Torrens Road Catchment

Draft Stormwater Management Plan

City of Charles Sturt
City of Port Adelaide Enfield

March 2015

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Document History and Status

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Objective of Plan

This Stormwater Management Plan (SMP) for the Torrens Road catchment has been prepared in accordance with the requirements of the *Guideline Framework for Uniform Catchment Based Stormwater Management Planning prepared by Local Government* dated August 2006.

The Plan provides a description of the existing catchment and issues relating to current stormwater management. It also provides an overview of opportunities to improve stormwater management within the catchment to address flood protection, reduce pollution impacts, use stormwater and enhance the environment and ecosystems affected by stormwater inputs.

Catchment Description

The Torrens Road catchment covers an area of approximately 23 km^2. With the exception of land at Gillman, the catchment has been largely urbanised and has a well developed existing stormwater drainage system, comprising a network of underground pipes, culverts and open channels. About one quarter of the catchment is undeveloped, comprising open space or vacant land such as that at Gillman, with development in the remainder of the catchment being almost equally divided between residential uses and commercial / industrial development.

The catchment is relatively flat and the northern portions are low lying. The low lying nature of the northern parts of the catchment mean that from time to time, high tides prevent the discharge of stormwater to sea by gravity and necessitate the temporary storage of food waters on land at Gillman.

Stormwater from the catchment is discharged to the North Arm and Barker Inlet, which are important marine habitats. In order to improve the quality of stormwater discharges, major wetland systems at Magazine Creek and the Range have been constructed to treat stormwater runoff prior to discharge into this system.

In recent times, a further major wetland system has been constructed within the St Clair development to mitigate peak flows from the development, and to act as a major stormwater harvesting site.

Key Issues

Much of the underground stormwater network was constructed as development of the area progressed during the middle part of last century. The main spines of this underground storm water system were subsequently upgraded during the 1980s. The result of this work has been that the existing system performs relatively well in dealing with minor and nuisance flooding. Due to the flat nature of the catchment, where flooding in major events does occur, it is relatively shallow. However, there are some areas of the catchment, particularly in Rosewater and Ottoway where much deeper flooding can occur in these more extreme events.

The key issues for management of stormwater from the catchment arise from a combination of:

- Infill development potentially resulting in an increase in runoff;
- The established drainage network not having sufficient capacity to cater for these increased flows and the significant cost that would be involved in upgrading this network;

- The potential for increased runoff to reduce the effectiveness of the existing wetland systems at the catchment outlet;
- The low lying nature of land at the catchment outlet and the need to maintain capacity to cater for these increased flows during high tides; and
- The impact of sea level rise on the catchment outlet.

Proposed Strategies

The Plan outlines a number of potential strategies for dealing with the above issues. These strategies include:

- Ensuring that development within the catchment includes the provision of on-site measures to reduce the 1 in 5 year peak flow and volume to pre-development levels. As a part of this strategy, it is proposed that a set of tools be developed to assist planners, developers and their consultants in consistently determining pre-development flows and assessing detention and retention requirements.

  The objective of this strategy is to preserve the design capacity of the existing underground drainage network by reducing peak flows. The proposed reduction in flow volumes (using on site retention) aims to preserve the standard of the existing flood storage at Gillman and to maintain the current effectiveness of wetland systems at Magazine Creek and the Range.

- Implementing flow monitoring on the main catchment outfalls in conjunction with rainfall monitoring.

  The purpose of this strategy is to assess the effectiveness of the proposed development controls described above.

- Implementing a water quality monitoring program to assess the performance of the Magazine Creek and Range wetland systems.

  The purpose of this strategy is to determine whether further modifications to these systems are required to improve their performance.

- Ensuring proposed development at Gillman is undertaken in a manner that maintain the existing flood storage function of this area and caters for sea level rise;
- Investigation and targeted upgrades of the drainage outfalls serving the Rosewater and Ottoway areas.

  Floodplain mapping has shown that the depth of flooding in these areas in a 1 in 100 year event is significant. Investigation is required to establish the feasibility (and cost / benefit) of undertaking works to improve the standard of flood protection.

- Provision of strategically located detentions in Fawk Reserve and possibly in the Eastern Parade reserve to assist in addressing local flooding.
- Provision of additional gross pollutant traps on branches of the main drains discharging to Magazine Creek.

  The benefit associated with construction of these traps will be a greater capture of gross pollutants, minimising future maintenance of the Magazine Creek wetlands and the export of materials potentially dangerous to marine animals into the North Arm.

- Managing stormwater quality from paved surfaces in new commercial and industrial developments to treat ruoff to remove sediment, oils and litter.
- Adopting the principles of water sensitive urban design in public infrastructure works to infiltrate and utilise stormwater and to treat runoff from paved surfaces.

Depending on the effect of the proposed on-site flow detention measures to manage flows from re-development, works to divert additional flows into Cheltenham and to construct new truck drainage in the catchment draining to Torrens Road could be undertaken.

Priorities and Timeframes

Priorities have been established for various elements of the strategy, taking into consideration the likely impact of these strategies and the benefits to be gained by their implementation.

The actions have been divided into those that should be undertaken in the short, medium and longer term.

Within the next two years it is proposed that the various monitoring activities be initiated, that planning processes within both Councils be implemented to ensure that new development is meeting the requirements for flows and volume reduction and that tools be developed to assist in this regard.

Within two to five years, investigation and planning for the proposed new outfalls and detention basins is to be undertaken, with a view that these works be progressively constructed over the next ten years, together with the proposed additional gross pollutant traps.

Costs

Budget cost allowances for various elements of the proposed strategy have been determined.

Establishment of the proposed flow, rainfall and water quality monitoring stations is expected to cost in the vicinity of $100,000.

The anticipated cost of flood infrastructure works in the catchment over the next ten years is of the order of $ 11.6 million, with an additional expenditure of $1.1 million on construction of gross pollutant traps.

Details of the breakdown of costs for the various elements of the strategy is provided in Sections 8 and 9 of this report together with proposed funding partners and cost sharing arrangements.

1 Introduction

This Stormwater Management Plan (SMP) for the Torrens Road catchment has been prepared in accordance with the requirements of the *Guideline Framework for Uniform Catchment Based Stormwater Management Planning prepared by Local Government* dated August 2006.

The Plan provides a description of the existing catchment and issues relating to current stormwater management. It also provides an overview of opportunities to improve stormwater management within the catchment to address flood protection, reduce pollution impacts, use stormwater and enhance the environment and ecosystems affected by stormwater inputs.

The strategies set out in this Plan are proposed as a means of ensuring that the above goals are achieved in an integrated and coordinated manner.

This document contains:

- A summary of existing information relevant to management of stormwater in the catchment;
- Catchment specific objectives for management of stormwater runoff from the catchment;
- Potential management strategies that may be used to meet the identified management objectives;
- Estimated costs and benefits associated with each of the strategies
- A clear definition of the priorities, responsibilities and timeframe for implementation of the Stormwater Management Plan.

The Torrens Road Catchment Stormwater Management Plan has been developed in association with a comprehensive land development potential study prepared by Jensen Planning & Design. In addition to the Cities of Charles Sturt and Port Adelaide Enfield, the plan has been prepared in consultation with the local community, business groups and relevant State Government departments and agencies including the Adelaide & Mt Lofty Ranges NRM Board and Renewal SA (formerly the Land Management Corporation).

2 Existing Catchment Features

2.1 Catchment Boundary

The outer boundary of the Torrens Road catchment was determined from a number of sources as follows:

- Catchment boundary information produced as part of the TRDA Catchment Hydrological Study (Tonkin, 1976);
- Road grading plans supplied by the City of Charles Sturt; and
- Catchment boundary information for adjoining catchments (which have a common boundary) sourced from Tonkin Consulting records.

Data from these various sources were combined and reviewed to develop an outer boundary for the catchment.

The catchment boundary is shown in Figure 2.1. The catchment has an area of 2322 ha. Approximately 550 ha of this area is undeveloped and lies within stormwater detention basins and wetlands at the downstream (northern) end of the catchment.

The catchment has been subdivided into sub catchments (draining to each individual drainage inlet) based on the available road grading information, drainage layout information and site inspections. These sub catchments are also shown in Figure 2.1.

2.2 Existing Infrastructure

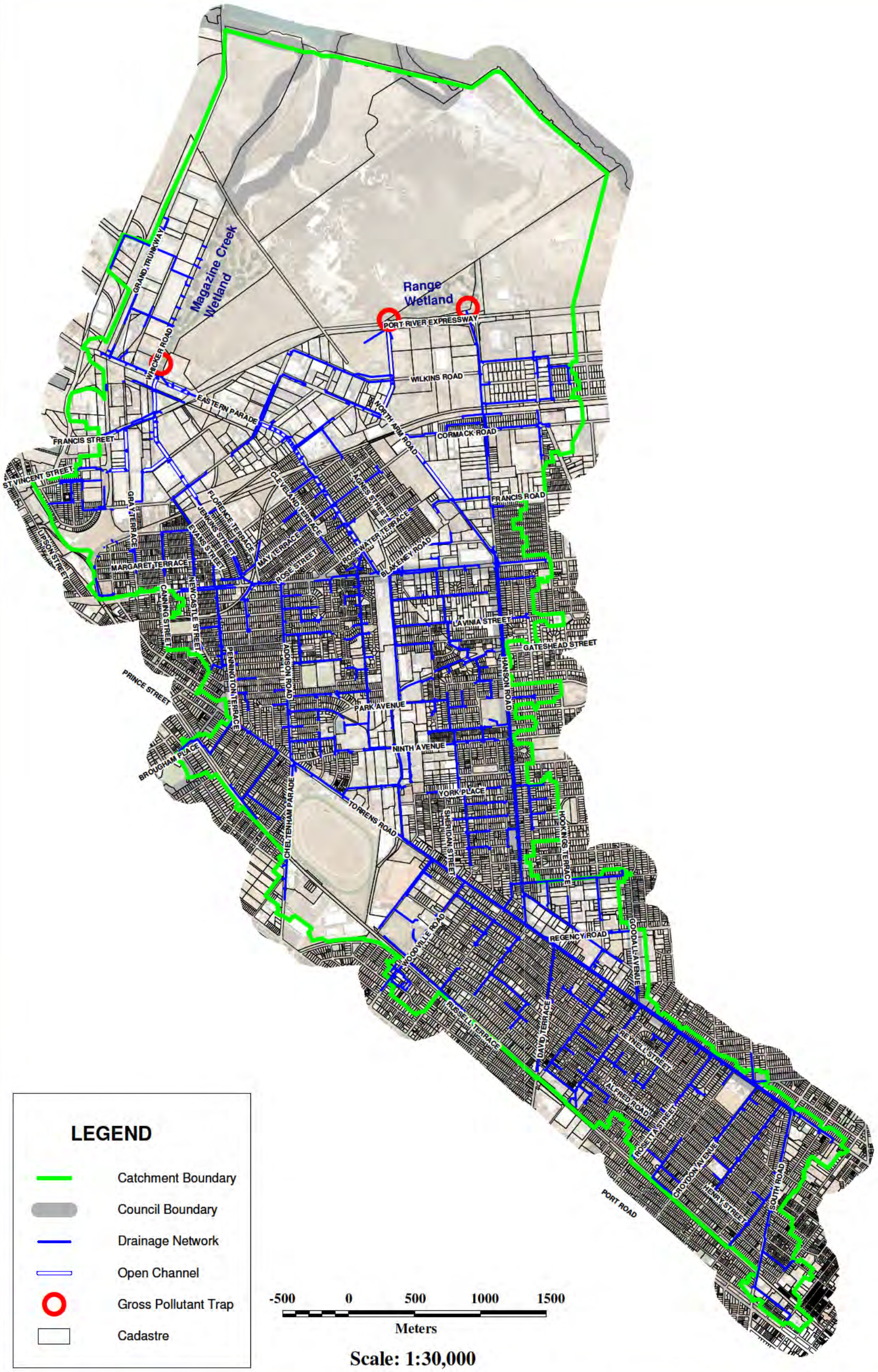
Drainage within the catchment is provided by a system that is predominantly comprised of underground drains. This drainage network feeds into a number of man-made open channel outfalls including the:

- Jenkins Street / Bedford Street Drain
- Eastern Parade Drain
- North Arm Road Drain
- Hanson Road Drain

The Bedford Street Drain and the Eastern Parade Drain discharge into the Magazine Creek Wetland, while the North Arm and Hanson Road Drains discharge into the Range Wetland. The wetlands provide an important function in improving the quality of stormwater discharged to the Barker Inlet and North Arm Creek. Gross pollutant traps are provided at the inlet to each wetland.

