5.1.8 Gawler Belt railway culvert

There is a low point along the Gawler to Kapunda railway line, approximately 250 m south of the intersection with Parkers Road. At this location the railway embankment acts as a barrier to floodwater moving west, causing deep ponding on the eastern (upstream) side of the railway line. In a 1% AEP event the ponding significantly encroaches on adjacent properties (refer Figure 5.15).

In a 1% AEP event there is approximately 1.5 m^3/s of floodwater that arrives in the low-spot due to overtopping of Parkers Road whilst an additional 0.22 m^3/s arrives from the upstream catchment to the east.

To reduce the amount of ponding on the eastern side of the railway line it is recommended that a culvert with the capacity to convey a 1% AEP flow be installed under the railway line (e.g. via pipe jacking). It is estimated that the pipe will need to be in the order of a DN900. Installation of a pipe under the railway line will increase the amount of floodwater moving in a westerly direction towards the natural depression on the western side of Clancy Road and will travel through private properties on the western side of the railway. It is recommended that an open drain (and easement) sufficient to convey the 1% AEP peak flow be constructed downstream of the culvert to safely convey floodwater through to an existing drainage easement adjoining Clancy Road. The capacity of the drain located within the existing easement would need to be assessed to determine if additional upgrades would be required.

The set of proposed works are shown in Figure 5.9. These works have the potential to slightly increase the downstream flood risk for rural living properties. Legal advice should be sought to understand if restoring the flow path intersected by the railway would be permissible.

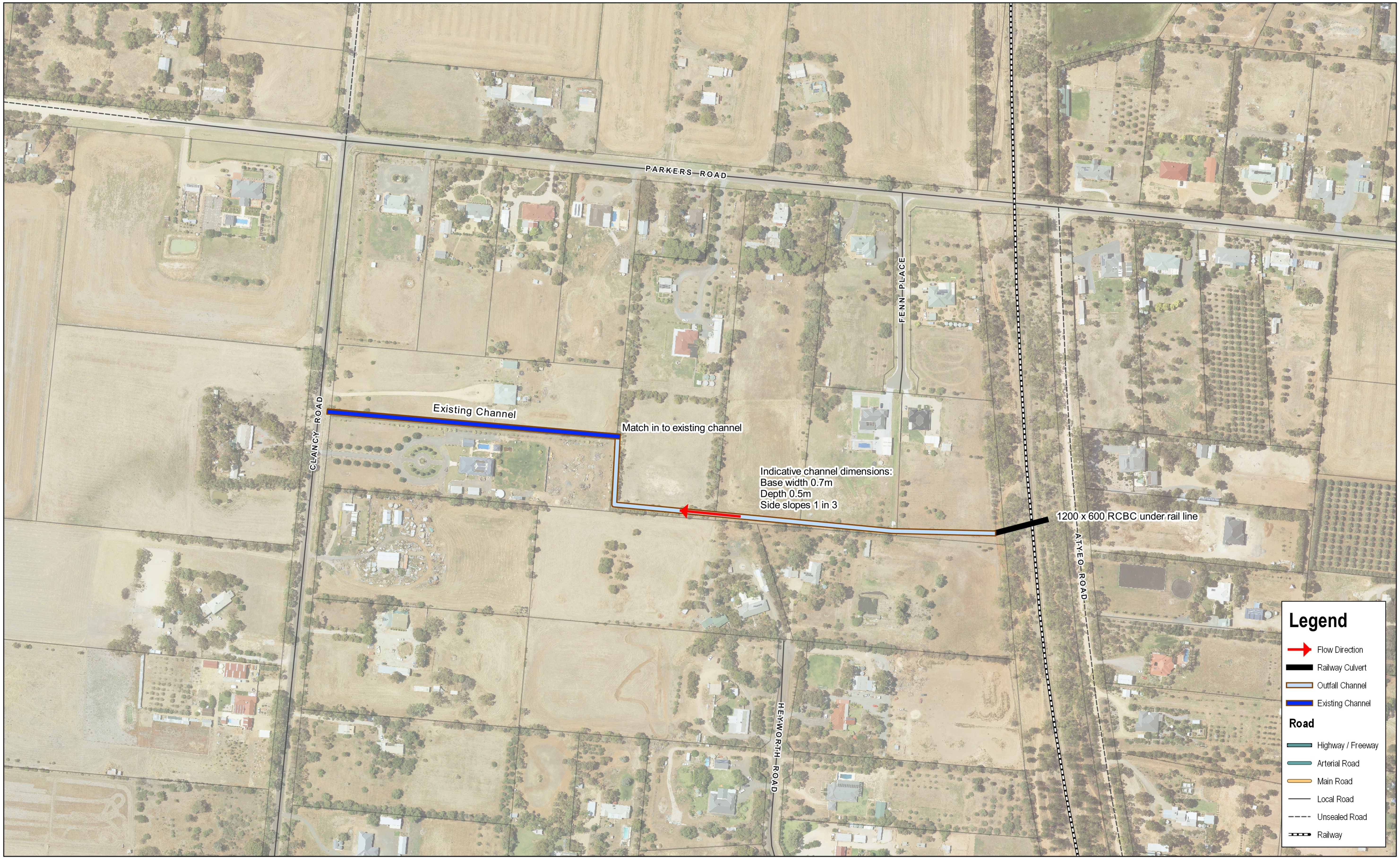
5.1.9 Gawler Belt interception drain

The Gawler Belt area is affected by extensive, relatively shallow flooding which is predominantly a result of floodwaters originating from the catchment area north of Redbanks Road and a lack of formal drainage in the area. A formalised open channel was investigated as a means of mitigating the flooding. It was proposed that the channel would intercept floodwater from the Roseworthy area and convey them to the large low spot south of Parkers Road in a contained and controlled manner.

Due to the rural land-use of the area, it was determined that a 5% AEP standard of protection would represent a good balance between cost of construction and the reduction in damages offset by the works. Two alignments were considered for the channel. The first is a longer path following property boundaries and avoiding driveway and road crossings as much as possible. The second is a shorter, more direct, path but involves numerous road and driveway crossings. The second alignment whilst shorter was determined to have a higher capital cost due to the number and size of the culvert crossings that would be required. The preferred alignment is shown in Figure 5.10.

The estimated flow rate for the 5% AEP event is 14 m^3/s. Depending on the slope of the natural surface, this required channel base width would be between 10 and 16 metres. Three road crossings and one railway crossing are required.

The proposed open channel results in substantially reduced flooding during the 20% and 5% AEP events; practically completely eliminating flooding from the areas upstream of the Parkers Road low spot. During the 1% AEP event, the area of land subject to shallow flooding is reduced by about half. During the 20% AEP event, more water reaches the Parkers Road low spot compared to the existing conditions because of the efficient flow path created by the channel. Although the floodwater that arrives at the low spot during the 20% AEP event does not encroach onto any existing dwellings the increased frequency of inundation could be perceived as “making flooding worse” even if the increase in depth of flooding is insignificant. Additionally, even though the existing low-spot is a natural flood basin, it is recommended that legal advice is sought to ensure the proposal is permissible and that specific land-owners are consulted.



