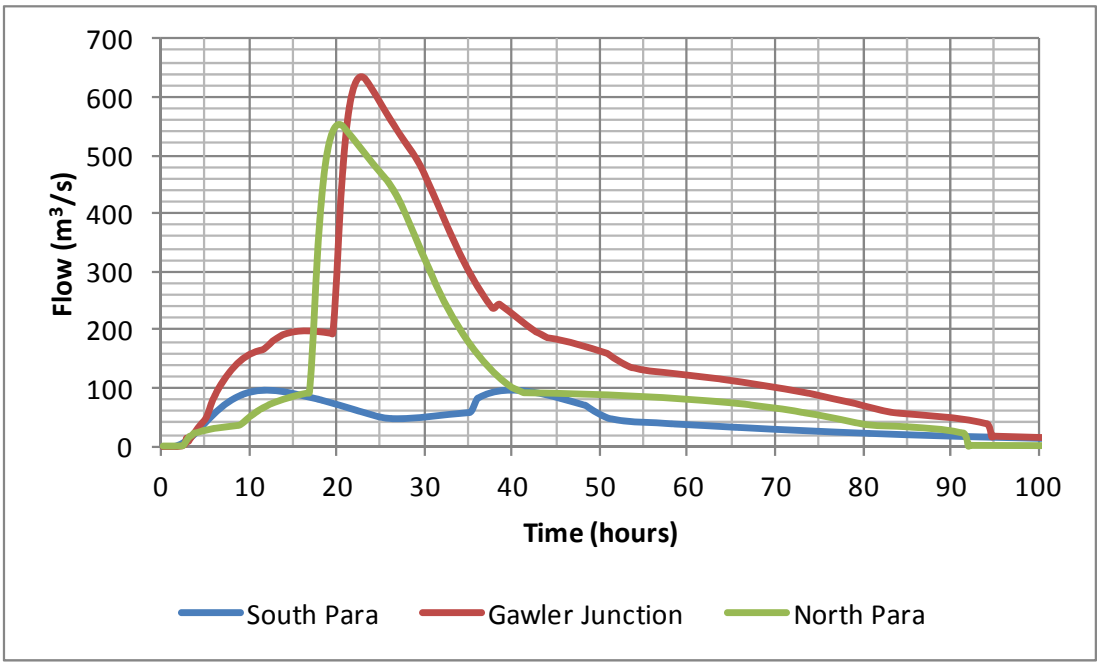


FIGURE 2-1 : NORTH PARA, SOUTH PARA AND GAWLER RIVER DESIGN HYDROGRAPHS - 1 IN 100 ARI

2.3 Floodplain Hydraulic Model Update

2.3.1 Introduction

The original hydraulic floodplain model was developed as a two-dimensional MIKE21 hydraulic model. For this update project, additional one-dimensional floodplain features such as culverts were required to be included and therefore a coupled 1D-2D MIKE FLOOD model was developed. The river and floodplain flow was represented in the 2D model grid and culverts were represented as 1D model elements, linked to the 2D model at their upstream and downstream end.

2.3.2 Model Resolution

The resolution for the updated hydraulic model was maintained at 15m grid as was used for the 2007 Gawler River modelling, the Light River floodplain and Smith Creek rural areas modelling.

The model grid was extended to the west to incorporate breakout flow paths through Two Wells and toward Middle Beach. The grid was also shifted slightly in order to match up with the 15m Light River model Digital Elevation Model (DEM) [3] which enabled the Light River DEM data to be incorporated.

The topography was built up in layers, from older to newer datasets, as summarised in Table 1.

TABLE 1 : MIKE FLOOD TOPOGRAPHY LAYERS

Layer	Dataset	Details
1 (Bottom)	Gawler River LiDAR (1m)	Grid shift issues in the original Gawler model and an inconsistency in grid origins between the Gawler River and Light River models were addressed by reverting back to the 1m LiDAR DEM and re-sampling a 15 m DEM on the same grid as the Light River model. The Bruce Eastick Flood Control Dam was removed from the topography as it was close to the upstream boundary. The effect of this dam will be captured in the hydrological assessment. The Northern Expressway and basins north of river were included within the model. Details from the old Gawler model were updated to include as constructed information for the basins and associated levee (on the southern side of the river).
2	Light River model DEM (15m)	Used as is, except at boundaries – boundaries clipped out of grid.
3	Smith Creek DTM (1m)	Used as is.
4	Buckland Park Ultimate	The Buckland Park ultimate DEM had fill areas raised to a flood-free level and approximate channel details.
5	Buckland Park Stage 1	Actual fill levels and final channel designs for Stage 1 were superimposed on the ultimate design to give better detail in the stage 1 area.
6	SA Greyhound Club Redevelopment	Design levels for tracks and building floors and existing site levels were combined to produce a DEM of developed conditions.
7	Eden Development Two Wells	Fill areas and channels/basins were included directly in the M21 grid. Fill areas were raised to 12.9 m which is the design fill level for the eastern edge of the development. This is well above the 200 year flood level for the site so further detail was not required.
8	Liberty Development Two Wells	Fill areas and channels/basins were included directly in the M21 grid. Fill areas were raised to 10.6 m which is the design fill level for the eastern edge of the development. This is well above the 200 year flood level for the site so further detail was not required.