To the north of the wetlands, a substantial area of low lying land is used for temporary storage of stormwater runoff during periods of high tide in the North Arm. A set of flap gates control the flow of storm water out of this area and prevent backflow of seawater into the area. Much of this area has been identified as 'existing key industry land' within the 30-year Plan for Greater Adelaide.

The existing infrastructure is shown in Figure 2.1.



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City of Charles Sturt and City of Port Adelaide Enfield

TRDA CATCHMENT AND DRAINAGE NETWORK

Figure 2.1

2.3 Existing Land Use

The existing land use is shown in Figure 2.2 and was derived by analysis of Planning SA GIS land use data and aerial photography.

Land use within the catchment is mixed, with residential development forming the most predominant use. Most of the residential development is located to the south of the Port Adelaide – Cavan railway line.

The industrial areas are concentrated mostly toward the northern end of the catchment within the suburbs of Port Adelaide, Gillman and Wingfield. However, a pocket of industrial development is also located in the area around the Cheltenham racecourse. Parts of this former industrial area are being converted to housing as part of the St Clair Development.

Commercial development is spread throughout the catchment but there are concentrated pockets in the suburbs of Port Adelaide, Gillman and Wingfield, at Athol Park and around the Arndale Shopping Centre near the intersection of Hanson Road and Regency Road.

Table 2.1 provides a breakdown of land use within the catchment.

Table 2.1 Land Use Breakdown

Land Use Category	Proportion of Total Catchment Area
Residential	29%
Commercial	10%
Industrial	17%
Recreation / Open Space	9%
Vacant Land	17%
Institutions	3%
Other (inc Road Reserves)	15%

There is a substantial area of 'Vacant Land' within the catchment. Most of this land (415 ha) lies in the northern portion of the catchment and is currently used for stormwater detention purposes. A portion of this land is to be developed as an industrial precinct.

The remaining vacant land within the catchment is mostly zoned for industrial land use.

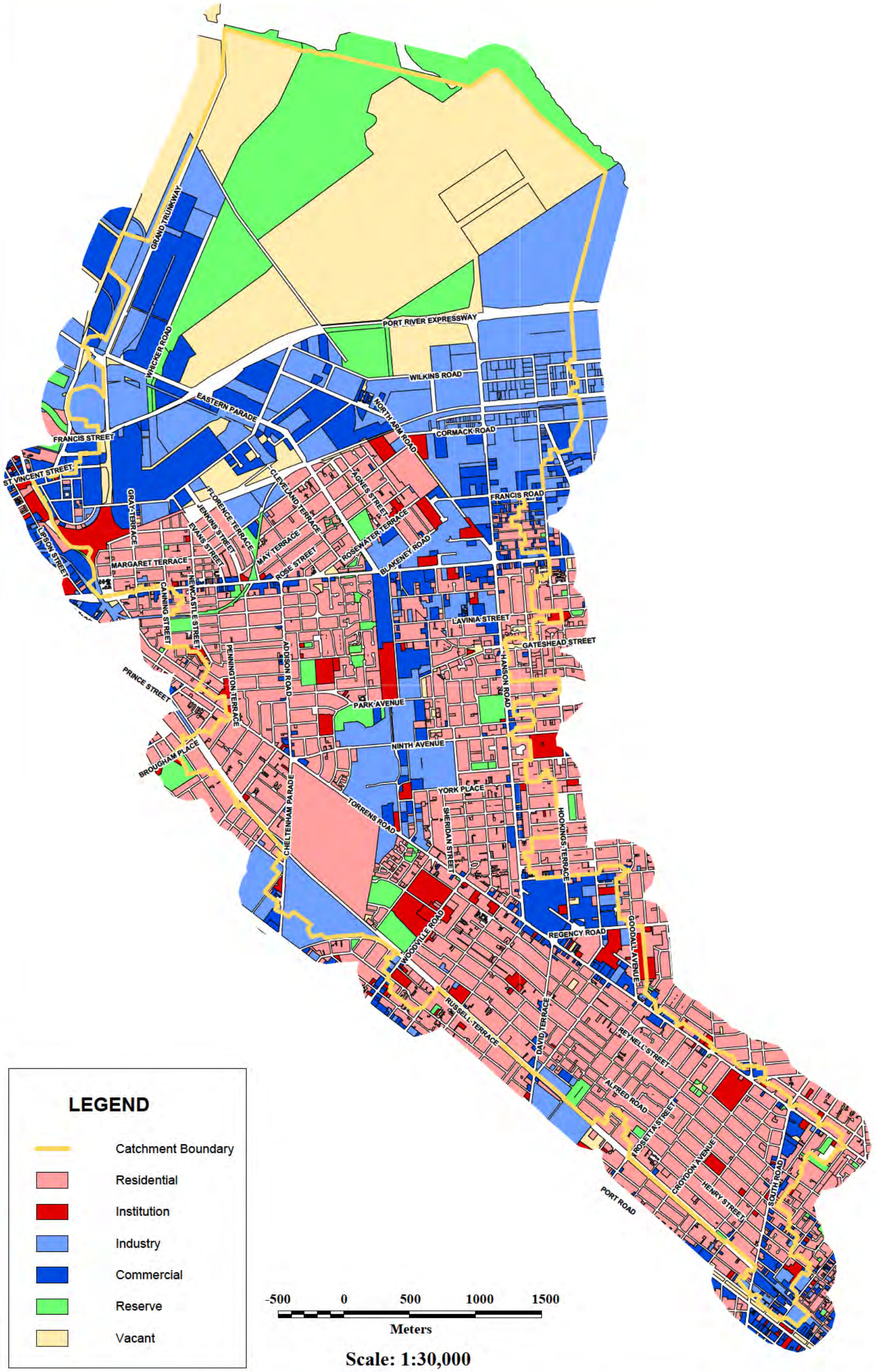
2.4 Soils

The distribution of soils across the catchment was derived from information contained in Bulletin 46 (Dept Mines, 1974) and is shown in Figure 2.3.

The catchment is underlain by two predominant soil types, these being:

- Red Brown Earth (RB6 – RB7)
- Estuarine Muds and Sands (EMS)

The Red Brown Earth (RB6 – RB7) soils are characterised by a brown sandy topsoil overlying red brown sandy clay of indefinite thickness. This soil type generally has a low potential for



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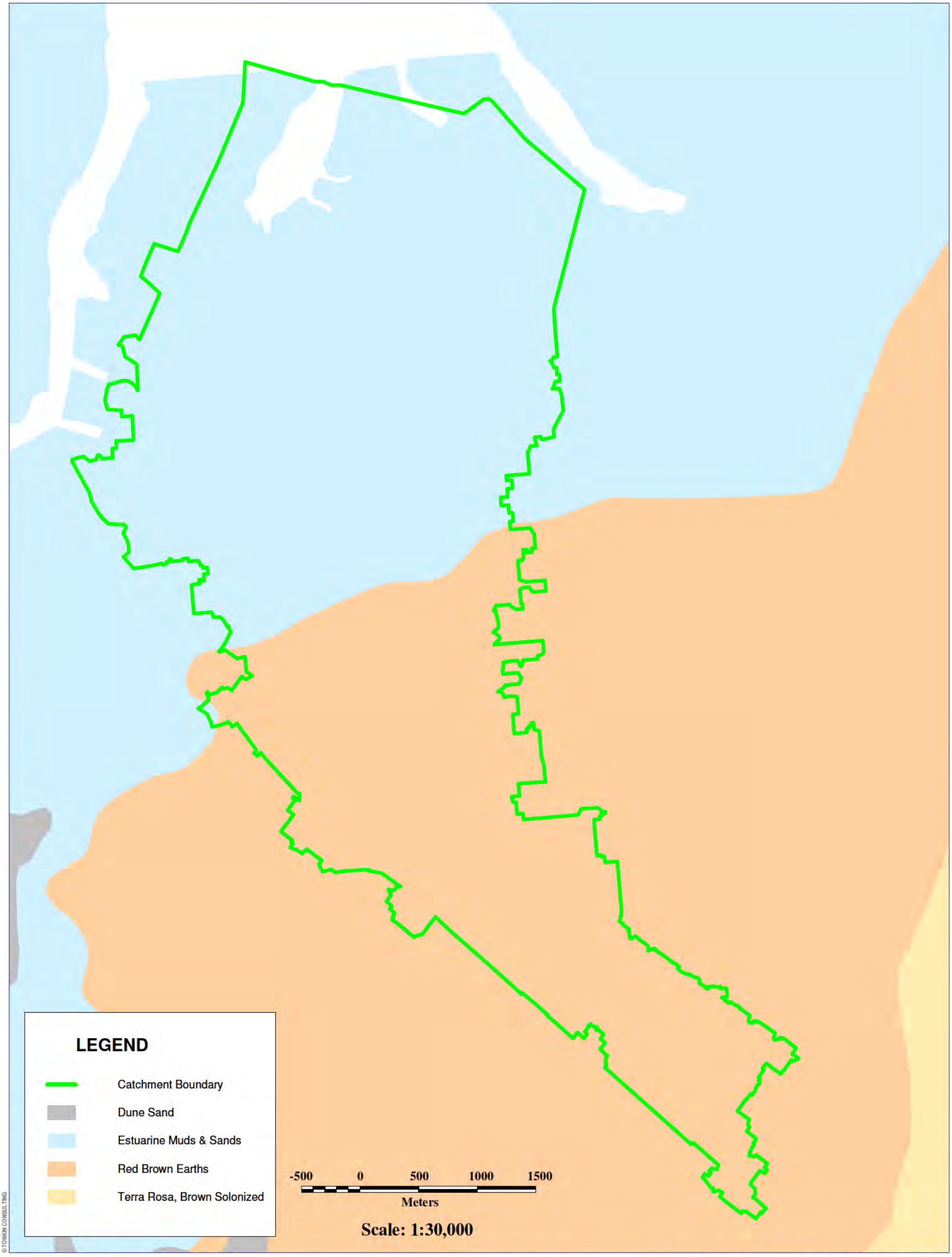
EXISTING LAND USE REGIONS

Figure 2.2



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SOIL TYPES

Figure 2.3

shrinkage or swelling movement in response to changes in soil moisture. Internal drainage of the soil profile is moderate to high.