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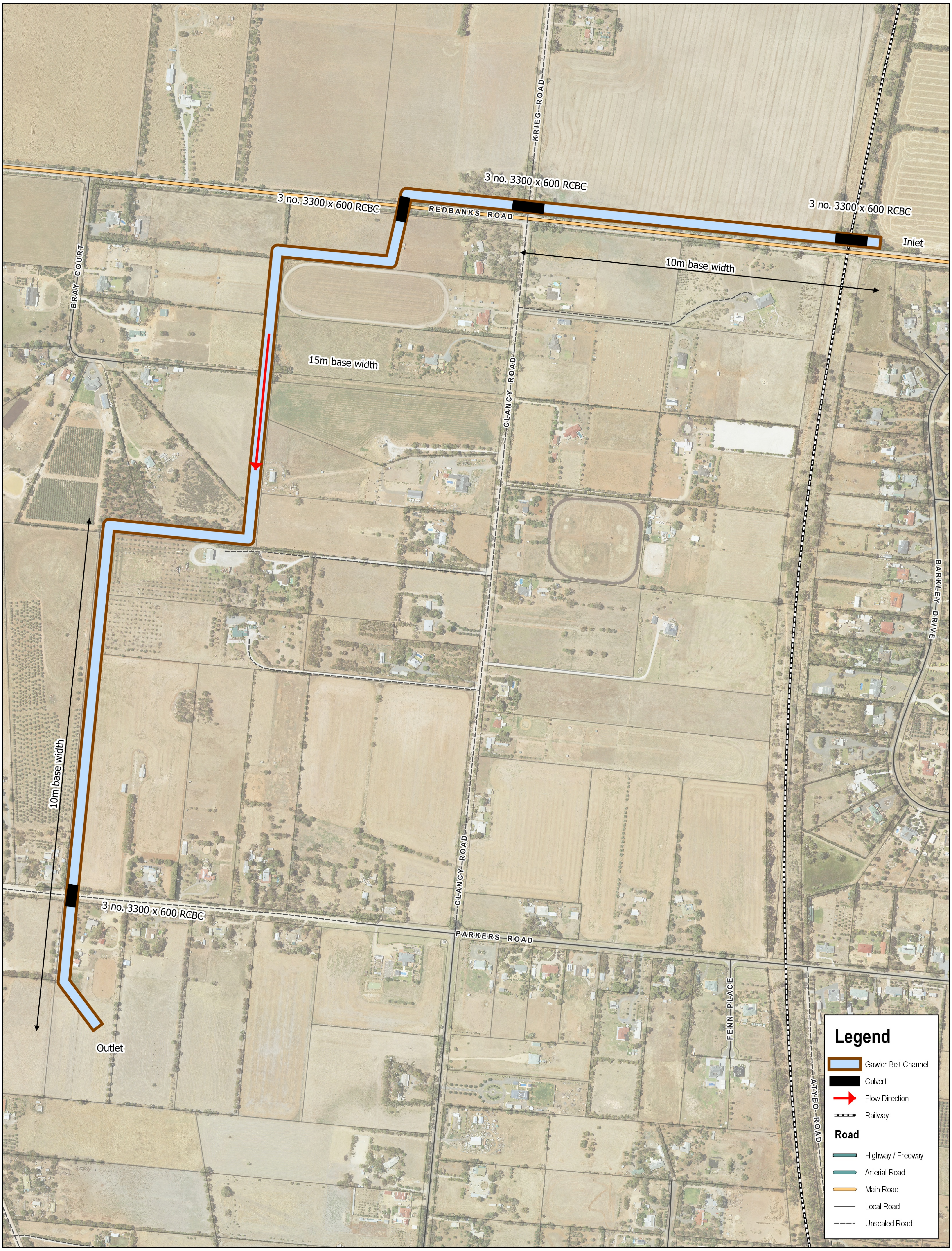
GAWLER BELT RAILWAY CULVERT

Figure 5.9



100 0 100 200 300 m

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GAWLER BELT INTERCEPTION DRAIN PREFERRED ALIGNMENT

Figure 5.10

5.1.10 Hewett rear of allotment drainage

The residential suburb of Hewett is very steep with rear of allotment drains in a number of areas to allow properties that grade away from the road to have a stormwater connection point. However, for some large allotments that front onto Explorer Parade and Oakland Circuit, there is no rear of allotment drain. While it is understood that the dwelling roofs drain to the adjacent street via sealed systems, there are large paved and garden areas that drain to the rear of the properties causing nuisance flooding issues within adjacent private properties. Subject to additional design development and site survey, a new section of rear of allotment drain to serve 34 to 42 Oaklands Circuit and 43 Explorer Parade is likely to alleviate this problem. The rear of allotment drain could connect into the existing Council drain in River View Drive.

The extent of the drain is shown in Figure 5.11.

5.1.11 Flow gauge for Clifford Road drain

The well-defined shape of the Clifford Road outfall drain coupled with its location at the bottom of a large urban catchment make the outfall drain ideally suited for flow measurement. Flow gauges play an important role in the development and calibration of hydrologic and hydraulic flood models. Knowledge gained from calibrated models helps reduce the uncertainty of predictions and can provide greater confidence in the functionality of proposed solutions. Other benefits of flow measurement include the ability to inform the development of water balance and catchment yield models for the investigation of water harvesting potential.

The Hillier Road bridge offers a suitable location for installation of a flow level meter. A beam sensor could be mounted onto the existing bridge structure to detect the water surface elevation beneath the bridge. Due to the well-defined shape of the drain, creation of a rating table would be a relatively simple process.

The flow gauge should be supported by a pluviometer to record rainfall intensity over the catchment. Estimation of rainfall within the catchment may be problematic as the two existing rain gauges in Gawler only offer daily rainfall measurements which are of limited use for calibration of flood models. Ideally, rainfall estimates at 10 minute intervals or less are required to achieve good replication of observed rainfall events (Ochoa-Rodriguez et al., 2015).

5.1.12 Evanston Oval parallel pipe upgrade

The open channel upstream of Evanston Oval conveys approximately 12.5 m^3/s, however, the existing pipe system beneath the oval only conveys approximately 9 m^3/s. This leads to floodwater spilling from the channel across the oval, over the railway and into properties along Railway Crescent. The addition of a parallel pipe to provide the necessary capacity to prevent flooding of the oval and surrounding properties was investigated.

In the long-term scenario it was assumed that other upstream measures proposed by the SMP have been installed. This assumption results in the peak flow arriving at the oval being reduced to approximately 9.5 m^3/s. While this is only 0.5 m^3/s more than the capacity of the existing drain a significant amount of head is required to drive 9 m^3/s through the drain, which results in upstream flooding. Installation of a DN1050 pipe parallel to the existing DN1650 results in full conveyance of the flood peak under the oval, thereby preventing flooding. If the other flood mitigation measures are not implemented upstream it will be necessary to review the required dimensions for the parallel pipe upgrade.

It should be noted that incorporating detention storage at the oval has been investigated but was not found to be effective (refer Section 5.1.3).

The location of the parallel pipe is shown in Figure 5.12.

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HEWETT REAR OF ALLOTMENT DRAIN

Figure 5.11

10 0 10 20 30 m

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EVANSTON OVAL PARALLEL PIPE UPGRADE

Figure 5.12

5.1.13 Corey Street flood control basin outlet optimisation

The Corey Street flood control basin is designed to mitigate rare floods (between 1% and 0.2% AEP) which generally have large volumes of runoff. Consequently, the main outlet of the basin is sized to prevent stormwater from activating the spillway in rare floods. This has the effect of underutilising the storage volume of the basin during more frequent flood events (where the discharge from the basin needn't be as large as rare events to avoid activating the spillway).

Careful design of an outlet structure that limits discharge from the basin in frequent flood events, but maintains the discharge required for rare flood events, would ensure that the basin's storage volume is more fully utilised in frequent flood events. This could potentially reduce flooding issues in the Coleman Parade and Sheriff Street drainage systems and may allow for water quality treatment opportunities within the basin.

5.1.14 Gawler River levee bank augmentation

A 4.8 km network of additional or augmented levees within five different sections along the North Para, South Para and Gawler River has been proposed as a potential flood mitigation measure. A concept design of the levee banks has been prepared as part of this SMP with the design summary information contained with a separate report (refer Appendix C). The levee height has been set to provide a 300 mm freeboard above the modelled 1% AEP flood level.

The concept design work identified a number of issues associated with the proposed levee works which included the following issues:

- Very limited space to construct a levee at a number of locations. The only viable alternative in these locations is to have a vertical wall.
- The levee crosses a number of thoroughfares including roads, car park entrances and rail lines. At these locations (at least seven in total) a temporary levee would be needed to erected by emergency services during a flood event to ensure the integrity of the levee is maintained at these locations.
- The levee is in private property for much of its length and would require significant community consultation.
- There are numerous significant trees along the proposed alignment. An augmented and/or new levee would either need the removal of a number of these trees or require a vertical levee.
- The levee may hinder pedestrian movements in some areas.
- A vertical levee in some locations could potentially reduce amenity, particularly within residential areas such as along Paterson, Nixon and Victoria Terrace.
- The ensure the long term integrity of the levee, regular monitoring would be required, along with maintenance, as required. This task is complicated by the levee being located in private property at a number of locations.