[3] DEM - a digital surface model representing the earth's surface and objects on it. They are used in developing digital topographic maps and assist in gaining a better understanding of how floods flow through the landscape.

Layer	Dataset	Details
9	Donaldson Road Development Two Wells	Areas to be filled and the basin were included in the M21 grid as per the Proposed Land Division plans. Roads were raised to 11.8-12.2 m AHD as per the plans.
10	Gullacci Development Two Wells	As constructed levels were converted to a grid and stamped into the model. However level information was not available across the entire development. Manipulation of the Mike 21 grid was undertaken to ensure all fill areas were included.
11	Gawler River Road	Levels were adjusted to as constructed levels which were available for a section of the road.
12	Gawler Skate Park	DEM generated from design contours and strings.
14	Hillier Development	Fill area raised in M21 grid above flood level. Reserve area lowered to 41.2 m AHD.
15	Gawler Par 3 Golf Course Levee	Levee alignment and heights were digitised from plans and added to the grid.
16	Gawler Footbridges	Proposed footbridges were incorporated over the Gawler River and its tributaries. These footbridges are part of the planned *Gawler Urban Rivers Shared Path*. Four of the key footbridges were incorporated into the model as 1D elements, with the deck height added to the 2D grid.
17	Northern Expressway Levee Survey	Survey of the Northern Expressway levee was incorporated into the model. This levee aims at stopping breakout flows to the south of Gawler River and is located upstream of the recently constructed Northern Expressway. The levee crest was incorporated in the 2d model topography.
18	Northern Expressway Survey	Survey of the recently upgraded Northern Expressway crossing of the Gawler River was incorporated into the 2d model. This also includes surrounding detention basins and earthworks.
19 (Top)	Breaklines and Channel	Breaklines from existing models were collated and stamped onto the grid. Road/levee embankments were treated by sampling the maximum level within 15m of the breakline and applying that maximum level to the grid. Railway embankments were treated similarly, but the embankments were lowered in places to account for wash-out of ballast when overtopping occurs. The Salt Creek crossing in two Wells was lowered as per the original Light River modelling. The Gawler and South Para crossings in Gawler township were lowered by approximately 0.2m. The rail lines elsewhere were not lowered. The Gawler River channel definition from the original Gawler model was stamped into the model grid. The Smith Creek channel was also stamped onto the grid.

2.3.3 Culverts

Culverts were adopted from the previous Light River and Smith Creek models. All major culverts were transferred from the Light River model, whereas culverts were selectively transferred from the Smith Creek model. This was because the Smith Creek model contained minor drainage pipes as well as major culverts. Minor culverts were not included in this model as the 15m grid spacing is too coarse to include minor culverts. Priority was given to including culverts through major embankments such as the rail line, Port Wakefield Road and the Northern Expressway. Culverts were also given priority if they were considered to be in an area where significant flow may occur.

A number of additional culverts were identified that were considered likely to impact on flow behaviour in large floods, but which had not previously been included in the models. These were surveyed by Australian Water Environments and included in the current model.

The four (4) proposed footbridges from the planned Gawler Urban Rivers Shared Path were also included as 1D elements.

A number of bridge span openings were not included as 1D elements but were included as openings in the 2D grid, particularly for major bridge crossings of the Gawler River and some large floodplain culverts and bridge spans, where the structure width was greater than 15m and the culverts/bridge openings were unlikely to flow full.

A total of 111 bridge/culvert crossings were included in the model. The Light River culverts and most of the Smith Creek culverts were previously benchmarked against an independent method (HY-8 culvert calculator) and entry/exit loss coefficients were adjusted as necessary. MIKE 11 default entry/exit loss coefficients were adopted for the remaining culverts. A map of culverts included in the model is provided in Appendix B.

Railway lines (near Virginia and Gawler) were included in the model as earthen embanks, however it was assumed that the ballast would not be an effective barrier to flow (i.e. the ballast would become buoyant and displaced if water levels reached the underside of the railway sleeper). This approach was consistent with recent floodplain mapping for the Light River and reflects a further refinement on the modelling approach that was applied for the 2007 Gawler River floodplain mapping process.