The Estuarine Muds and Sands are grey, dark grey or mottled silt and sand deposits that contain some accumulations of organic material. They are generally not subject to shrinkage or swelling movements in response to wetting and drying. Drainage through the soil profile is generally relatively rapid.

Both soil profiles found in the catchment would be suitable, under the right conditions, for installation of devices for the disposal of stormwater by infiltration. This is due to their relatively low potential for movement as a result of changes in moisture content and their good internal drainage characteristics.

2.4.1 Acid Sulphate Soils

There is a medium to high likelihood of acid sulphate soils (ASS) in the section of Estuarine Muds and Sands as shown in Figure 2.3. ASS is unlikely to be encountered throughout the remainder of the catchment.

These soils have the potential to detrimentally impact stormwater assets such as concrete pipes, culverts and pits. New infrastructure in this area would need to be designed to protect it from ASS while existing assets would need regular inspections to ensure they are functional.

When disturbed, Acid Sulphate Soils (ASS) have potential to release acidity and toxic contaminants to waterways which can cause damage to stormwater infrastructure and the environment. Erosion of bottom sediments containing monosulfidic material (MBO) during high stormwater flows can deoxygenate waterways and mobilise contaminants. Prolonged exposure of potential ASS to air may also cause irreversible loss of soil physical properties, further impacting stormwater assets.

2.5 Groundwater

An assessment of groundwater characteristics in the region has been undertaken by Australian Groundwater Technologies (AGT) to determine the viability of large scale Aquifer Storage and Recovery (ASR) schemes in the Torrens Road Catchment. A summary of the findings of the investigation, based on a desktop evaluation of available information, is provided below. A copy of their report is contained in Appendix B.

2.5.1 Hydrogeological Assessment

There are shallow aquifers occurring at depths ranging from 5 m to 80 m across the catchment. They vary greatly in thickness, lithology and permeability and have a high salinity and low yields. As a result, they are not considered suitable for large scale ASR schemes. Small scale community developments could access the Quaternary system for on-site retention either using a bore for recovering the water, or simply recharging the aquifer with a soakage system.

The deep aquifer systems beneath the Study Area comprise the Tertiary aquifers of the Port Willunga Formation. These aquifers include the T1 and T2 aquifers which are extensive and well developed in general. They are the preferred target for large scale ASR schemes due to:

- High aquifer transmissivity and well yields; and
- High storage capacity.

The T1 aquifer comprises two sub-aquifers, T1A and T1B. The T1A aquifer is generally considered unsuitable for ASR due to its unconsolidated nature. The more consolidated T1B aquifer has better potential for ASR

Injection rates in the T1B aquifer typically lie in the range between 8-10 L/s. Injection rates for the T2 aquifer are higher, typically in the range between 10 to 15 L/s.

For large scale ASR schemes, where large volumes of water are available to harvest, the T2 aquifer is normally preferred due to its greater thickness, transmissivity and well yields and its greater storage capacity.

One of the constraints of completing an ASR well in the T2 aquifer is the potential presence of sand layers at depth within the lower Port Willunga Limestone. Where sand is encountered, significant airlift development may be required to adequately develop the well. This could prolong well completion and increase the cost although this is compensated by the higher yield.

The T1 and T2 aquifers are separated by a low permeability layer of Hindmarsh Clay which provides an effective hydraulic separation between the aquifers. There is therefore the potential to utilise the T2 and T1B aquifers concurrently to provide additional storage capacity.

2.5.2 Existing Groundwater Users

There are several major industrial groundwater users in the vicinity of the Torrens Road Catchment including Penrice Soda to the north east (T1), Penrice Osborne to the northwest (T1 and T2) and Coopers Brewery to the east. Currently no abstraction data is available in the public domain for surrounding industrial users with the exception of a period between 1982 and 1984. Although this data is in excess of 20 years old, the relative volume of extraction provides an indication of the location of the main groundwater users. For example, abstractions of 546 ML/year and 940 ML/year were recorded at Penrice Osborne and Penrice Soda respectively. More recently, a 300 to 400 ML/year abstraction was reported for the Coopers Brewery site.

2.5.3 Potential ASR Sites

The properties of the aquifers underlying catchment are such that they do not limit the potential siting of an ASR scheme within the area. The availability of land for storage and treatment of water prior to injection in addition to the proximity to storm water drains will play a more significant role in this regard.

From a groundwater management perspective and potential demand for low salinity injected water, there would be benefit in locating any major ASR sites in the catchment near the existing large industrial users.

3 Previous Investigations

There have been a number of investigations associated with management of stormwater runoff from the TRDA catchment. These investigations date back to the 1970s and are described below:

TRDA Catchment Drainage Investigation (1976)

This investigation was carried out by BC Tonkin & Associates (now Tonkin Consulting) and involved the development of a detailed hydrological model of the catchment to determine the capacity and standard of existing drainage systems in the area and to identify potential flooding locations.

The modelling showed that the design capacity of existing drainage systems in the catchment was relatively low and that significant upgrading work would be required to achieve an adequate capacity sufficient to cater for the existing level of development. Various options for upgrading the system were examined and recommendations were made for the construction of new trunk drains and outfalls from the area.

The proposed works were subsequently constructed by the Torrens Road Drainage Authority (which comprised the Cities of Port Adelaide, Hindmarsh, Woodville and Enfield). The Torrens Road Drainage Authority ceased to exist following completion of the works.

Report on the Capacity Requirements of Ponding Basins to Serve the TRDA Catchments (1981)

This investigation was carried out by BC Tonkin and Associates (now Tonkin Consulting) and involved an assessment of the available capacity for ponding stormwater within the area north of Eastern Parade. The area is low lying and as a result, the investigation involved a detailed consideration of the interaction of stormwater flood flows and tide levels to determine the probability of various peak flood water levels in the basin.

Magazine Creek and Range Wetland Technical Feasibility Study (1994)

This investigation was carried out by Eco Management Services and involved investigation of the technical feasibility of constructing the Magazine Creek and Range Wetlands.

The investigation involved assessment of the likely performance of these systems in water quality improvement, the hydraulic and ecological requirements for their design.

The report formed the basis for the detailed design of these wetland systems.

Magazine Creek and Range Wetland Design Report (1995)

This report contains a summary of design information relevant to the Magazine Creek and Range wetlands. These wetlands were constructed in 1998.

Land Management Corporation Stormwater Detention Study (1998)

This investigation was carried out for the Land Management Corporation (now Renewal SA) and considered the land area requirements for stormwater detention in the region north of Eastern Parade. In particular, the potential to develop land currently used for stormwater detention was assessed.

The investigation identified the minimum land area that should be reserved for stormwater detention and the storage volume requirements within that area. The assessment included an

allowance for the effect of greenhouse on sea levels. In order to achieve the required flood storage within this area, some excavation would be required.

Cheltenham Racecourse Wetland Investigation (2000)

This investigation was carried out by PPK Pty Ltd and involved the development of a concept plan for construction of a system of wetlands for water quality improvement and water harvesting with the Cheltenham Racecourse. The proposed scheme involves diversion of flows from the adjacent Port Road Drain catchment into the wetland and discharge of treated flows at a restricted rate into the Cheltenham Parade drain. Further studies by URS showed this scheme to be neither practical nor economical.

Gray Terrace Catchment Drainage Investigation (2001)

This investigation involved an assessment of the requirements for upgrading drainage in the Gray Terrace catchment at Rosewater. Design of the drainage works recommended in the Study is ongoing.

Port Adelaide Seawater and Stormwater Flooding Study (2006)

Tonkin Consulting and WBM Oceanics undertook an investigation of the likely extent of flooding that would be produced by high tides in combination with stormwater flows. The catchments considered in the investigation were located along the LeFevre Peninsula and also included those areas draining to the Magazine Creek, Range and Barker Inlet wetlands. The investigation considered the impacts of sea level rise and also the likelihood of storm flows occurring coincidentally with high tide.

Maps showing likely areas of inundation under various sea level rise scenarios were produced as part of the Study.

Stormwater Harvesting at Cheltenham Racecourse Development Site (2009)

This investigation was carried out by Wallbridge & Gilbert in association with Designflow. The investigation considered various options for harvesting stormwater at the Cheltenham site. The Study recommended that excess low flows be diverted from the River Torrens into the Torrens Road drain and that flows from this drain be directed into a wetland and ASR scheme within the site. This proposal is being implemented as part of the 'Waterproofing the West' project in conjunction with the St Clair development.

Gillman Development Structure Plan (2009)

This Study considered the vacant industrial land at Gillman north of the Port River Expressway. The investigation identified a range of issues and potential management options to facilitate development of the land. Part of the assessment included a consideration of stormwater management and the need to ensure adequate flood storage was retained in the area to protect existing low lying development in the upstream catchment from flooding.

A Structure Plan for the site was produced that took into consideration the existing site constraints and suggested a proposed staging for development.

St Clair Development Stormwater Management Strategy (2010)

This investigation was carried out by AECOM and involved the development of a Master Drainage Strategy for the St Clair development.

Gillman Master Plan (2013)This Study was undertaken for Renewal SA and provided a MasterPlan for the Gillman site. As a part of the investigations, the impact of development encroaching into the existing flood storage areas was modelled and the extent of proposed development was set to ensure that the existing level of flood protection to upstream development was maintained, allowing for development of the upstream catchment and sea level rise.

4 Development Potential

Assessment of the likely extent and nature of future development (redevelopment) within the catchment was undertaken using data gained from a number of sources as follows:

- Liaison with the City of Charles Sturt and Port Adelaide Enfield to identify significant policy changes that may influence future development potential;
- Liaison with Housing SA regarding future proposals for regeneration of their housing stock;
- Liaison with the Department of Planning Transport and Infrastructure to identify changes in transport infrastructure which may affect future development;
- Liaison with proponents of the St Clair and Westwood developments;
- Liaison with the Department of Planning and Local Government in relation to the 30 year Plan for Greater Adelaide;
- Liaison with Renewal SA in relation to land at Gillman and elsewhere in the catchment;
- Review of the Development Potential report for the catchment (Jensen Planning and Design, June 2009). This report is included in Appendix A.
- Review of relevant documents including the Residential Metropolitan Development Program , Gillman Structure Plan, Gillman Master Plan, Cheltenham and Environs Master Plan, Industrial Land Study and the City of Charles Sturt Open Space Strategy; and
- Review of site value – capital value data and ABS data to determine historical development trends and the likelihood of future development.

Details of the investigations are contained in the accompanying report on Planning and Development Issues prepared by Jensen Planning and Urban Design provided in Appendix A. The key findings of the investigations relating to the analysis of development potential are set out below.