Based on the above list of issues, the construction of the levee bank is not recommended.

5.1.15 Review of low-standard drainage systems

Based on the drainage standard assessment (Section 2.3.1), low-standard drainage systems should be targeted for review and upgrades proposed where review finds the standard of protection can be cost-effectively improved.

Tonkin recommends as a minimum that the following drainage systems be reviewed:

City of Gawler

- Coleman Parade (between Mueller Drive and Corey Street)
- Penrith Avenue (between Gosford Street and the system outlet)

- Reid Street (between Finniss Street and Whitelaw Terrace)
- Sheriff Street (between Mount Terrace and Adelaide Road)
- Sunnyside Drive (between Williams Street and the system outlet)

Light Regional Council

- Murray Road (between Perseverance Place and the system outlet)

5.1.16 Non-structural flood mitigation measures

Education and awareness

Detailed flood plain mapping of the catchment is available. To meet Objective 1.5, this information should be made widely available to the community so that they understand where flooding is likely to occur. Awareness of flood risk can allow the community to better manage their risk and reduce flood damages. This awareness could be achieved via letters and brochures, circulating floods maps publicly (e.g. accessible via the internet) and having information available at public places such as libraries and Council offices. Businesses and residents can be encouraged to develop flood action plans to reduce damages during a flood for example by changing the manner in which valuable items are stored.

Flood warning and flood forecasting

Whilst the response time for the local drainage catchments is relatively short, if the community were forewarned of the potential for a flood, the magnitude of the social and economic damages could be reduced significantly.

Warning of flooding provides the community and emergency services time to enact response measures such as placing sand bags around flood prone areas or moving valuable portable property out of flood areas. The potential reduction in flood damages when more than 12 hours of warning is provided, as opposed to less than two hours, can range from 20% up to 50% depending on the relative experience of the community in dealing with flooding (DNRE, 2000). Similar to education and awareness, these potential reductions are significant compared to the structural measures.

Given the relatively short response time of the local catchments (typically 1-2 hours) the only opportunity to provide a meaningful warning time would be to issue a flood warning before a rainfall event occurs. The reliability of such warnings (if based on predicted rainfall) could result in complacency within the community if the warnings are issued too frequently without actual flood events occurring.

Longer response times are available in the Gawler Belt area and areas flood prone due to the Gawler, North Para and South Para Rivers. For these areas, adequate flood warning time could allow for a significant reduction in flood damages.

The cost of setting up and maintaining a flood warning system varies depending on the nature of its setup. If utilising existing monitoring capabilities of other agencies, the expense would be less than independently establishing monitoring systems. If a warning system was set up, it could cover an area wider than just the study area to leverage economies of scale.

5.1.17 Review of the strategic plans, asset plans and development plans

Jensen Plus were engaged to review the strategic plans, asset plans and development plans of the four councils within the SMP study areas (Gawler, Barossa, Light and Playford) to identify changes to these policies that could result in improved management of stormwater.

There is broad policy coverage for a range of stormwater management issues across these strategic and statutory plans. The review focussed principally on the level of controls available within the planning system. Whilst there is good policy coverage addressing issues of stormwater harvesting opportunities and water quality, the review identified a number of non-structural stormwater management measures that could be implemented; these are outlined below.

Use of mapping outputs from the SMP

The SMP project has generated GIS-based flood modelling data for the study area. Combined with flood plain mapping for the Gawler River, North Para River and South Para River, this information should be utilised in the planning of new developments to ensure that new development has adequate flood protection (Objective 1.1). It is recommended that this should include ensuring existing overland flood flow paths are retained and that floor levels of tenements are set above the predicted level of the 1% AEP flood (including appropriate freeboard).

Councils should utilise ePlanning and the SA Planning Portal to regularly and quickly update the extent of floodplain areas shown in the Planning and Design Code (as overlay) when revised modelling is undertaken or as mitigation measures are implemented.

Planning for climate change

The latest climate change science predicts an increase in rainfall intensity of extreme events. This will result in increased peak flows and may lead to changes in the extent and severity of inundation during flood events.

Council will be able to understand some of the potential impacts of climate change by assessing the climate change flood plain map undertaken as part of this study (refer Section 5.1.18). This knowledge can then be used to plan stormwater management strategies that are robust despite the changing climate (Objective 1.6).

Consistent strategic plans

The councils should continue to work collaboratively to:

- Ensure that stormwater management goals, objectives, strategies and actions within strategic documents recognise the need for cross boundary management of stormwater and flood risk.
- Within the areas identified as flood prone, and new urban growth areas, each council should adopt the agreed assumptions around potential imperviousness (high, medium, low) to inform policy, modelling and mitigation strategies.

Changes to the Development Plan/Planning and Design Code

Development Plans are soon to be replaced with a new Planning and Design Code. The structure and format of the new codes are not yet known. The following strategies provide some recommended changes to existing planning policy to provide consistent treatment of development within flood prone areas across the study area.

The four councils should collaboratively develop a suite of more detailed flood risk and stormwater management design responses and techniques for inclusion within the Development Plan to better guide assessment and responses about achieving existing SAPPL policy objectives. These techniques should be informed by the measures that have worked and not worked in previous development schemes and scenario and should be broad enough to cater for catchment (land division) scale through to site (renewal) scale design responses. This can also then be easily transferable to (and potentially inform) the imminent Planning and Design Code.

The Development Plans should be updated to include the following requirements:

1. In areas identified as having a medium to high potential for an increase in impervious area (refer Development Potential report in Appendix D), for new development and areas where the capacity of the downstream stormwater infrastructure is limited (be it greenfield, brownfield, infill or commercial / town centre), the policies should mandate on-site detention measures for discharge from all new developments.
2. The requirements should be to limit post-development peak discharge rates to pre-development discharge rates (Objective 1.4).

3. Where it is not practicable to limit discharges to pre-development levels. (e.g. if the site of development is currently largely pervious), the policy should specify an acceptable level of runoff. The measures should consider the 20% AEP and 1% AEP floods. Example policy wording would be:

   All new buildings and building extensions of 40 square metres or more in floor area in flood prone areas should incorporate sufficient on-site stormwater detention/retention to limit the rate of stormwater runoff from the subject land so that pre-development flows are not exceeded:

   a. within residential zones

   i. 20% AEP flood event (runoff coefficient 0.25)

   ii. 1% AEP flood event (runoff coefficient 0.45)

   b. within non-residential urban zones

   i. 20% AEP flood event (runoff coefficient 0.65)

   ii. 1% AEP flood event (runoff coefficient 0.85).