2.3.4 Model Boundary Assumptions

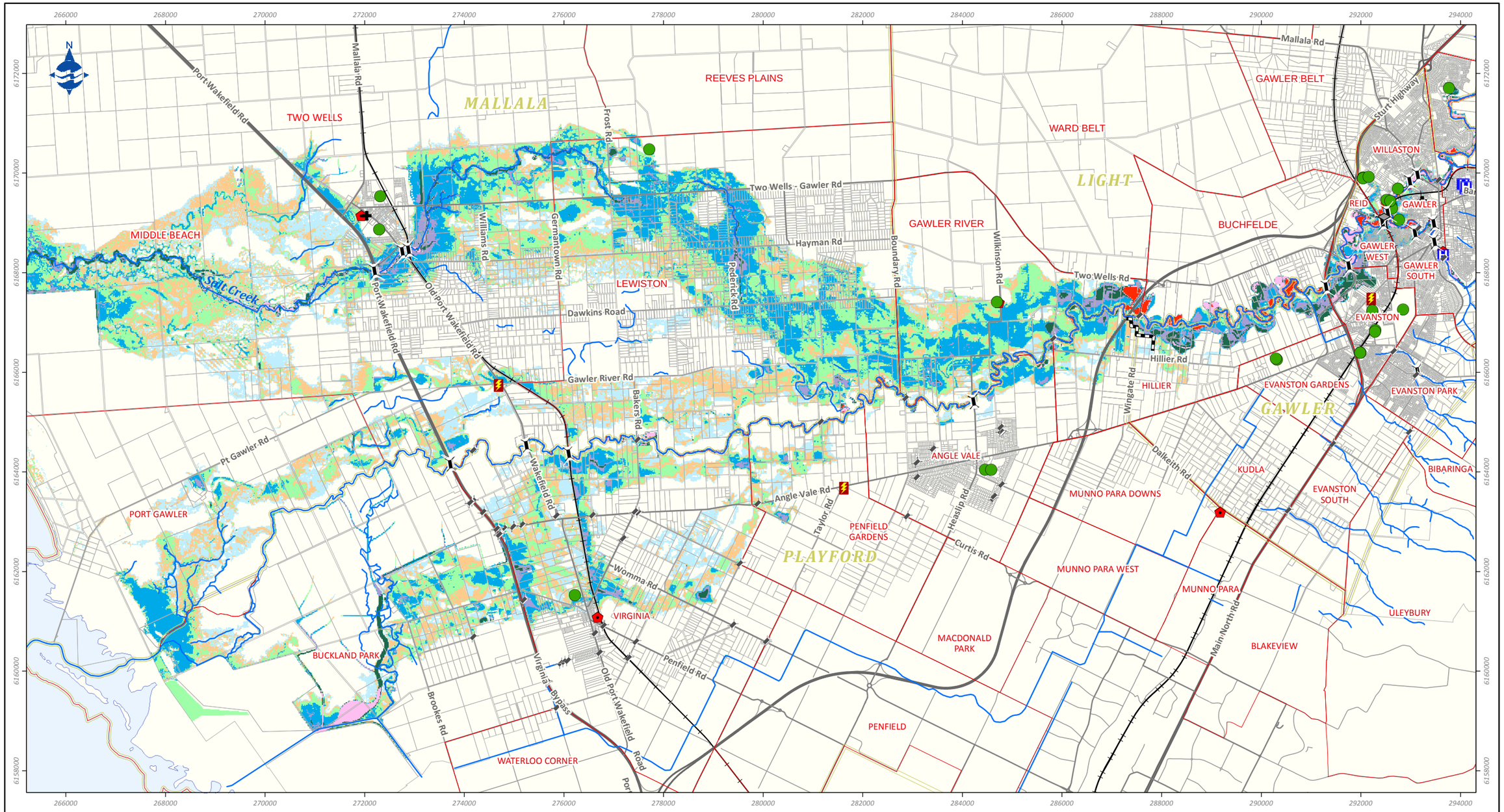
Inflow boundaries were applied for the North Para and South Para upstream of Gawler. These hydrographs were extracted from the hydrological model (RRR) downstream of Turretfield and at the South Para SE Gawler gauging station.

An ocean level boundary was applied along the western and southern model edges. A level of 1.5 m AHD, equal to the Highest Astronomical Tide was applied.

2.4 Updated Floodplain Inundation Maps

The updated flood extent for the 1 in 100 ARI event is provided in Figure 2-2. There are a few minor variations from the 2007 mapping as described below:

- The flood extent is slightly reduced;
- Areas of approved development in the floodplain have been raised above the flood level;
- There is less flooding near Angle Vale for the 1 in 100 ARI event and the township is no longer considered to be at risk for the design flood event; and
- There is a minor breakout around the Northern Expressway - but the volume is very small and hence the impact remains localised.



Legend

- Sports Ground
- CFS / MFS
- Hospital / Ambulance
- Police Station
- ETSA Substation
- bridge
- ford
- weir
- Railway

Roads:

- *Major*
- *Intermediate*
- *Minor*
- Levee
- Watercourse
- Cadastral Parcels
- Local Government Boundary
- Suburb Boundary

Flood Depth (m):

- *0.001 - 0.10*
- *0.11 - 0.25*
- *0.26 - 0.50*
- *0.51 - 1.00*
- *1.01 - 1.50*
- *1.51 - 2.50*
- *2.51 - 5.00*
- *Greater than 5.00*

0 1 2 3 4 5

Kilometres (Scale 1:80,000 A3 Sheet)

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Australian WATER Environments

A Findings Report for the
Gawler River Flood Mitigation Scheme

Current Conditions

1 in 100 ARI Flood Inundation

14147 D005 v1 100yr ARI Flood Inundation - current conditions 150915 fig2_2
Last Updated: 15/09/2015

Figure 2-2

3 References

Australian Water Environments, 2004. *Gawler River Flood Mitigation Scheme Cost Benefit Analysis*. Prepared for the Gawler River Floodplain Management Authority