4.1 Historical Development Trends

Census data was used to provide estimates of the changes in number of dwellings within the City of Charles Sturt over the period 1996 – 2006. Details of the analysis are contained in Appendix A. In summary, the analysis has indicated that over the 10 year period, a 4% increase in number of dwellings has occurred. This increase has occurred mainly as separate houses and units rather than semi-detached or attached dwellings.

The analysis of historical development within the Port Adelaide Enfield area was not undertaken as a part of this investigation, as only a small portion of the Council area comprises residential development within the Torrens Road catchment. It is expected that a similar development trend would have been experienced within this area.

4.2 Prediction of Development Trends using Site Value Data Analysis

As part of the Initial Catchment Management Plan for the Torrens Road catchment, an analysis of site value and capital value data was undertaken to identify those allotments having the potential to be subdivided. As a part of the analysis, the concept of the ratio between capital value and site (land) value was proposed as an indicator of the likelihood of allotments being redeveloped. Those allotments having a capital value close to the site value were considered to be more attractive to developers and therefore more likely to be redeveloped.

As a part of the preparation of this Plan, the outputs of the previous analysis were reviewed and used to determine the likely location and extent of residential redevelopment in the catchment based on the capital value to site value ratio. In undertaking the analysis, two planning horizons were considered, these being:

- A 'short term' horizon of 10 years, and
- A 'longer term' horizon of 30 years.

Various ratios of capital value to site value were used to determine the location of allotments likely to be redeveloped within particular time frames. Based on the analysis, it was assessed that a capital to site value ratio of 1.2 would provide for a 4 to 5% increase in number of dwellings (corresponding to the 10 year planning horizon), while a value of 1.6 would produce an increase in number of residences corresponding to a 30 year time horizon.

4.3 SA Housing Trust

The SA Housing Trust owns scattered pockets of housing throughout the catchment. These include:

- Double units (all north of Torrens Road) within the suburbs of Pennington, Woodville North, Athol Park, Woodville Gardens and Mansfield Park;
- Attached houses scattered throughout the catchment, and
- Some flats and single units.

Redevelopment of Westwood (which involves redevelopment of double units in Athol Park and Mansfield Park) is ongoing and nearing completion. Management of stormwater from this re-development area was considered with the City of Port Adelaide Enfield and City of Charles Sturt.

There have been some investigations of the potential for redevelopment of parts of Pennington. However, this area is now located in a Residential Character Zone and is unlikely to be developed to a higher density..

There are no current plans for redevelopment of the remaining SA Housing Trust stock in the catchment in the short term. However, in the longer term it is likely that some of the sites will be redeveloped due to deterioration of the housing.

4.4 Renewal SA

Renewal SA and the Adelaide City Council owned approximately 550 ha of future industrial land at Gillman and Dry Creek zoned 'MFP' and 'Industry'. Parts of this land are being considered for industrial development. Development of this land is likely to occur over a period of 15 to 20 years and will occur in stages. Some of the land is currently used for storm water and tidal management.

A Master Plan for the development of this land has been prepared by Renewal SA (Jensen Planning, 2013). A part of the preparation of this Master Plan included consideration of the manner in which the current stormwater management function of the land was to be maintained, including a consideration of the impact of sea level rise.

The land has now been sold to a private developer. Further planning work for development of the land is being undertaken. There is a need to ensure that the final development of the site maintains its current stormwater and flood management function. . This is further discussed in Section 5.5.5 of this Plan.

In the longer term Renewal SA also considers that land on the northern side of Torrens Road at Woodville North could be converted to a residential area. However, this would require a change to its current zoning.

4.5 Cheltenham Racecourse and Former Sheridan Site

The former Sheridan site and the Cheltenham Racecourse are currently being developed for residential purposes. It is expected that completion of this development will occur over a period of 8 to 10 years from commencement.

4.6 Development along Transport Infrastructure

The 30 year Plan for Metropolitan Adelaide has identified a desire to increase development within an 800 metre distance of main roads (public transport). Taking this into consideration, an increase in dwelling density is envisaged along Port Road and Torrens Road over the long term.

In addition, Transit Oriented Developments (TODs) involving higher density development is envisaged within 400 m of transport nodes. Potential locations for this may include Kilkenny Railway Station and Woodville Railway station.

4.7 Impact on Runoff

Using the above assessment of development potential, an analysis of existing directly connected impervious area within the catchment and changes in impervious area likely to be brought about under the two development scenarios was undertaken. For the types of storm event which are of relevance to the design of street drainage systems, changes in directly connected impervious area will provide a close correlation with changes in peak flow.

Figure 4.1shows the existing directly connected impervious area for various sub-catchments within the Torrens Road Catchment based on an assessment of existing land use.

The impact of redevelopment as described above was determined by assessing the likely changes in impervious area within each sub catchment due to:

- Subdivision and redevelopment of residential allotments.
- Demolition of existing houses on single allotments and replacement with new residences.
- Extension and upgrading of existing residences

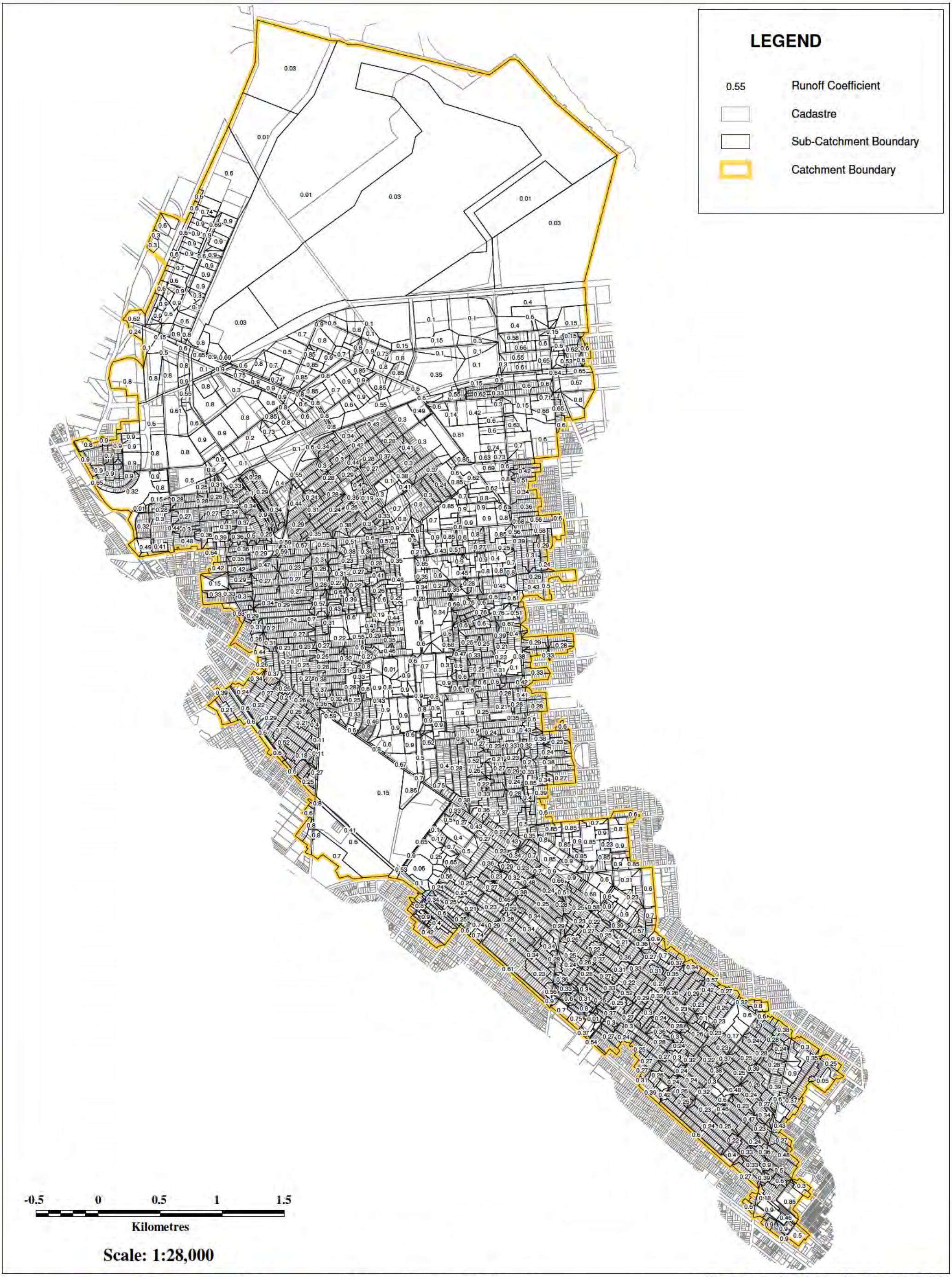
The change in directly connected impervious area within each sub catchment was determined and the results are presented in Figure 4.2 and Figure 4.3. Figure 4.2 shows the likely increase over a short term planning horizon (estimated to be 10 years). Figure 4.3 shows the likely increase over a longer term planning horizon (estimated to be 30 years).

As peak flow is closely correlated with impervious area in an urban catchment, the Figures provide an indication of the likely increases in flow brought about by uncontrolled redevelopment in various areas of the catchment.

Apart from the major residential development areas such as Cheltenham noted above, the plans indicate a relatively widespread increase in runoff.

In addition to the increase in runoff from residential areas, development of vacant land within industrial areas of the catchment is also expected to impact runoff. The existing vacant industrial land is predominantly located near the downstream end of the North Arm and Hanson Road Drains and within the TRDA basin area. Careful management of runoff from

industrial development within these areas will be required to ensure that there is no adverse impact on downstream systems.