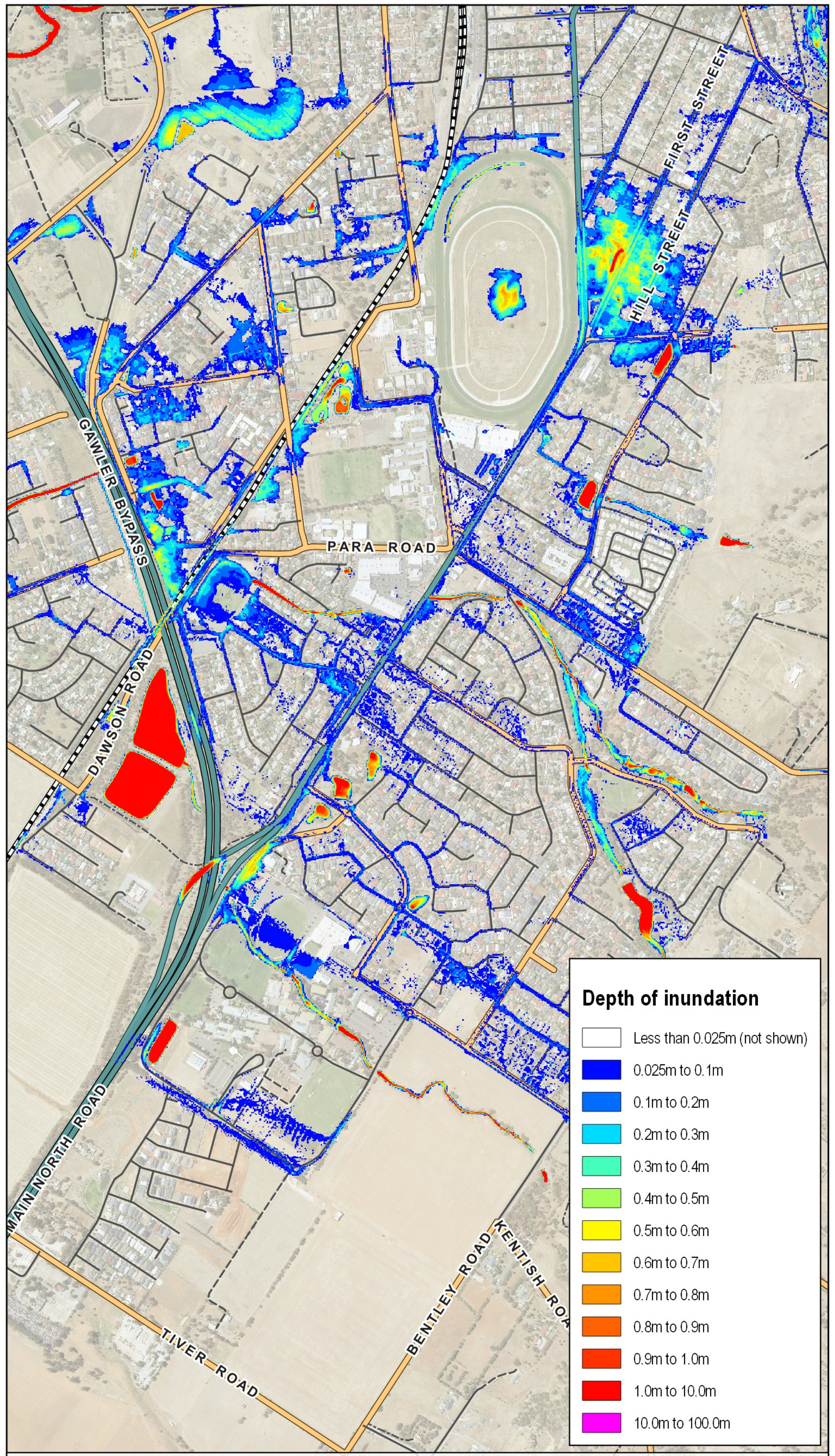
4. The Development Plans should provide consistent guidance on maximum site coverage and levels of fill above the existing natural surface.
5. The Development Plans should be changed to apply consistent fencing treatments and development setback distances from creek lines and flow paths, including cross-council and cross-owner lines. Setback distances should be watercourse specific, depending on its size and geometry.
6. The Development Plans should be changed to mandate that development within areas categorised as high and medium flood hazard risk areas demonstrate safe access routes to higher ground for major flood events.
7. Development controls should be reviewed with the aim of providing greater policy flexibility within development zones and policy areas so that integration of community facilities (such as local parks, playgrounds and outdoor recreation spaces) with stormwater management flow-paths, basins, wetlands and recycling areas can, subject to safety, orientation and structural requirements, be achieved.

Council should undertake spot checks to ensure that development complies with the development approval requirements.

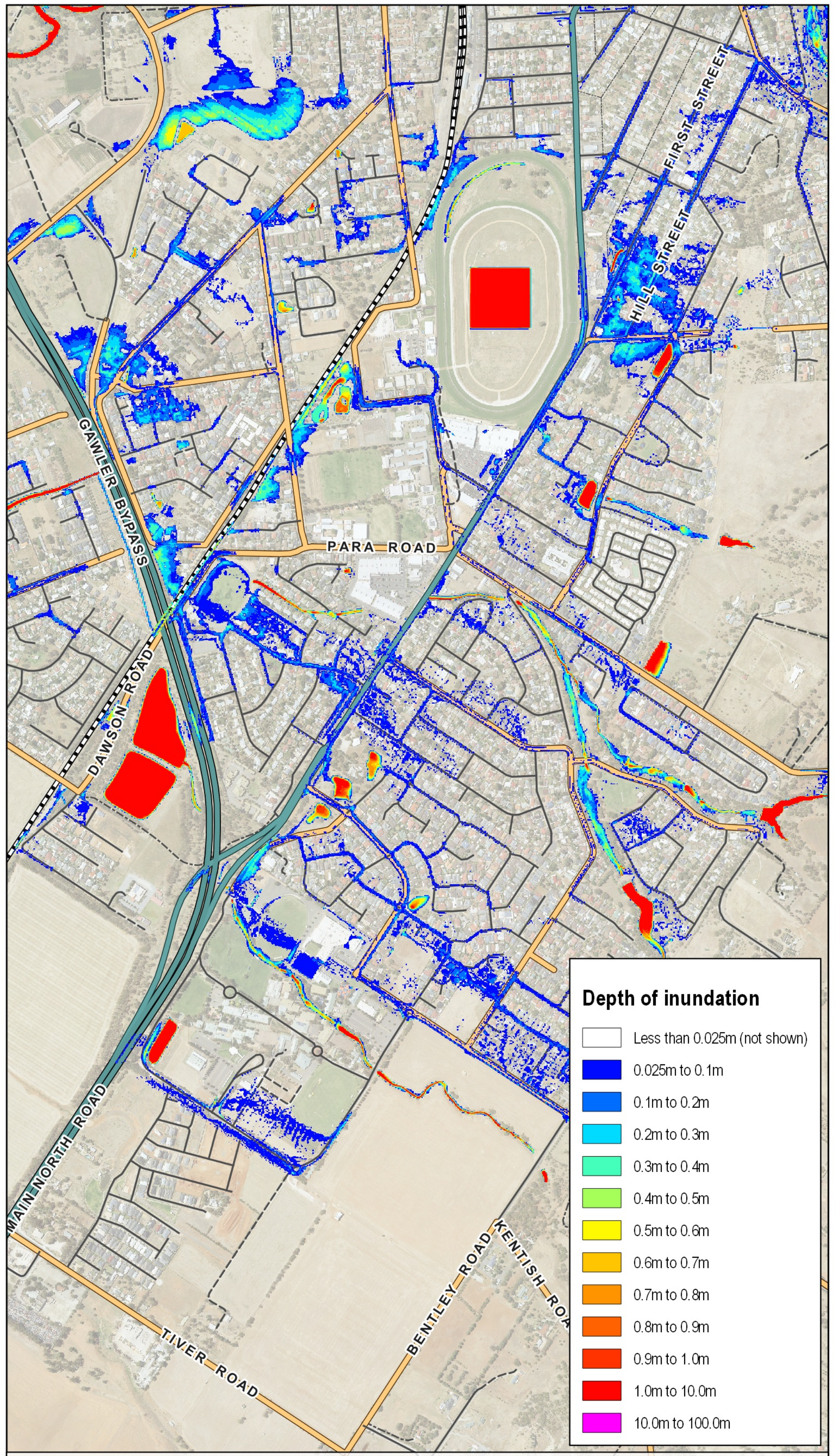
Infrastructure Schemes

While it may be challenging to implement, the councils should continue to liaise with DPTI in relation to establishing requirements for a Basic Infrastructure Scheme for regional stormwater management specifically for identified greenfield growth area locations as notified by the Councils (noting that downstream impacts and mitigation measures may cross Council borders). The scheme would potentially detail:

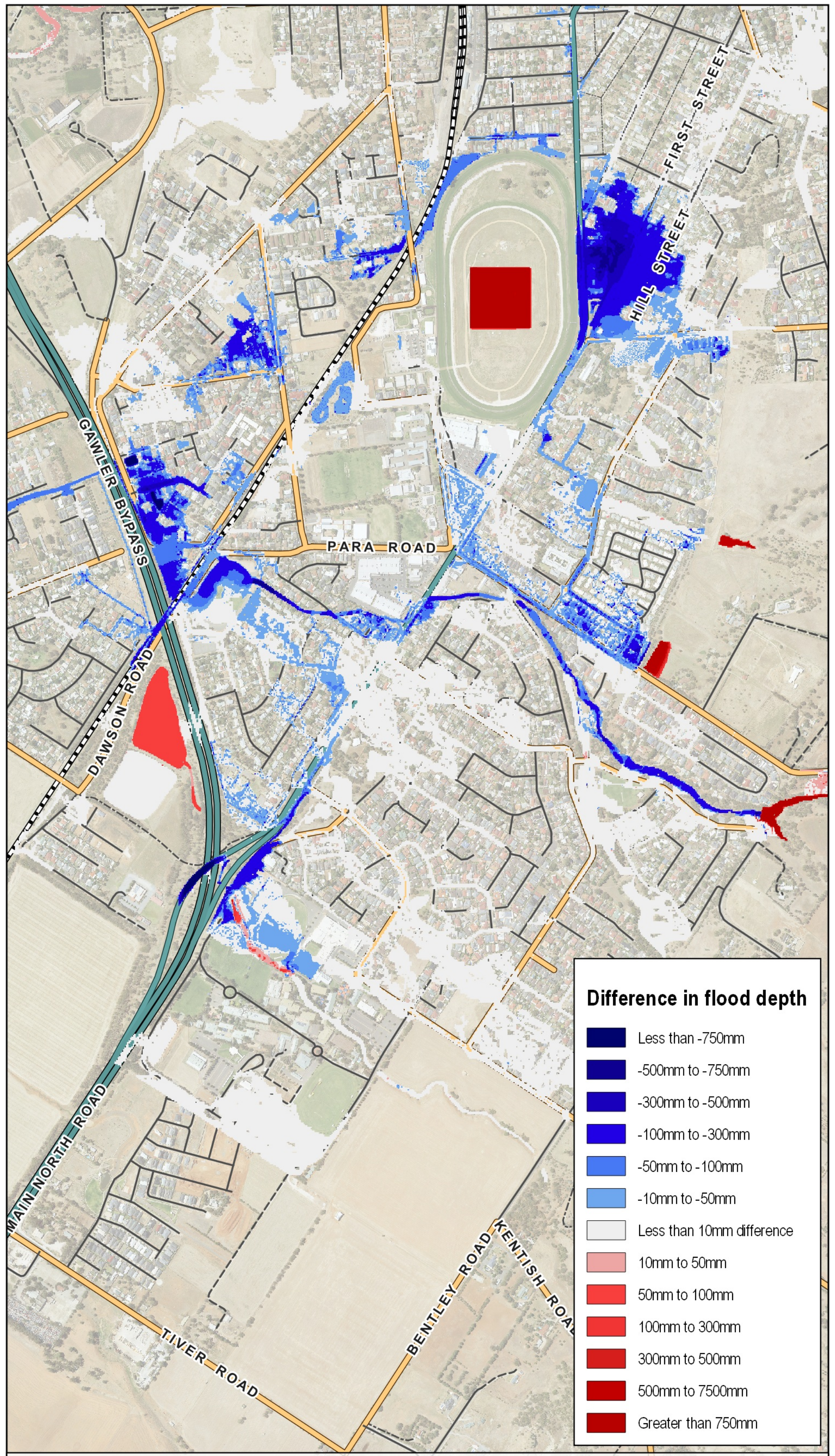
- the nature and intended scope of the stormwater management infrastructure
- the development triggers that generate the need for the stormwater infrastructure
- proposed designated growth areas needing future infrastructure
- proposed timing or staging of scheme elements
- an assessment of the costs and benefits and proposed scheme funding arrangements
- contributions arrangements to spread costs of infrastructure to all those who benefit
- basic infrastructure or assets which may be transferred to councils when the scheme is completed.