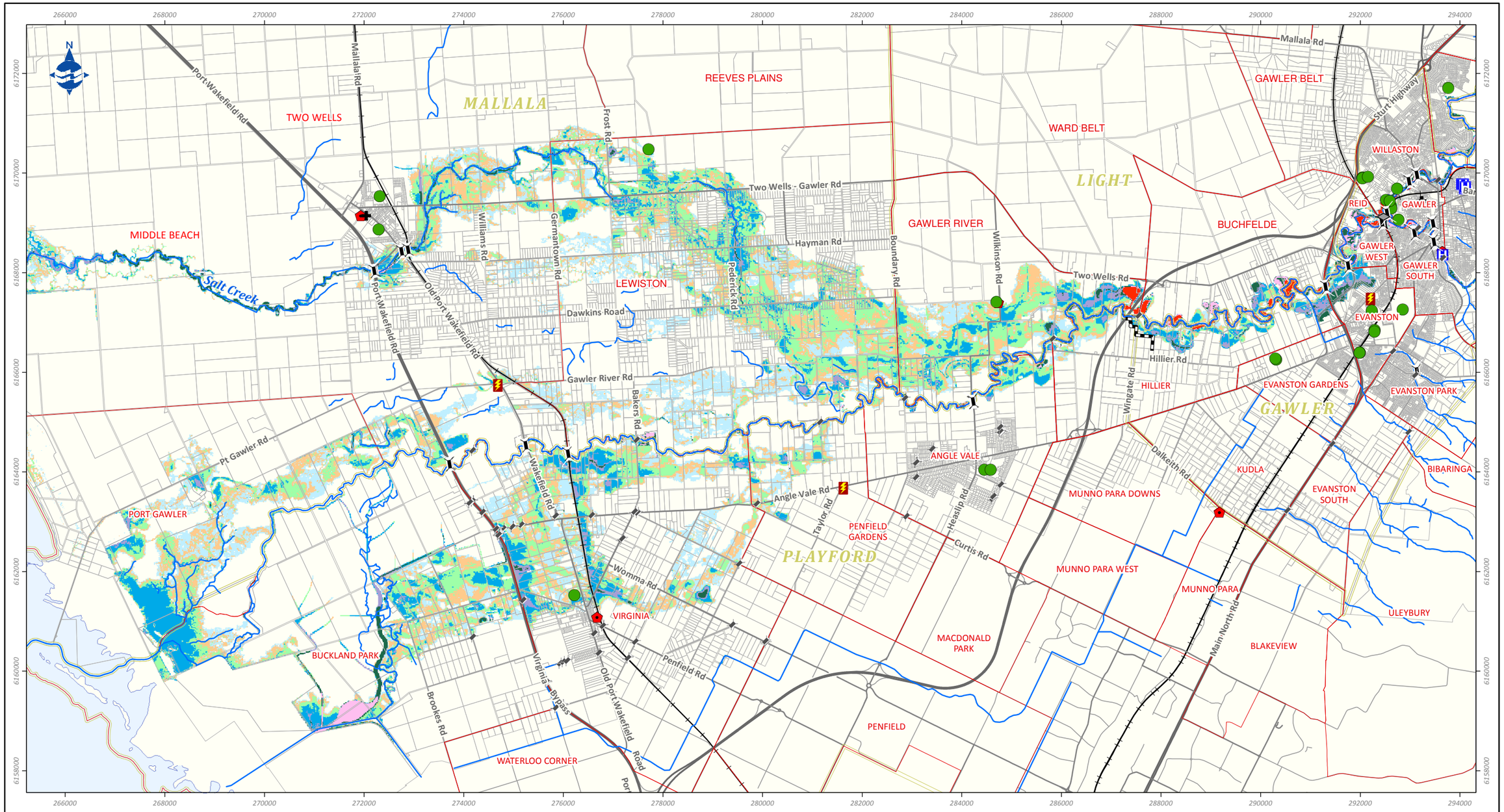
Australian Water Environments, 2007. *Floodplain Mapping for the Gawler River.* Prepared for the Gawler River Floodplain Management Authority

Australian Water Environments, 2009. *Flood Damage Estimates, South Para Reservoir Flood Mitigation Works*. Prepared for the Gawler River Floodplain Management Authority

Bureau of Transport Economics (2001). *Economic Costs of Natural Disasters in Australia. Bureau of Transport Economics Report Number 103*. Published by the Commonwealth of Australia
ISBN 0 642 45633 Xs

Commonwealth of Australia, 2012. *National Guidelines for the National Flood Risk Information Program*

Appendix A : Flood Depth and Hazard Maps - 1 in 50 ARI, 1 in 100 ARI and 1 in 200 ARI