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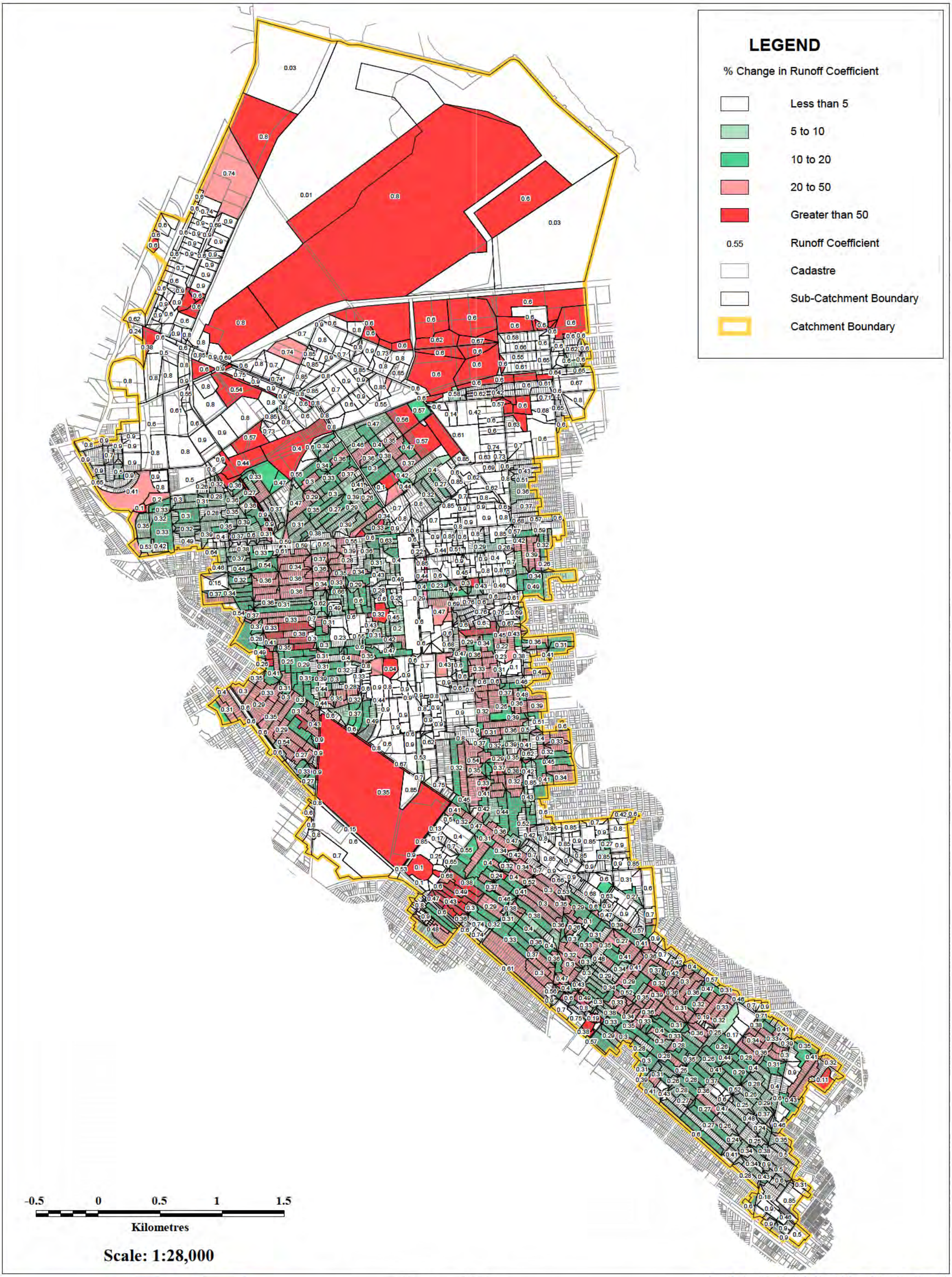
City of Charles Sturt & City of Port Adelaide Enfield

TORRENS ROAD STORMWATER MANAGEMENT PLAN
EXISTING RUNNOFF COEFFICIENTS

Figure 4.1



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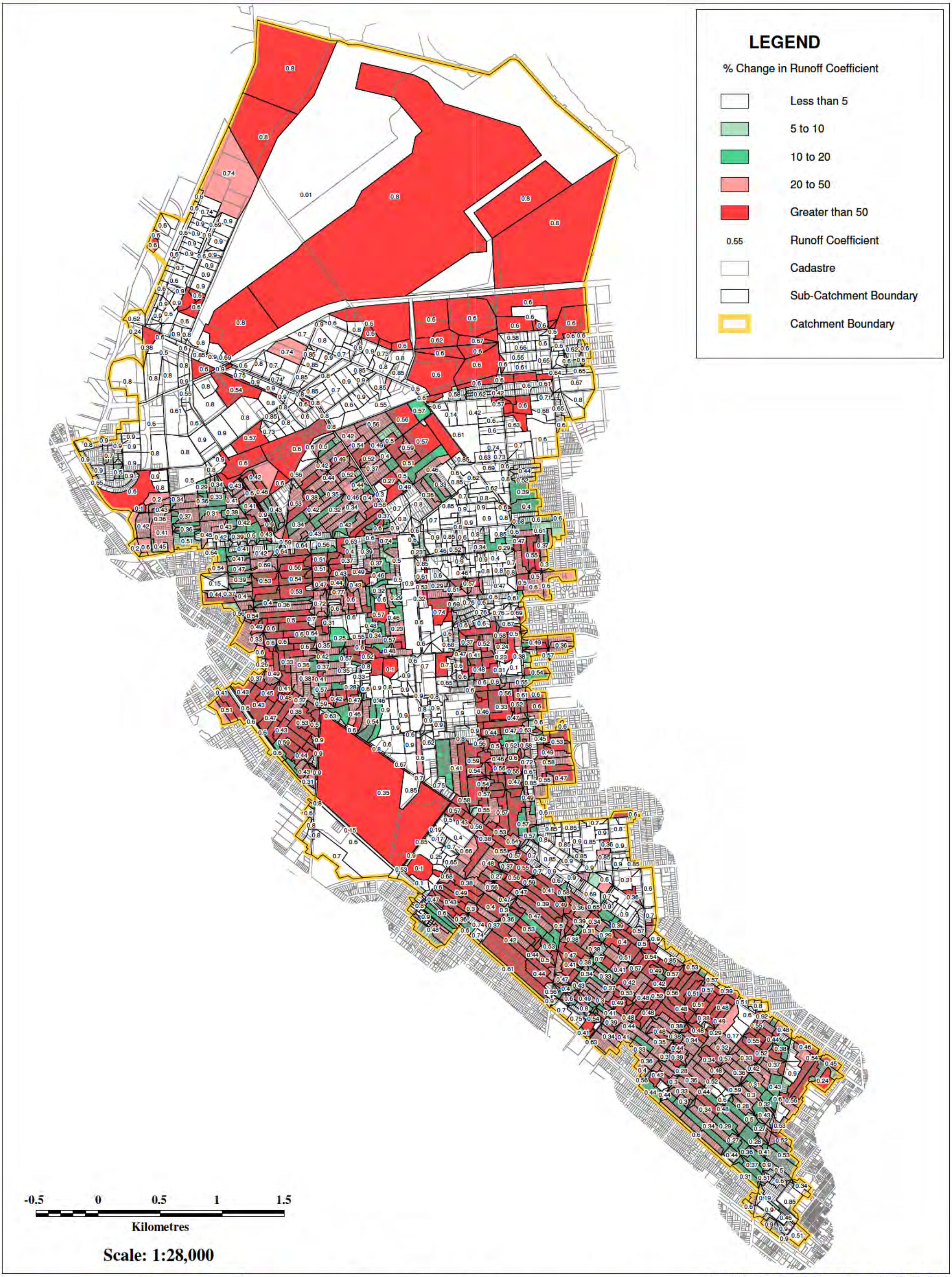
TORRENS ROAD STORMWATER MANAGEMENT PLAN
RUNNOFF COEFFICIENT INCREASE (10 YEAR TIME HORIZON)

Figure 4.2



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TORRENS ROAD STORMWATER MANAGEMENT PLAN
RUNNOFF COEFFICIENT INCREASE (30 YEAR TIME HORIZON)

Figure 4.3

5 Hydrological Analysis

5.1 Overview

The existing stormwater infrastructure was analysed to assess the system performance and the potential for flood inundation. The key factors that were taken into consideration when assessing the performance of the infrastructure were as follows:

- Increased generation of runoff due to development (10 and 30 year scenarios);
- Climate Change
- Performance of existing storm water infrastructure;
- Extent of 1 in 100 AEP floodplain;
- Opportunities for storm water harvesting & reuse; and
- Stormwater quality

The existing drainage performance and key issues identified are outlined in this chapter.

5.2 Climate Change Impacts on Rainfall

Numerous reports and strategies offer commentaries on climate change and its impact on rainfall. However, the common reference for predictions is work published by the CSIRO and Bureau of Meteorology in 2007 (CSIRO and BOM, 2007). There are a number of reports that assist in interpreting the results of this work for the Adelaide Region, for example the recently published Department of Environment and Natural Resources, 2010 Regional Climate Change Projections: Adelaide and Mount Lofty Ranges, South Australia.

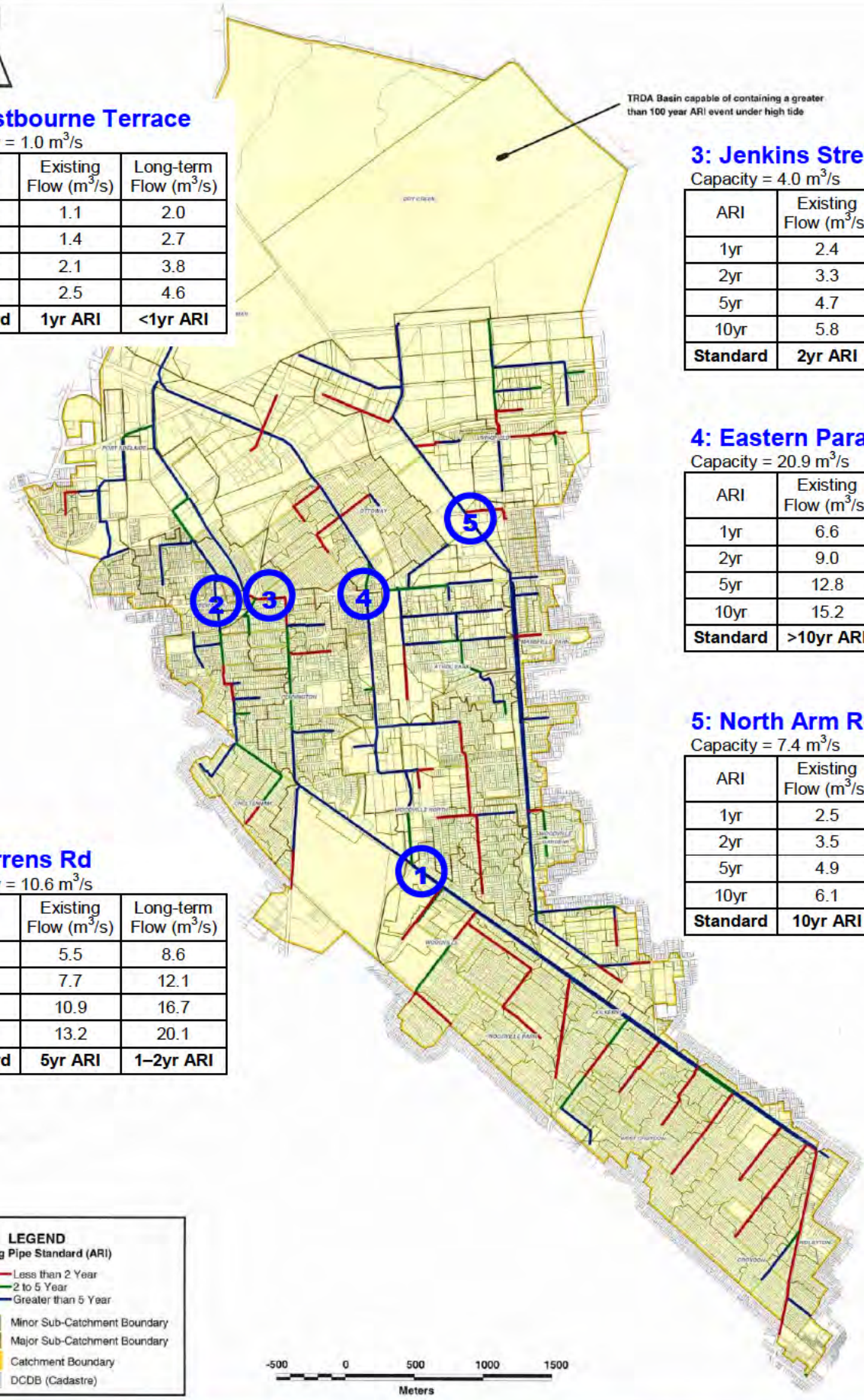
All of the climate change models are driven by an increase in carbon dioxide levels in the atmosphere and the impact that this has on warming of the global climate. There are principally two areas of uncertainty in the predictions from the models. The first stems from the uncertainty about future levels of carbon dioxide which depend on population, economic development, and adoption of alternative energy technologies. The second uncertainty relates to the scientific uncertainty because different global climate models predict different outcomes. On balance however, predictions indicate a warmer and drier future.