FLOOD INUNDATION
LONG-TERM DEVELOPMENT SCENARIO



FLOOD INUNDATION
LONG-TERM DEVELOPMENT SCENARIO WITH MITIGATION



DIFFERENCE MAP

0 250 500 750 1000 m

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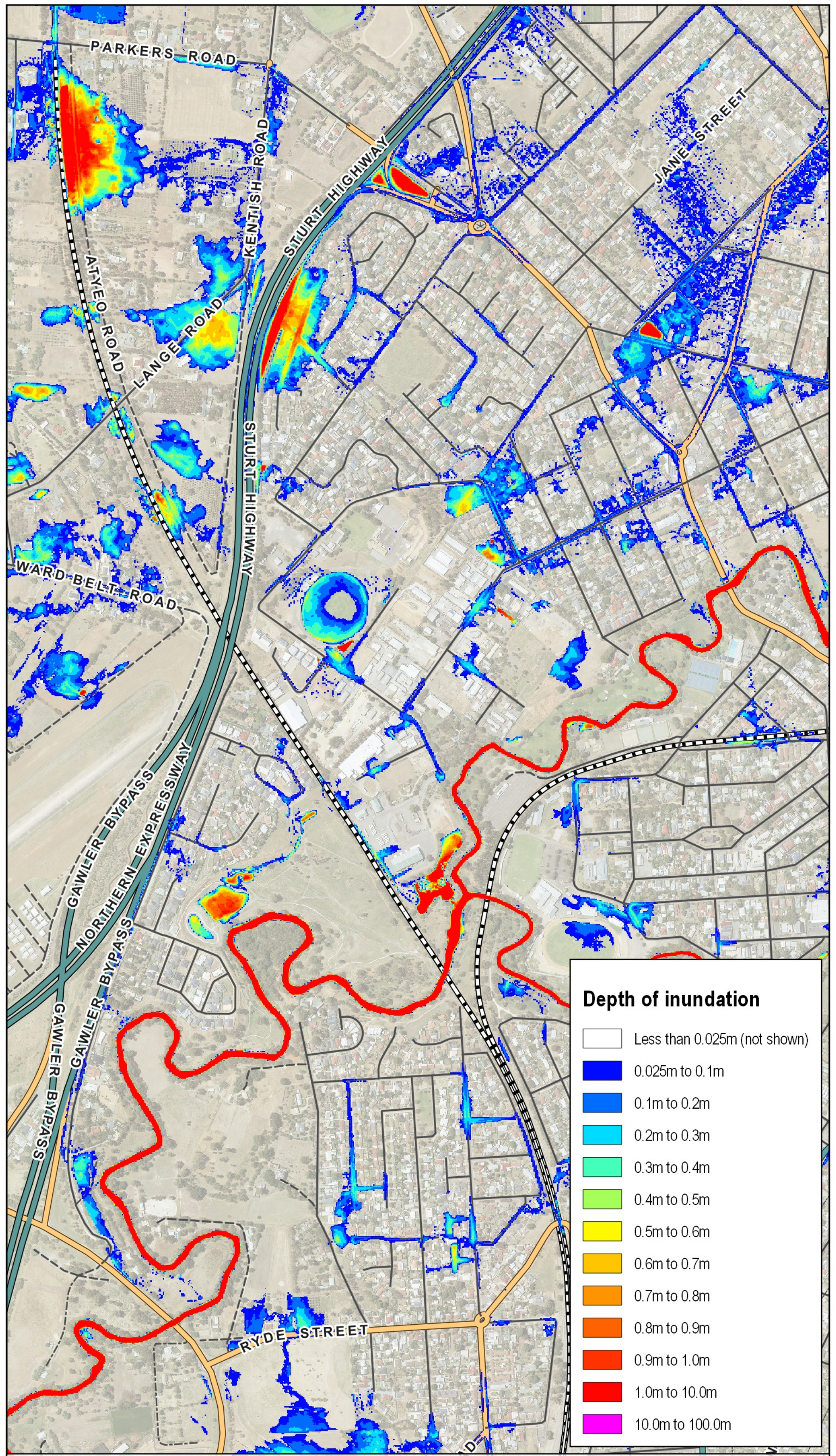
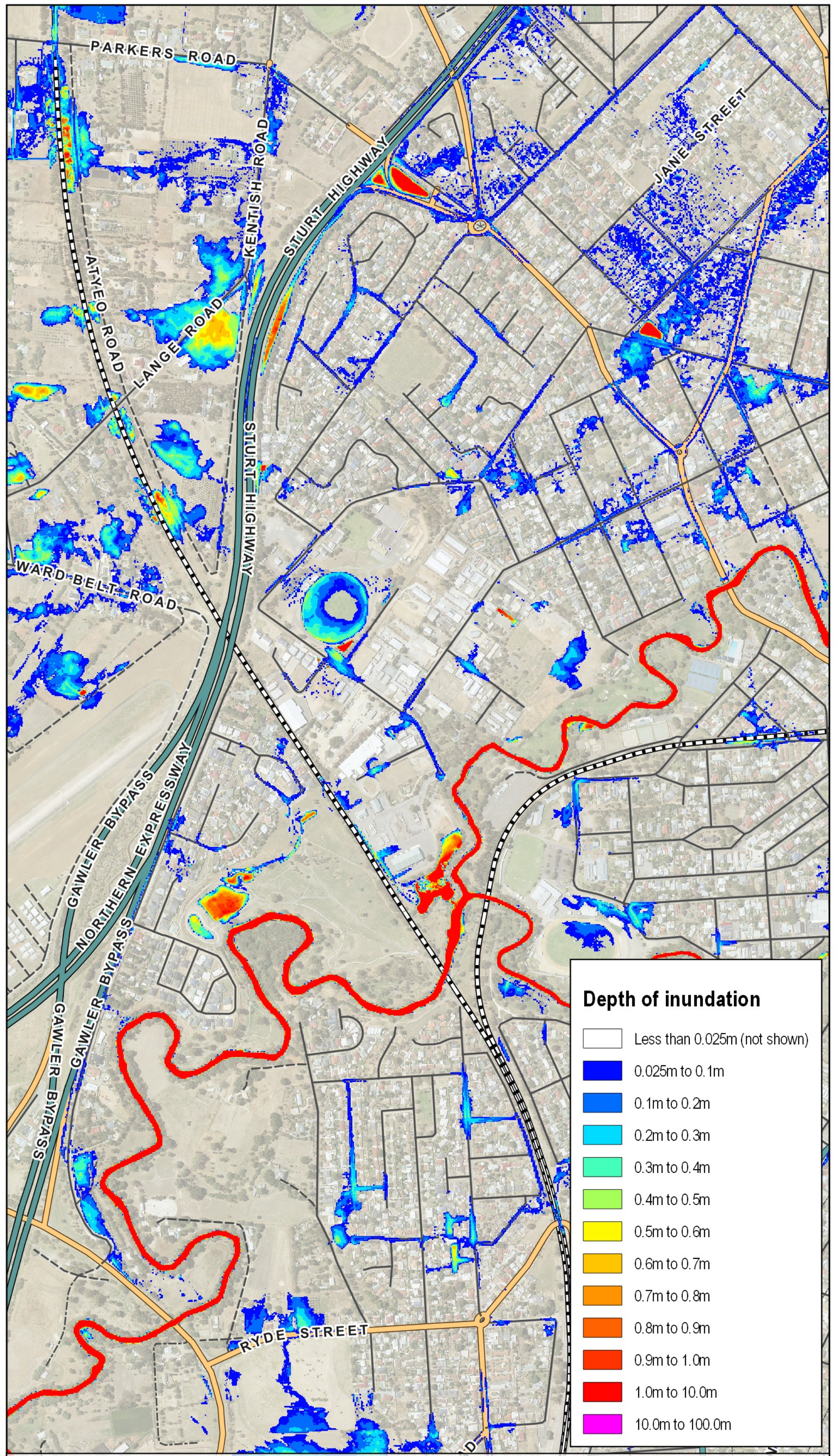
MITIGATION MODELLING DIFFERENCE MAP FOR 1% AEP (SOUTHERN AREA)

(on-site detention not included)