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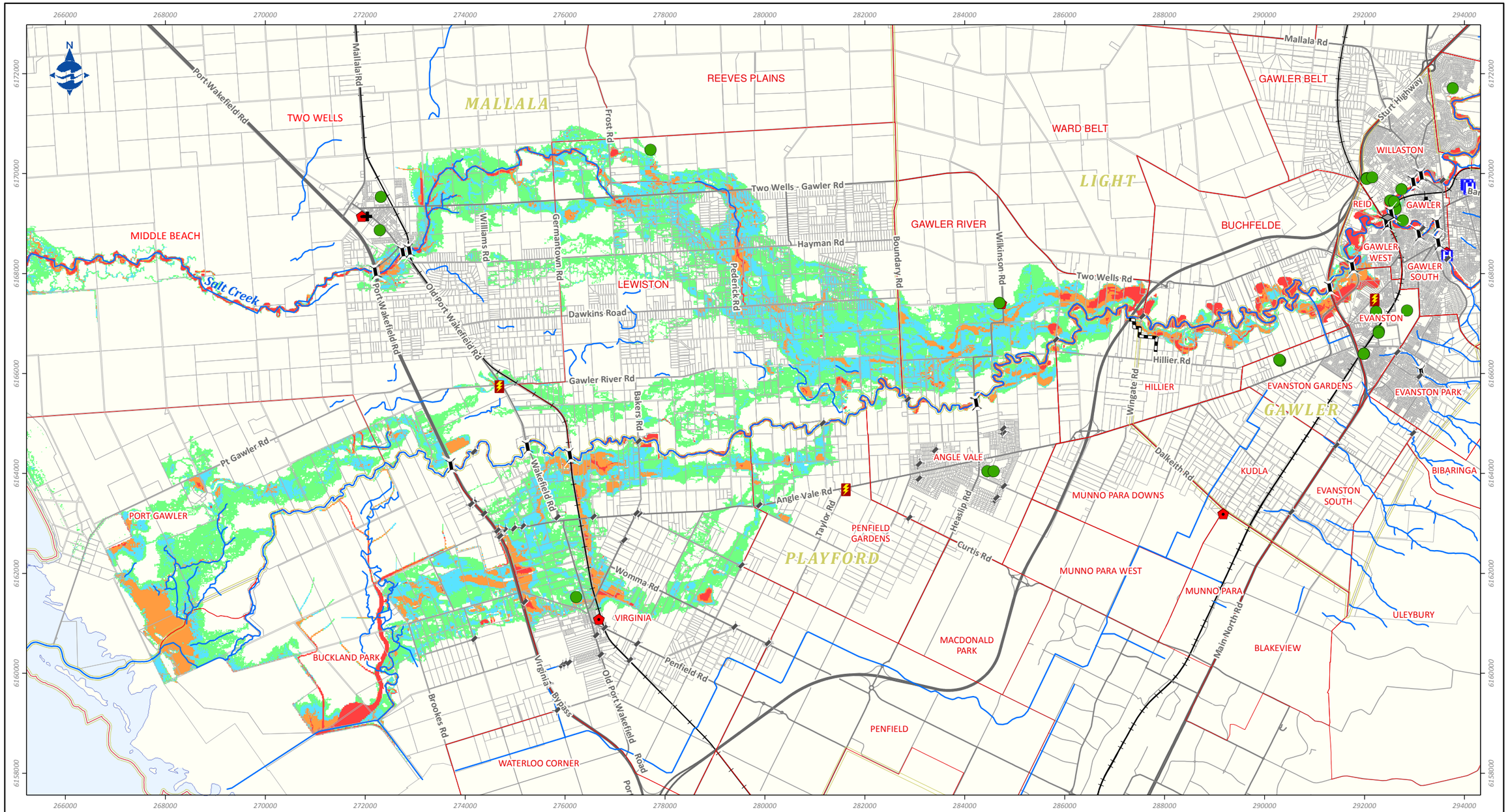
Current Conditions

1 in 50 ARI Flood Inundation

14147 D020 v4 Gawler River Flood Mapping 150501
Last Updated: 1/05/2015

Figure x.x



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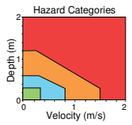
Hazard Category:

- *Low*
- *Moderate*
- *High*
- *Extreme*



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1 in 50 ARI Flood Hazard

14147 D020 v4 Gawler River Flood Mapping 150501
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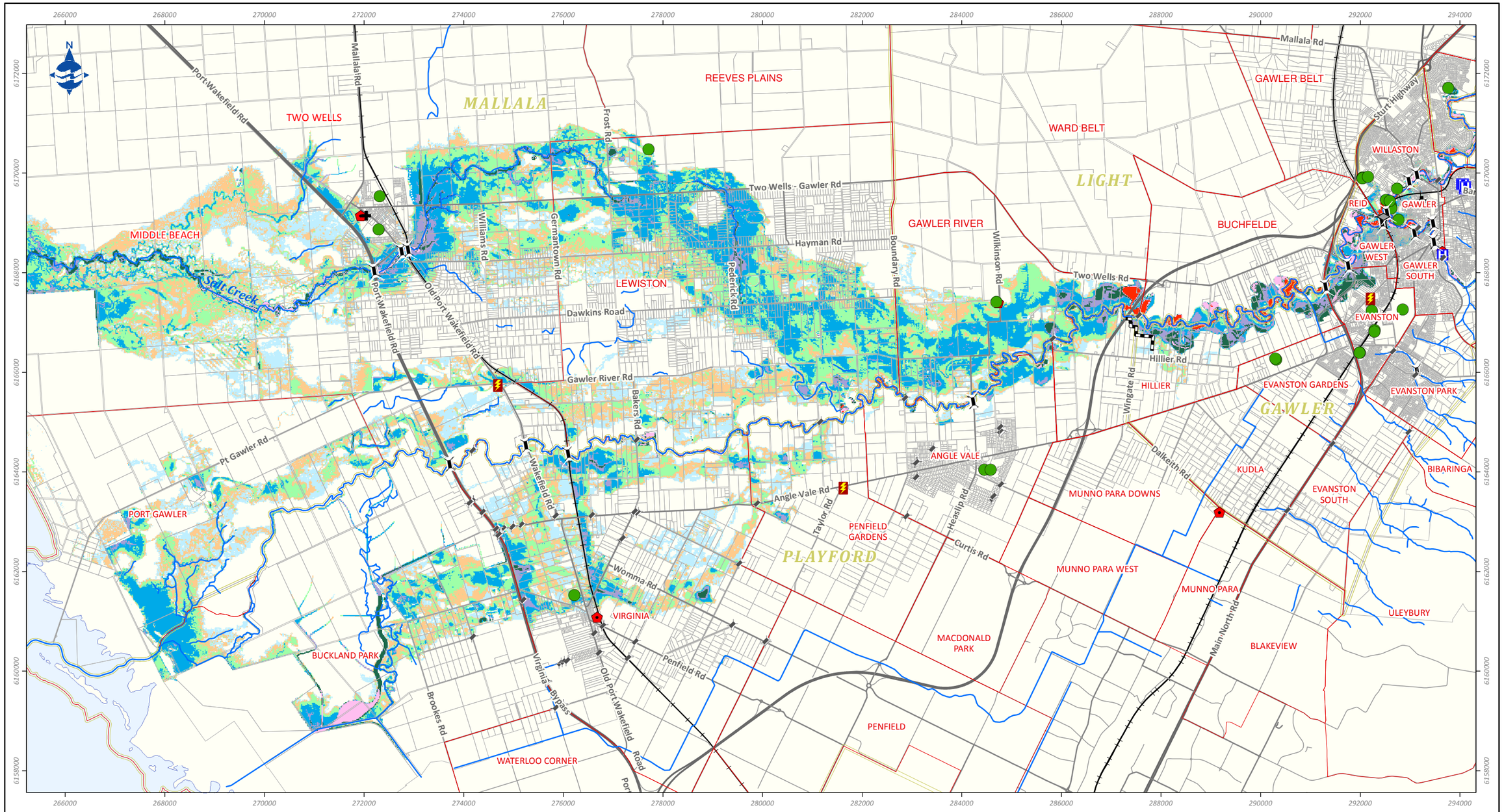
Figure x.x