There is potentially an impact on rainfall intensity, and it is possible that even with an overall drier climate the incidence of high intensity rainfall may increase. Current predictions in relation to this are less certain than for other climate parameters, and indications for southern South Australia are that rainfall intensity may not significantly change or may even decrease. For this reason, the current rainfall intensity has been adopted for this study.

The impacts of sea level rise are discussed in Section 5.5.5 and Section 7.2.5 of this report.

5.3 Drainage Network Standards

The performance of the existing drainage network has been assessed by Tonkin Consulting in previous studies using ILSAX. This assessment was revisited as part of the current study, using the same model, with particular focus on the performance of the main trunk drains. The effect of development over the 30 year timeframe on the main trunk drain performance was determined and is shown Figure 5.1.



2: Eastbourne Terrace

Capacity = 1.0 m^3/s

ARI	Existing Flow (m^3/s)	Long-term Flow (m^3/s)
1yr	1.1	2.0
2yr	1.4	2.7
5yr	2.1	3.8
10yr	2.5	4.6
Standard	**1yr ARI**	**<1yr ARI**

3: Jenkins Street

Capacity = 4.0 m^3/s

ARI	Existing Flow (m^3/s)	Long-term Flow (m^3/s)
1yr	2.4	4.7
2yr	3.3	6.1
5yr	4.7	8.6
10yr	5.8	12.3
Standard	**2yr ARI**	**<1yr ARI**

4: Eastern Parade

Capacity = 20.9 m^3/s

ARI	Existing Flow (m^3/s)	Long-term Flow (m^3/s)
1yr	6.6	6.5
2yr	9.0	9.5
5yr	12.8	13.6
10yr	15.2	16.0
Standard	**>10yr ARI**	**>10yr ARI**

5: North Arm Road

Capacity = 7.4 m^3/s

ARI	Existing Flow (m^3/s)	Long-term Flow (m^3/s)
1yr	2.5	3.4
2yr	3.5	4.7
5yr	4.9	6.6
10yr	6.1	7.9
Standard	**10yr ARI**	**5–10yr ARI**

1: Torrens Rd

Capacity = 10.6 m^3/s

ARI	Existing Flow (m^3/s)	Long-term Flow (m^3/s)
1yr	5.5	8.6
2yr	7.7	12.1
5yr	10.9	16.7
10yr	13.2	20.1
Standard	**5yr ARI**	**1–2yr ARI**

LEGEND

Existing Pipe Standard (ARI)

- Less than 2 Year
- 2 to 5 Year
- Greater than 5 Year
- Minor Sub-Catchment Boundary
- Major Sub-Catchment Boundary
- Catchment Boundary
- DCDB (Cadastre)

-500 0 500 1000 1500

Meters

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TRDA DRAINAGE NETWORK STANDARDS

Figure 5.1

The standards presented in Figure 5.1 are based on an analysis that assumes all flows from the upstream catchment are able to reach each section of drain. In practice, due to limitations in the capacity of the underground network, the main drains are likely to reach their capacity less frequently than indicated. Figure 5.1 illustrates the design standard that would result for each section of drain if all upstream underground systems were to be upgraded. A clearer picture of the pattern of flooding throughout the catchment under existing conditions is provided in the floodplain maps included in Appendix C.

As can be seen in Figure 5.1, while the main Torrens Road drain (north of Cheltenham) currently has a 5 year ARI standard (if all upstream systems were to be upgraded), this can be expected to reduce to a 2 year ARI standard as development occurs over the next 30 years (if all upstream systems were to be upgraded). Upstream of Cheltenham, there is a flow splitter box in the Torrens Road Drain distributing flows between the Eastern Parade Drain and Jenkins Street Drain. The splitter box is designed such that low flows are directed down the Eastern Parade drain, with higher flows spilling into the Jenkins Street drain

While the Eastern Parade Drain has a high standard (>10 year ARI), the Eastbourne Terrace and Jenkins Street drains are much lower, both reducing to less than a 1 year ARI standard in the 30 year development scenario.

5.4 Floodplain Modelling

Floodplain mapping (using TUFLOW) of the Torrens Road catchment with the existing drainage network and existing development was undertaken as part of previous investigations carried out for the Cities of Charles Sturt and Port Adelaide Enfield. These maps are contained in Appendix C and show the likely extent of inundation under existing conditions for the 5 and 100 year ARI events.

As part of the development of this Stormwater Management Plan, floodplain mapping of the catchment with increased development (as described for the 30 year scenario) was carried out for the 100 year ARI event. These maps are also contained in Appendix C.

The maps show that under existing conditions, there will be little surface flooding within the catchment for a 5 year event. For the 100 year event, much more significant inundation will occur, in particular in the northern parts of the catchment.

With increased development, the extent of inundation in a 100 year event increases marginally. Mapping of the 5 year event with increased development was not undertaken as part of this current plan. However, previous mapping has indicated that the impact of redevelopment on the extent of flooding in a 5 year event is more significant.

5.5 Key Issues Identified

There are several areas within the Torrens Road Catchment that present issues and/or opportunities for stormwater management. These are outlined as follows:

5.5.1 Torrens Road Precinct

The Torrens Road trunk drain is fed by a number of smaller lateral drains extending to the south-west of Torrens Road. If the additional development within 800 m of road corridors, envisaged in the Greater Adelaide Plan eventuates, runoff from this catchment is expected to increase significantly. If the existing underground system serving this area is upgraded to cater for these flows, this increase in runoff is expected to reduce the performance of the existing Torrens Road drain in the 30 year time horizon. This will result in an increased incidence of surface flooding around Torrens Road and along the lateral systems feeder this drain.

Six of the lateral drains feeding into the Torrens Road drain have enlarged stubs at Torrens Road, indicating that upgrades were expected to these laterals to cater for increased runoff. These upgrades could be undertaken to reduce local surface ponding in (say) a 5 year event. However, upgrading all these laterals will increase the peak flow in the Torrens Road drain, exacerbating downstream flows.

5.5.2 Hamilton Road Precinct

There is a potential area of local flooding on Hamilton Road, Woodville North, centred around Eleventh Avenue. This is in part due to the low standard of the upstream drainage network (Owen Street, etc.), but is also the result of surface flows spilling from Hansen Road. The drain in Hansen road that serves the local catchment is under capacity and results in surface flows spilling into the Hamilton Road system.

There are two reserves in the area, Fawk Reserve (Oval) and Sparrow Reserve which present opportunities for stormwater detention.

5.5.3 Cheltenham & Rosewater

Floodplain modelling has predicted significant flooding in the Rosewater area, particularly between Newcastle Street and Eastbourne Terrace. Two trunk drains run through this area, the Jenkins Street drain which extends from the Torrens Road flow splitter box, and the Eastbourne Terrace drain. Both of these drains have a 2 year ARI or lower standard, which is predicted to reduce to less than a 1 year ARI standard in the 30 year time horizon. Flooding from the Jenkins Street drain in the Rosewater area travels via surface flow into the Eastbourne Terrace drainage system.

The current Cheltenham Racecourse redevelopment is planned to incorporate 6 ha of wetlands as part of a stormwater harvesting scheme. This scheme provides an opportunity for stormwater detention to relieve the downstream drainage networks & maintain a reasonable performance standard. This option is discussed later in this report.

5.5.4 Ottoway

Floodplain modelling has predicted significant flooding in the Ottoway area, particularly in the streets surrounding Eastern Parade south of the railway line. This is partly due to flows in Eastern Parade exceeding the capacity of the channel and railway culverts, resulting in flows spilling into the surrounding street network. The more significant cause of flooding in this area is flows from the local catchment being unable to drain into the Eastern Parade outfall under high flows, resulting in significant ponding of stormwater in low lying areas south of the railway.

There is an opportunity to increase the capacity of the Eastern Parade outfall and improve underground drainage to relieve this flooding.

5.5.5 Gillman Ponding Basins

The Magazine Creek and Range Wetlands drain into low lying land further to the north. Much of this land is below high tide levels in the North Arm. Due to the close proximity to sea level, flap gates prevent sea water incursion during high tide events, but allow stormwater to exit to the North Arm at other times. The ability of these ponding areas to cater for large storm events in combination with high tide is under pressure due to the following three factors:

- Sea level rise
- Land development

- Increased inflow volume from upstream catchment

The above factors assume that discharge from the basins to the sea is by gravity. Given the volume of stormwater generated from the catchment, and the peak flow rates, this is considered to be the most practical and cost effective method of currently operating this system.

Sea Level Rise

The current Coast Protection Board Policy Document (Coast Protection Board, 2012) requires coastal development to cater for a mean sea level rise of 0.3 m, with a further requirement that such development must be capable of being modified to provide protection from a 1 m sea level rise.

Future increases in sea level will reduce the length of time when tides permit discharges to occur from the basins during a normal tide cycle. This may eventually reach the point where the reduced outflow rate affects the performance of the basins.

Sufficient storage needs to be maintained to cater for catchment runoff during these longer periods of elevated tide.

In addition to sea level rise, some level of land subsidence can be expected in the Port Adelaide area that will further exacerbate the effects of sea level rise. More details can be found in the Port Adelaide Seawater & Stormwater Study (Tonkin Consulting 2006).

Land Development

The proposed Gillman development will partly encroach into the area currently used for ponding of stormwater.

The Gillman Area Structure Plan (Jensen Planning, 2009) and the subsequent Gillman Masterplan and Feasibility Study (Jensen Planning, 2013) considered the performance of the ponding area in the context of the proposed development.

Error! Reference source not found. provides an extract from the Masterplan showing the proposed stormwater management arrangements.