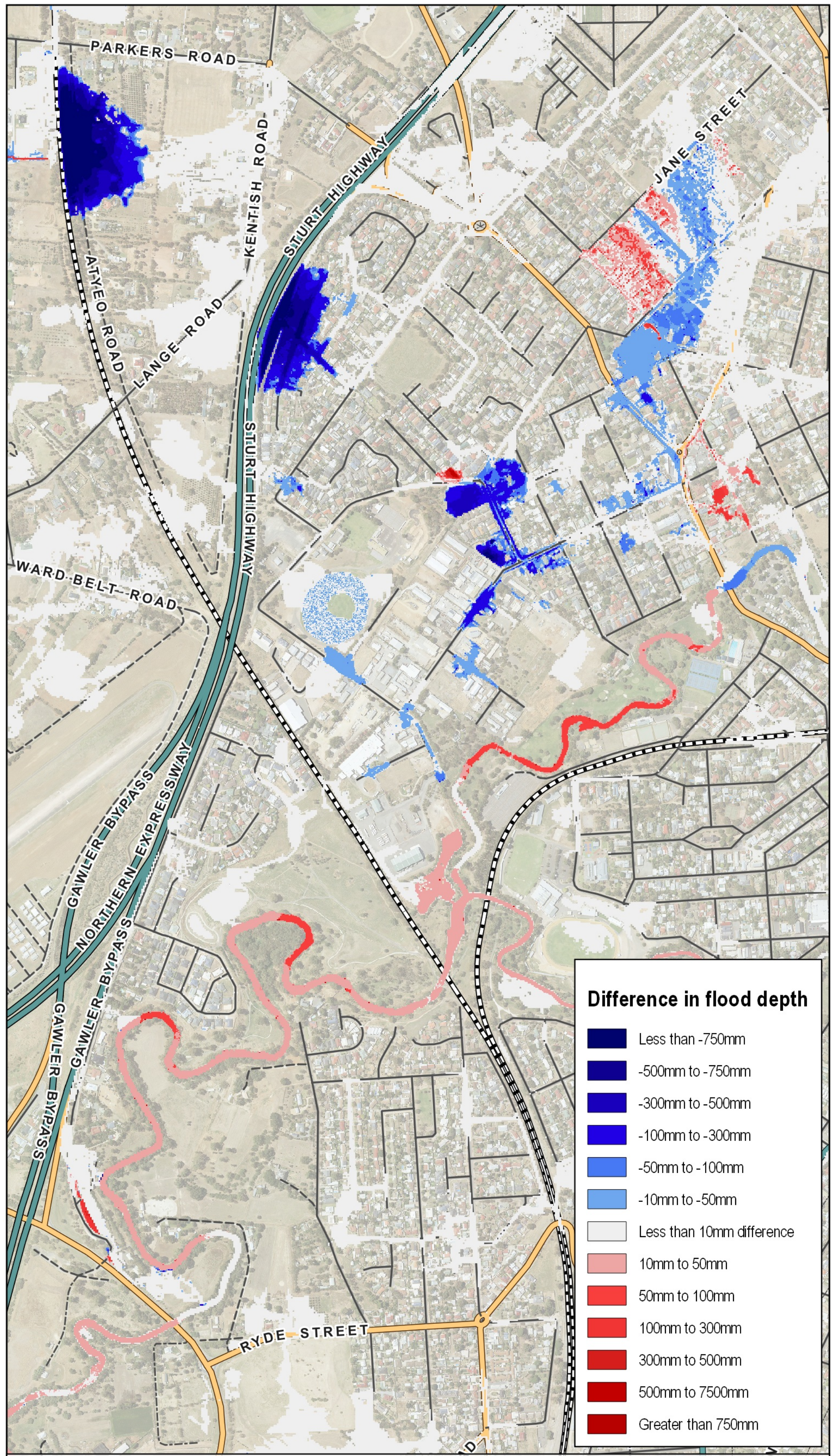
Figure 5.13



FLOOD INUNDATION
LONG-TERM DEVELOPMENT SCENARIO



FLOOD INUNDATION
LONG-TERM DEVELOPMENT SCENARIO WITH MITIGATION



DIFFERENCE MAP

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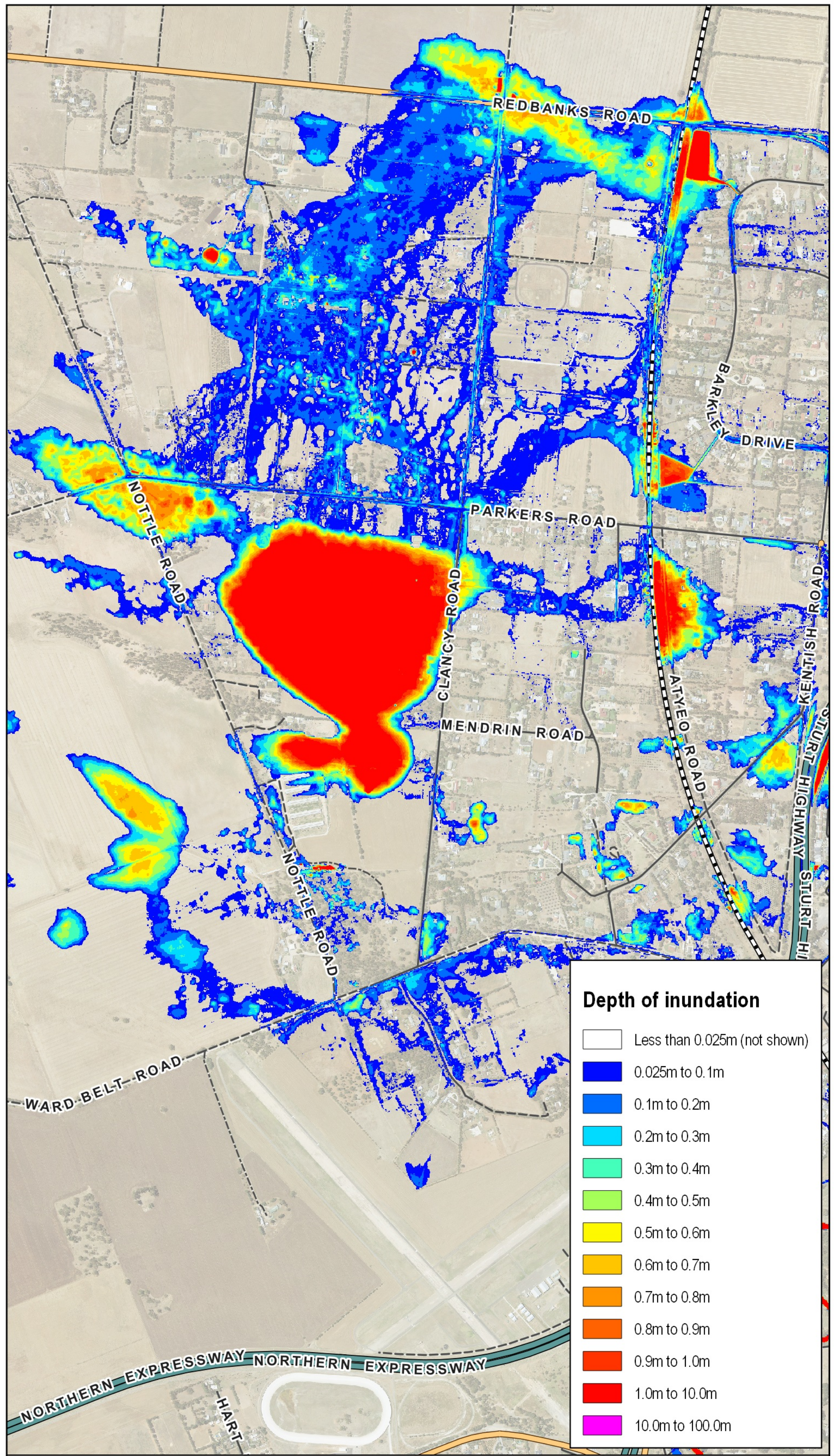
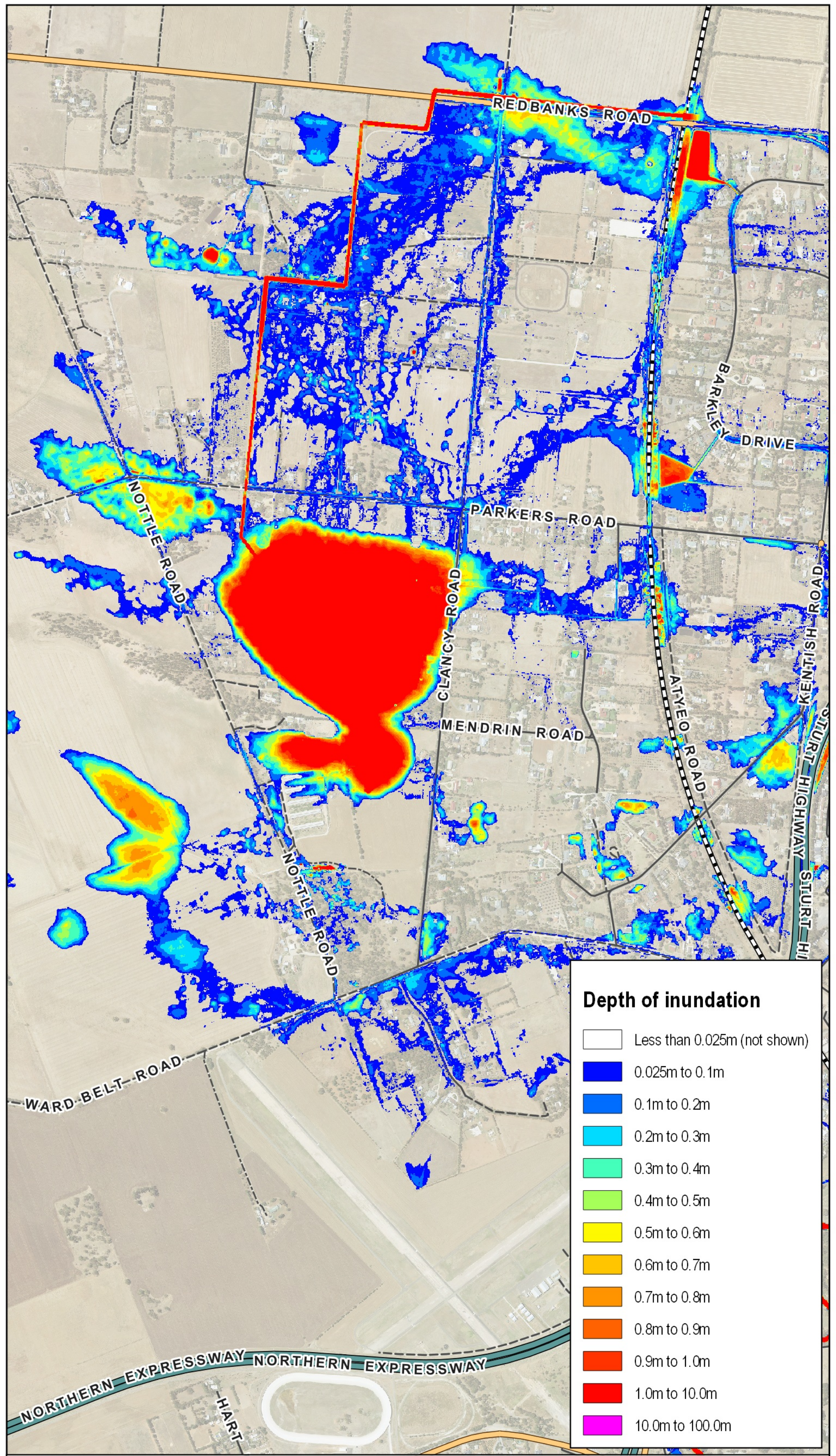
MITIGATION MODELLING DIFFERENCE MAP FOR 1% AEP (EASTERN AREA)

(on-site detention not included)