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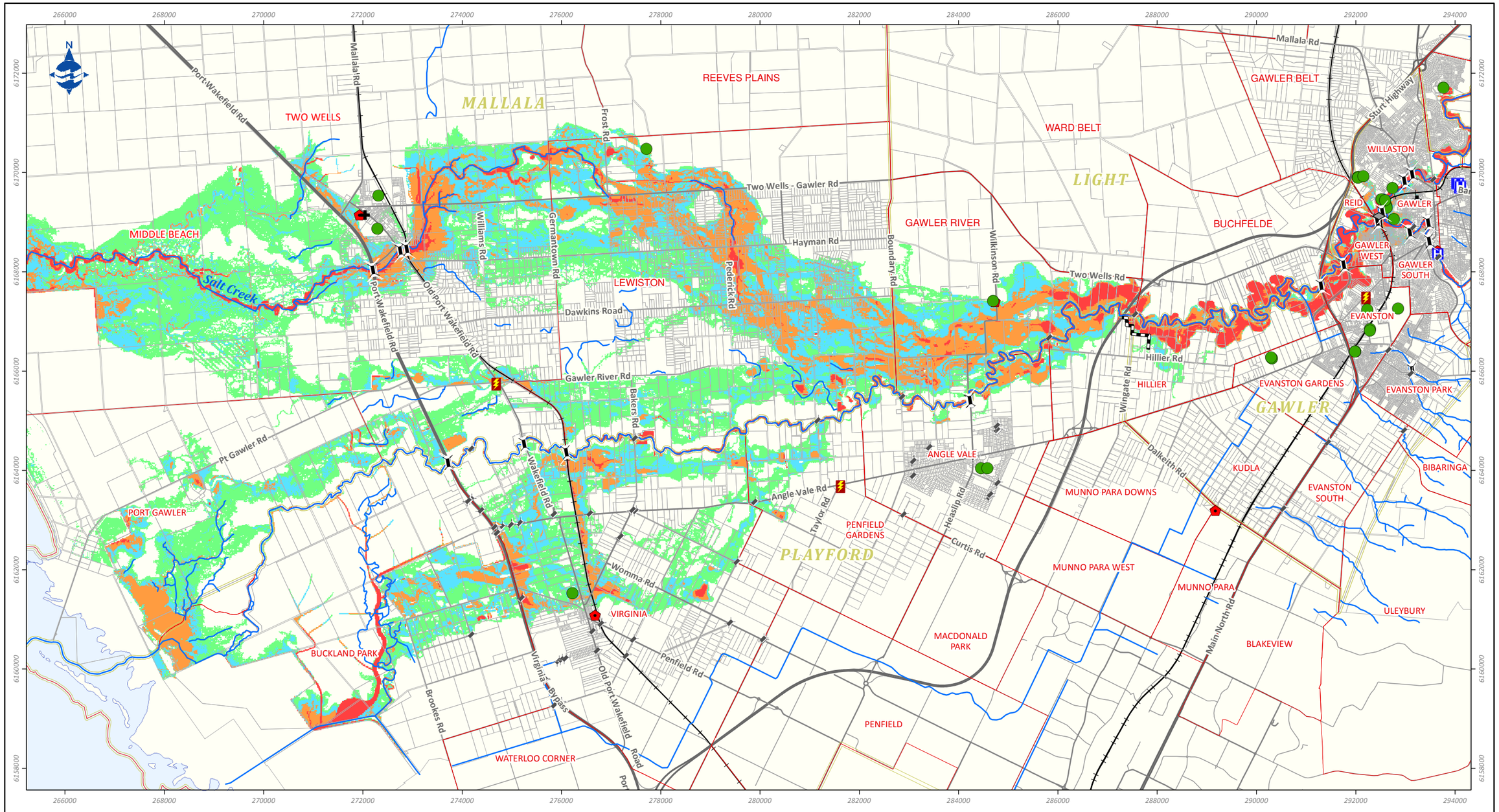