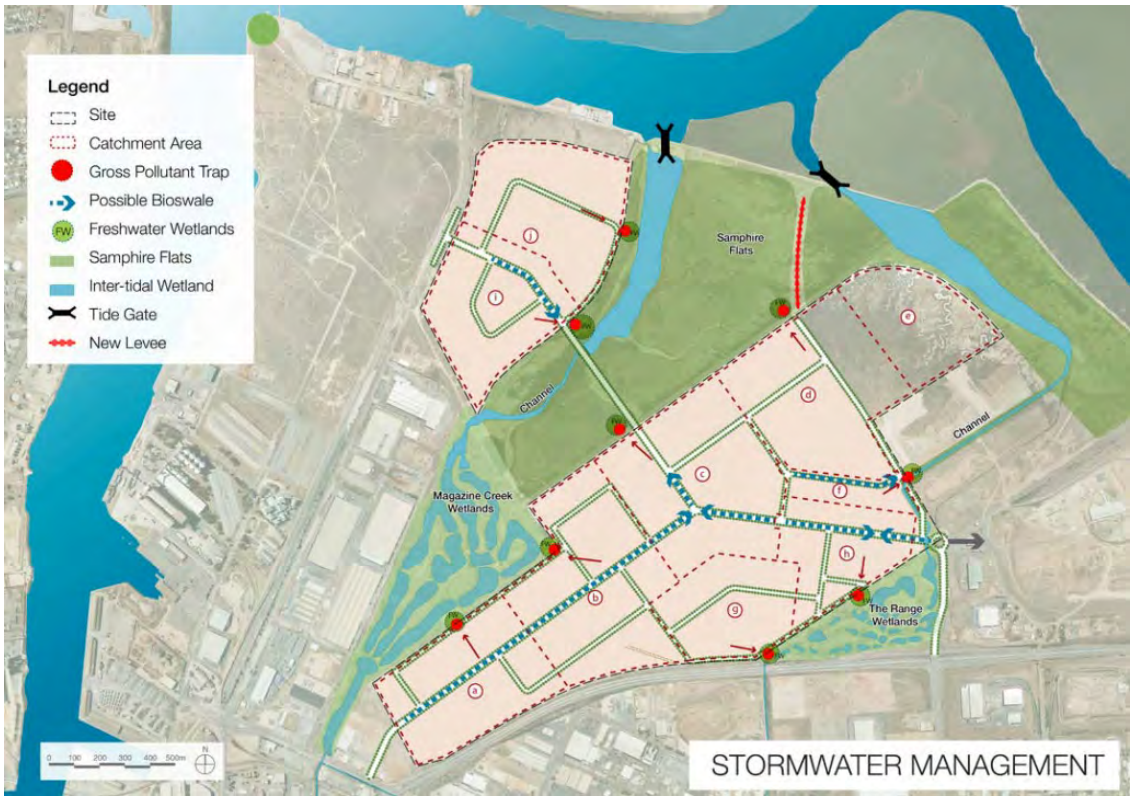


Figure 5.2 Gillman Master Plan (Jensen, 2013)

As a part of the investigations conducted for preparation of the Masterplan, the impact of the proposed development on flood storage and the interaction of stormwater flows with tide was modelled with up to 1 m sea level rise. This modelling showed that the proposed development (which included upgrade and augmentation of the existing flood gates) would maintain the same 1 in 100 year ARI flood level upstream of both the Magazine Creek and Range wetlands as would occur with the current basin configuration.

The Gillman land has now been sold to a private development consortium. It will be necessary to ensure that the final proposal for development of the site maintains the performance of the existing system, taking into account sea level rise and increased runoff from the upstream catchment.

Increased Inflow Volume from Upstream Catchment

Development within the Torrens Road Catchment will ultimately result in an increased flood volume to be treated by the wetlands and stored by the ponding basins during storm events. An increase in the flood level will result in stormwater backing up in the upstream system, reducing the performance of the drainage network. Modelling has predicted that over a 30 year time horizon, the 100 year flood level in the Magazine Creek wetland and associated ponding basin will increase by 80 mm (Ruan Consulting, 2006) as shown in Figure 5.3. The impact on the Range Wetland will be lower.

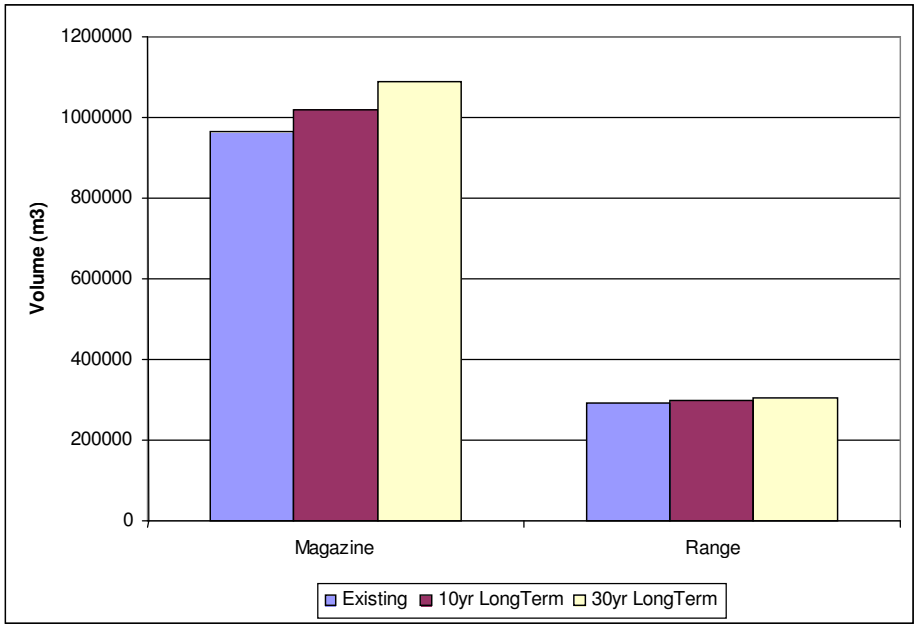


Figure 5.3 Ponding Basin Inflow Volumes (1 in 100 AEP)

The Gillman Ponding Basins and associated wetlands play a key role in managing stormwater runoff from the catchment. There is a risk that without proper planning, the capacity and function of these basins could be compromised by encroaching development and increasing flows from development of the upstream catchment.

5.6 Stormwater Harvesting

An overview of potential stormwater harvesting schemes within metropolitan Adelaide was investigated as part of the 'Urban Stormwater Harvesting Options Study' (W&G, 2009). This Study identified the opportunity to harvest stormwater at the Magazine Creek and Range wetlands (yielding approximately 610 ML/year) and also at Cheltenham.

The Magazine Creek and Range schemes have not been further investigated but it was noted that these wetland have a significant risk of shallow groundwater intrusion which would limit the viability of a reuse scheme at these sites. Careful consideration of this issue and further investigation would be required to pursue this opportunity.

The potential for recharging and reusing stormwater at Cheltenham has been investigated in more detail and is being designed as part of the Waterproofing the West Scheme. The proposal involves the construction of a wetland in the St Clair Development. Stormwater from the underground drainage system in Torrens Road will be diverted into the wetland as part of this scheme. In addition, flows will be diverted from the River Torrens into the upstream end of the Torrens Road Drain to further increase the volumes of water harvested. It is expected that the completed scheme will yield approximately 1.3GL/year.

5.7 Stormwater Quality

Runoff from the Torrens Road Drain catchment discharges into the Port River - Barker Inlet system. The importance of this system is well documented because of its extensive mangroves and seagrass communities and its role as a spawning, breeding and shelter zone for many

aquatic species. Pollutants of particular significance to this system include nutrients, heavy metals, organic compounds and litter.

Currently, all runoff from the Torrens Road Drain catchment is intercepted in the Magazine Creek and Range Wetlands prior to discharge to the Barker Inlet. These wetlands were designed to adequately treat stormwater runoff from the entire catchment to a level that will protect the downstream receiving waters. The sizing criterion for the wetlands was to provide a 10 day average detention time.

There are no natural watercourses or other natural water bodies of significance within the catchment. The protection of aquatic ecosystems other than the Port River - Barker Inlet from the adverse impacts of urban runoff is therefore not required.

While the quality of runoff from the catchment is adequately managed by the Magazine Creek and Range Wetland systems, there are some issues associated with the management and performance of the wetlands (and the quality of water discharged from the wetlands) that would benefit from implementation of further stormwater quality improvement strategies in the catchment. These issues include:

Gross Pollutant Management

It has been estimated that the catchment draining to the Magazine Creek wetland would produce approximately 360 m^3 of gross pollutants in an average year based on a generation rate of 0.4 m^3/ha/yr. The catchment draining to the Range wetland would produce approximately 150 m^3 of gross pollutants based on the same generation rate.

The only trash collection facilities within the catchment are the racks at the inlet to the wetlands. Materials that are not intercepted by the trash racks will either accumulate in the wetlands, or be transported into the downstream ponding area and possibly into the Barker Inlet.

The floating material can cause unsightly conditions immediately after a major stormwater event. Certain types of debris can also be a hazard to marine life in the Barker Inlet. Significant inputs of organic material into the wetlands could also lead to depletion of oxygen in the water column during decay of the material (although this is less likely to be an issue due to the size of the wetlands).

It is therefore desirable that inputs of gross pollutants to the wetlands be reduced.

Sediment Export

There is currently only limited facility to trap and remove coarse sediment at the inlet to each of the wetlands. Under present conditions, this material is likely to accumulate in the most upstream ponds of the system. At some point, dredging and removal of this material will be necessary.

In order to minimise the frequency of these dredging operations, good catchment management usually employs a 'treatment train' approach where sediment export is minimised at source and facilities are provided at key locations in the catchment to trap sediment where it is able to be more easily and economically removed. Export of sediment, particularly from construction sites, is likely to be a significant issue in the catchment due to the extent of development and redevelopment that has been identified.

The control of sediment export from the catchment is therefore desirable.

Pollutant Point Sources

While most pollutant sources within urban catchments are diffuse, some activities produce higher sources of pollutants. These activities may include construction and certain types of industrial and commercial land uses. The catchment contains significant areas of industrial and commercial land use and as a result, these activities are likely to have a substantial impact on water quality.

In order to reduce the impacts of these activities on the performance of the wetlands, good catchment management usually employs an approach of providing additional measures at source to capture these pollutants.

Major Transport Routes

The catchment includes a number of existing and proposed major road transport corridors. Due to the traffic volumes, runoff from these roads is likely to contain higher levels of pollutants than from other less heavily trafficked corridors. In addition, there is a higher potential for chemical spills on these roads.

Increased Flows Due to Redevelopment

Design of the Magazine Creek and Range wetlands was undertaken using estimations of runoff from the catchment based on the current level of development. Increased impervious area within the catchment will result in an increase in the quantity of runoff to be treated.

6 Stormwater Management Objectives

6.1 Stormwater Management Goals

The key issues to be addressed in the development of any plan for the management of stormwater runoff from an urban catchment include:

- Flooding
- Water Quality
- Water Use
- Environmental Protection and Enhancement

Arising from these issues, broad goals for management of urban stormwater runoff can be developed and are commonly identified as follows:

Goal 1: Flood Management

Provide and maintain an adequate degree of flood protection to existing and future development.

Goal 2: Water Quality Improvement

Improve water quality to meet the requirements for protection of the receiving environment and downstream water users.

Goal 3: Water Reuse

Maximise the economic use of stormwater runoff for beneficial purposes while ensuring sufficient water is maintained in creeks and rivers for environmental purposes.