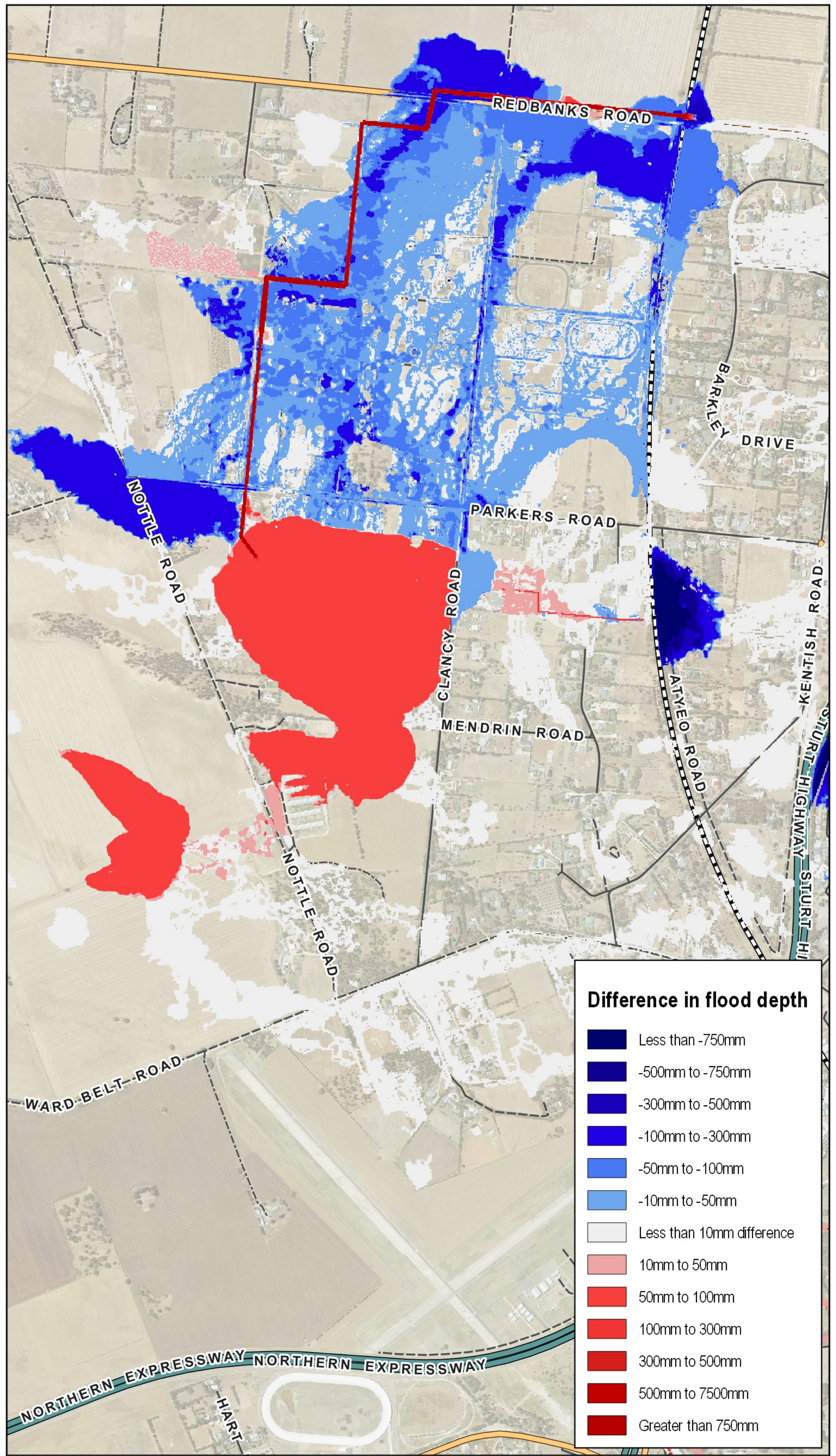
Figure 5.14



FLOOD INUNDATION
LONG-TERM DEVELOPMENT SCENARIO



FLOOD INUNDATION
LONG-TERM DEVELOPMENT SCENARIO WITH MITIGATION



DIFFERENCE MAP

0 250 500 750 1000 m

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MITIGATION MODELLING DIFFERENCE MAP FOR 1% AEP (GAWLER BELT AREA)

(on-site detention not included)

Figure 5.15

5.1.18 Potential impacts of changing climate

Review of the climate projections for the study region shows that under a high emissions scenario (RCP 8.5) rainfall intensity will increase by 7.8% by mid-century (2050). An assessment of the potential impacts of changing climate has been made by increasing the rainfall by 7.8% and re-running the flood model for the long-term development scenario with mitigation

Unsurprisingly the depth of flooding is increased as a result of the higher rainfall intensity. Generally, the largest increases in flood depth occur in low-spots within the study area. It appears that the steep catchments are not sensitive (i.e. flood depth changes by less than 25 mm) to the increase in rainfall modelled. However, due to the increased volume of runoff low-spots fill to higher levels. In some cases, this impacts the performance of proposed mitigation strategies.

For example, the flooding of First Street is adversely impacted by the additional volume of runoff if no changes are made to the proposed Gawler Racecourse basin strategy. Flood depths are up to 150 mm to 180 mm deeper as a result. This increase could be addressed by using larger pipe sizes to drain the additional volume generated by climate change.

Each mitigation strategy will be affected by climate change differently and the Councils are advised to undertake investigations to understand the changes as they proceed with detailed design of each options or as a part of a broader climate change adaptation strategy.

5.2 Water quality improvement strategies – areas of existing development

The following sections detail the proposed strategies for improving the water quality of the runoff from the developed areas of the catchment. The stated water quality objectives for the study area reflect the South Australia state wide targets which target the following reductions in average annual loads:

- Gross Pollutants – 90%
- Sediments – 80%
- Total Phosphorus – 60%
- Total Nitrogen – 45%

Water sensitive urban design (WSUD) requires the "integration of a range of practices in a defined program" (ARQ, 2006). The hierarchy for the implementation of measures is as follows:

1. Retention and restoration measures which focus on retaining and restoring natural channels, wetlands and riparian vegetation
2. Source control via non-structural measures which aim to change human behaviours (e.g. education)
3. Source control via structural measures
4. In-system measures.

Given the heavily developed nature of the study area and the distributed nature of the outfalls to the receiving area, the opportunities for the large schemes that can treat a significant portion of the study area are limited. Opportunities for water quality improvement within the existing developed areas of the catchment are therefore largely limited to the retrofitting of the system to incorporate in-system measures.

The incorporation of WSUD into the areas of new development will be consistent with WSUD best practice and should aim to achieve the stated water quality targets.

5.2.1 New gross pollutant traps

A number of gross pollutant traps (GPTs) and trash racks exist within the study area. The MUSIC modelling shows that these, along with a number of existing small basins and wetlands, remove 61% of gross pollutants that are generated within the study area (assuming the ultimate state of development), with a residual gross pollutant load of 44 tonnes.

The installation of additional GPTs is recommended to further reduce the residual load of gross pollutants that are discharged to the receiving waters (Objective 2.1).The seven priority locations for the installation of new GPTs were identified based on a review of the results from the MUSIC modelling. They are all located on outlets which currently (untreated) discharge in excess of 2 t of gross pollutants per year. Installation of GPTs in these locations, as listed in Table 5.1 is therefore considered to represent the best value for value for money. The locations of the proposed additional GPTs are shown in Figure 5.16. Actual locations of each GPT would be subject to further design development need to consider issues such as access for maintenance and hydraulic losses that the GPT would introduce into the underground drainage network. Council should also consider the installation of GPTs on any outlets that drain catchments that are predominantly commercial or industrial.

The theoretical maximum removal of gross pollutants, as listed in Table 5.1 is based on high-flow GPT units (consistent with those already installed within the study area) with all pipe flows being directed to the GPT. The assumed pollutant removal efficiencies are based on manufacturer's specifications.

In reality the actual reduction achieved will be dependent on the selected GPT and maximum treatable flow rate.