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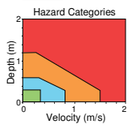

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Kilometres (Scale 1:80,000 A3 Sheet)

Government of South Australia

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WATER TECHNOLOGY

Australian WATER Environments

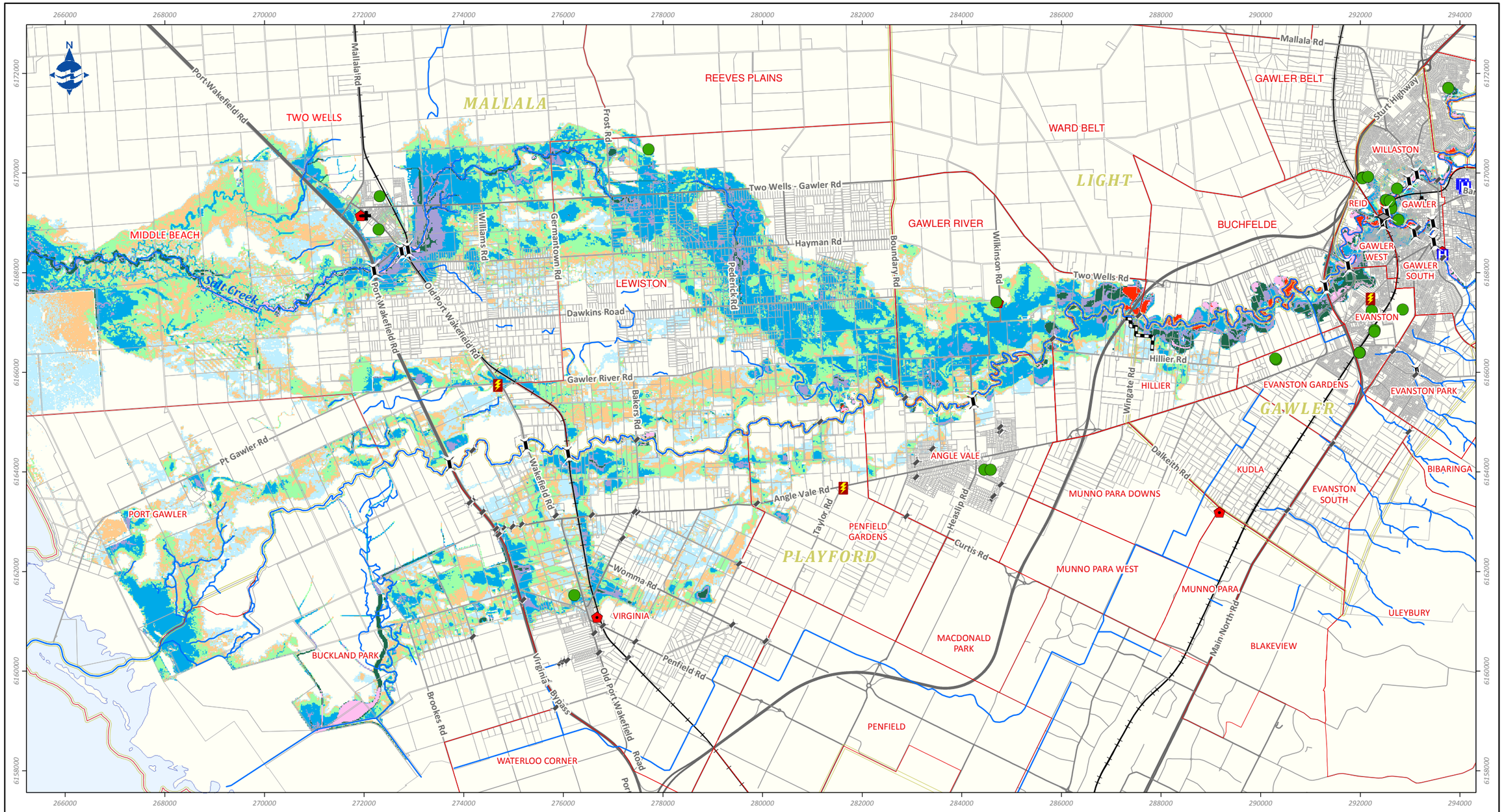
A Findings Report for the
Gawler River Flood Mitigation Scheme

Current Conditions

1 in 100 ARI Flood Hazard

14147 D020 v4 Gawler River Flood Mapping 150501
Last Updated: 1/05/2015

Figure x.x



Legend

- Sports Ground
- CFS / MFS
- Hospital / Ambulance
- Police Station
- ETSA Substation
- bridge
- ford
- weir
- Railway

Roads:

- *Major*
- *Intermediate*
- *Minor*
- Levee
- Watercourse
- Cadastral Parcels
- Local Government Boundary
- Suburb Boundary

Flood Depth (m):

- *0.001 - 0.10*
- *0.11 - 0.25*
- *0.26 - 0.50*
- *0.51 - 1.00*
- *1.01 - 1.50*
- *1.51 - 2.50*
- *2.51 - 5.00*
- *Greater than 5.00*

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Kilometres (Scale 1:80,000 A3 Sheet)

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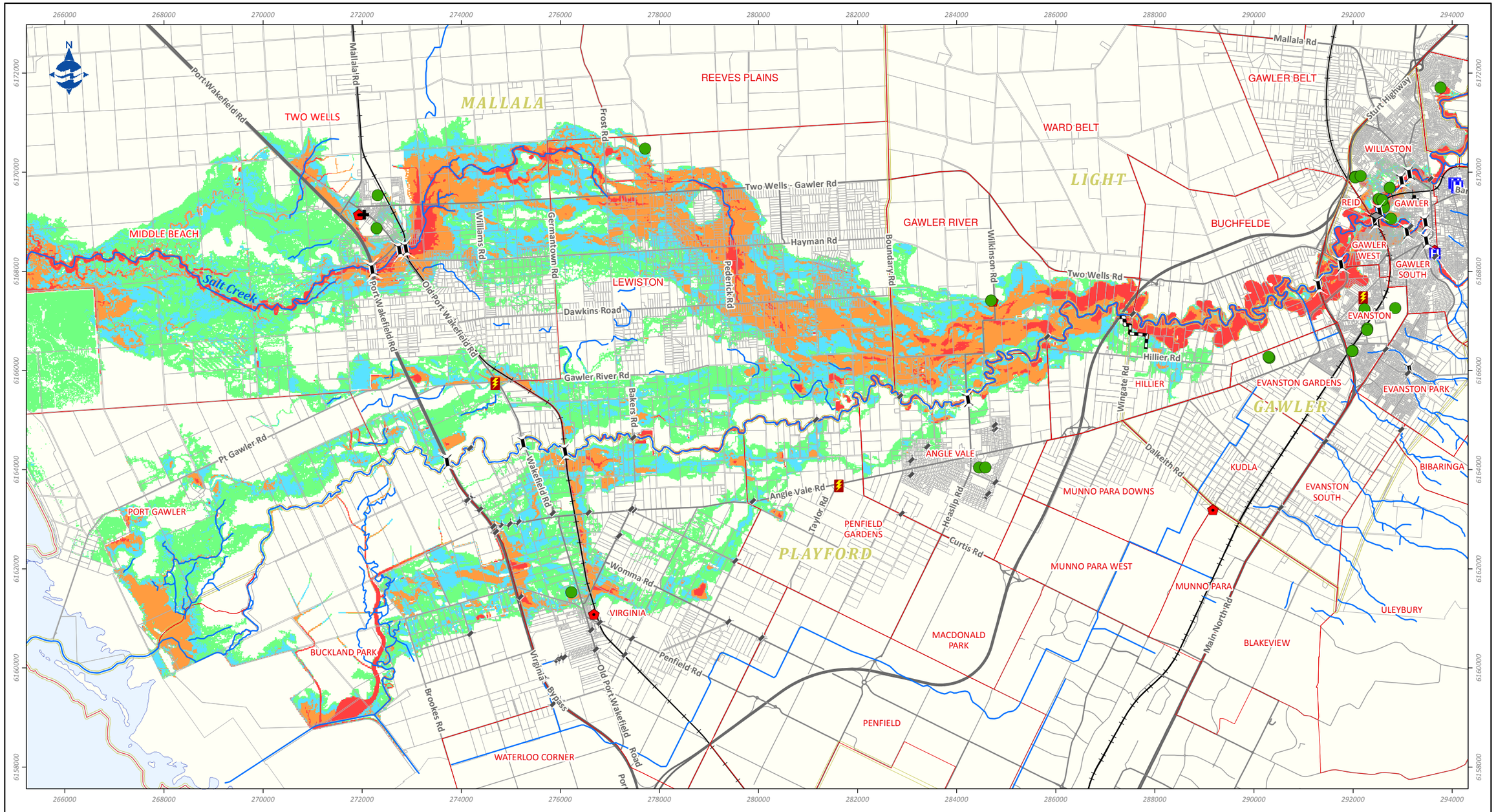
Current Conditions

1 in 200 ARI Flood Inundation

14147 D020 v4 Gawler River Flood Mapping 150501
Last Updated: 1/05/2015

Figure x.x



Legend

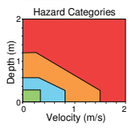
- Sports Ground
- CFS / MFS
- Hospital / Ambulance
- Police Station
- ETSA Substation
- bridge
- ford
- weir
- Railway

Roads:

- *Major*
- *Intermediate*
- *Minor*
- Levee
- Watercourse
- Cadastral Parcels
- Local Government Boundary
- Suburb Boundary

Hazard Category:

- *Low*
- *Moderate*
- *High*
- *Extreme*



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Kilometres (Scale 1:80,000 A3 Sheet)

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Current Conditions

1 in 200 ARI Flood Hazard

14147 D020 v4 Gawler River Flood Mapping 150501
Last Updated: 1/05/2015

Figure x.x

Appendix B : Culverts included in Mike Flood Model

M:\Jobs\3300-3399\3317_Gawler_River_Fld_Mark_2\Spatial\ESRI\Mxds\Figures\Model_Dev_Report\Fig_A3_Culverts_v03_A4.mxd

27/11/2014