Goal 4: Environmental Protection and Enhancement

Manage stormwater runoff in a manner that protects and enhances biodiversity and the natural environment. In association with this goal, land used for stormwater management purposes should be developed, where possible, to facilitate recreation use and to enhance amenity.

The development of a Stormwater Plan for the Torrens Road Catchment has required that these broad goals be further refined to identify catchment specific management objectives. These specific objectives have enabled targeted management strategies to be identified and assessed.

6.2 Guidelines for Urban Stormwater Management

Development of catchment specific objectives for management of runoff from the Torrens Road Drain catchment have been carried out with reference to the principles contained in the document 'Guidelines for Urban Stormwater Management' prepared by Planning SA (2002).

The catchment specific objectives that have been developed (as set out in below) are consistent with the directions for management of stormwater promoted by the guidelines.

6.3 Catchment Specific Objectives

6.3.1 Flood Management

Existing Drainage Standard

Drainage within the Torrens Road Catchment is currently provided by a system predominantly composed of underground drains. Components making up the existing drainage system can be broadly categorised into three components:

Lateral or Feeder Drains

These drains collect runoff from streets within the catchment and have the primary function of preventing nuisance flooding of roadways.

Main or Trunk Drains

These drains form the main spines of the underground drainage system and act as the discharge point for the lateral drainage systems. The main drains can carry substantial flows and have the primary purpose of preventing property damage due to concentrated flood flows.

Outfall Channels

The outfall channels collect flow from the main drains and have the primary purpose of transferring floodwaters to the catchment outlet without damage to property.

The existing standard for each of these components varies across the catchment and recommendations for upgrading the system were made in the Torrens Road Drainage Study (BCT, 1976). This investigation also provided recommendations on appropriate design standards for various components of the system as follows:

- Lateral Drains : 5 year ARI
- Main Drains : 10 year ARI
- Outfall Channels : 10 year ARI

Selection of the desirable design standard for the feeder drain system was based on commonly accepted practice. Selection of the design standard for the main drains and outfall channel was based on an assessment of the costs associated with upgrading these systems and the likely consequences of flooding if the capacity of these systems was to be exceeded.

It should be noted that due to changes in design rainfall data, changes to hydrological analysis methods and changes in the expected extent and nature of development within the catchment since 1976, current estimates of the level of protection afforded by the existing drainage system will vary from that estimated in 1976. This is demonstrated by the data shown in Figure 5.1.

As a part of this Stormwater Master Plan, it is appropriate that the existing design standards be reviewed to ensure that they are consistent with current practice and that they take account of likely changes to the nature of development within the catchment.

Currently Accepted Design Standards

Australian Rainfall and Runoff (IE Aust, 2000) provides some guidance on design standards for urban stormwater drainage. The design standard is embodied in the major-minor principle, which aims to ensure that development is protected from inundation in a 100 year ARI event. Under the major-minor principle, the drainage system is considered to be comprised of a minor

(generally underground) component that prevents nuisance flooding of roadways resulting from relatively frequent storm events, and a major component (generally along surface flow paths such as roads and reserves) that carries excess runoff during more substantial storm events. The combined capacity of the minor and major system components should be sufficient to carry the peak flow produced by a 100 year ARI event. A design standard of between 2 and 5 years is generally adopted for the minor system.

The major-minor philosophy is generally applied to the design of drainage systems serving areas of new development.

Within areas that are already developed, the ability to provide the same level of protection from flooding as in an area of new development is generally limited by the layout of existing roads and reserves and by the topography. Within the Torrens Road Drain catchment, the situation is even more complex due to the fact that the main drainage outfalls have been established and have a fixed capacity. The cost associated with upgrading these outfalls would be prohibitive and would present a number of practical difficulties.

In these existing developed areas, the selection of an appropriate design standard to protect property that is at risk of inundation therefore requires the exercise of engineering judgement to balance the cost of the works against the benefits obtained.

Proposed Underground Drainage Design Standard

Lateral and Feeder Drainage Systems

A 5 year ARI design standard was recommended in the Torrens Road Drainage Study for street drainage systems feeding the main drains in the catchment. This standard is considered to be an appropriate target for new development as it is in accordance with generally accepted practice for the design of minor drainage systems.

Throughout much of the TRDA catchment, the relatively low standard of the feeder drainage systems may currently play an important role in limiting the rate at which flows are discharged into the main drains. This behaviour will increase the level of protection afforded by these main drains at the expense of some localised flooding. As a result, for existing systems in roads that are not used as main transport routes, a design standard as low as 2 year ARI is considered to be acceptable, provided that adequate surface flow paths are available for major flows.

Where property is likely to be inundated as a result of overflow of the underground drainage system (for example at a trapped low point), a higher design standard (up to a 100 year ARI) is appropriate. However, in most locations within the Torrens Road Drain catchment, physical constraints, the capacity of the downstream drainage system or the cost of carrying out works is likely to limit the design standard that is able to be achieved. In these circumstances, any works carried out to improve the degree of flood protection provided to property should provide the highest design standard (up to a 100 year ARI) that can be practically achieved within the given constraints.

Trunk Drains and Outfall Channels

Construction of the main drains and outfall channels serving the catchment has been completed. Increasing the design standard for these components of the system to a level above their current capacity would be expensive and given existing physical constraints would present a number of practical difficulties. The objective for management of these systems should therefore be to preserve the current capacity to ensure that it is not reduced by future development.

Flood Storage in TRDA Ponding Basin

The undeveloped area at Gillman provides temporary storage for flows generated from the upstream catchment which may be unable to be discharged to sea during periods of high tide. The existing basin has sufficient storage to ensure that flood levels in the basin would not impact on upstream development during a 100 year ARI event. See discussion in Section 7.2.5

Flood Management Objectives

Based on the above, the following catchment specific objectives for management of flooding in the Torrens Road Drain Catchment have been set: Due to the different constraints that are present in new and existing areas of development, different objectives have been set for each of these areas.

New Development

For new development undertaken within the catchment the following flood management objectives will apply:

Objective 1.1

Protect all new development from inundation in a 100 year ARI event.

Objective 1.2

Provide an underground drainage system having a minimum capacity sufficient to carry a 5 year ARI flow in areas of new development.

Objective 1.3

Ensure that gutter flow widths within any new streets are limited to a maximum width of 2.5 m during a 5 year ARI rainfall event. Gutter flow widths on major transport routes should be limited in accordance with the design requirements set out by the Department of Planning, Transport and Infrastructure (DPTI) for these roads.

Objective 1.4

Ensure that runoff from any new development does not increase the degree of flood risk to other properties for all events up to a 100 year ARI. Both flow peak and volume of runoff need to be considered.

Existing Development

Within areas of existing development in the catchment, the following flood management objectives will apply:

Objective 1.5

Where economically and practically viable, protect existing development from inundation in a 100 year ARI event. A lower standard of flood protection may be adopted where physical and economic constraints limit the ability to achieve a 100 year ARI level of protection. Where a lower standard is adopted, this should be justified based on an assessment of the saving in construction costs relative to the increase in flood damage costs.

Objective 1.6

Where economically and practically viable, provide an underground street drainage system having sufficient capacity to carry flows resulting from at least a 2 year ARI event in areas of existing development. A higher design standard should be provided where adequate surface flow paths are not available to carry major flows and the consequences of nuisance flooding of roadways are significant.

Objective 1.7

Maintain the current design capacity of the main drains and outfall channels serving the catchment.

Objective 1.8

Provide and maintain flood storage at the downstream end of the catchment to provide for high tide levels in the North Arm and ensure that upstream development is not affected by the stored floodwaters in a 100 year event.

6.3.2 Water Quality Improvement

The role of the existing Magazine Creek and Range wetlands in treating stormwater discharged from the catchment was discussed in Section 5.7 above. In order to address the specific issues identified, the following catchment specific objectives for management of water quality from the Torrens Road Catchment have been set:

Objective 2.1

Reduce the quantity of gross pollutants entering the Magazine Creek and Range wetlands by implementing measures to improve capture in the upstream catchment.

Objective 2.2

Intercept pollutants at source from land uses and activities having a high potential for pollutant generation such as industrial, commercial, roads and new major transport routes.

Objective 2.3

Manage increased flows from redevelopment such that the existing performance of the Magazine Creek and Range wetlands is maintained and the Port River - Barker Inlet system is protected.

6.3.3 Stormwater Use

New proposals for harvesting stormwater from the catchment are described in Section 5.6 above.

There is no requirement to maintain environmental flows within catchment watercourses as these comprise highly modified channels. It is also unlikely that the quantities of stormwater harvested from the catchment would ever be significant enough to affect the viability of the downstream wetlands. Indeed, with ongoing redevelopment, there is an advantage in minimising inflows to the wetlands to ensure that their effectiveness in improving runoff quality is maintained.

The following catchment specific objectives for water use have therefore been adopted:

Objective 3.1

Where economically viable, utilise stormwater runoff for beneficial purposes in catchment scale facilities.

Objective 3.2

Encourage on-site use of stormwater runoff to minimise discharges to the downstream stormwater system.

6.4 Environmental Protection and Enhancement

There are no existing natural watercourses or water bodies of significance within the catchment other than the Magazine Creek and Range Wetlands. As a result, opportunities for environmental enhancement in association with management of urban stormwater will be limited to those that may be associated with construction of new stormwater management facilities on areas of open space.

Development of multiple use drainage open space requires a careful consideration of the interaction between drainage provision, environmental enhancement, water quality and recreation provision. By application of appropriate principles and implementation of suitable guidelines it is possible to serve a range of needs while at the same time providing a suitable drainage system. In doing so, advantages can be compounded beyond that which may be achieved if each component were considered in isolation.

The following general objectives have therefore been adopted:

Objective 4.1

Within new developments, encourage the use of open space provided for drainage infrastructure for other purposes such as amenity enhancement, passive or active recreation and environmental enhancement.

Objective 4.2

Where new stormwater management facilities are constructed on existing open space maximise the community use and benefit derived from the facility and ensure that opportunities for biodiversity, amenity and environmental enhancement are realised.

Consideration needs to be given to maintaining the existing open space for its intended purpose. For example stepped basins can be designed such that a large part of the open space is still available for community use and only inundated during larger storm events.

7 Stormwater Management Strategies

7.1 Overview

A number of potential stormwater management strategies have been identified to achieve the objectives for stormwater management set out in Section 6. These strategies are described below together with potential options for implementation.

7.2 Flood Management

7.2.1 Torrens Road Precinct

Strategy 1: Upgrade Lateral Drains

This strategy involves upgrading the lateral drains that feed into the Torrens Road drain to cater for the increased runoff generated from the envisaged increase in development densities between Torrens and Port Roads, due to their proximity to major transport corridors. The upgrades would also extend the lateral drains to reduce the length of surface flow before capture. This would effectively reduce nuisance flooding within the suburbs to the south of Torrens Road.

Upgrading all the lateral drains will increase flows in the Torrens Road drain significantly, reducing the standard of the drain (refer Figure 5.1). As a result, upgrade of the Torrens Road Drain itself would also most likely be required under this scenario. For this reason, alternative strategies have been considered and identified for this catchment (as described below). These strategies will be more cost effective and further consideration of this option has therefore not been carried out.

Strategy 2: Targeted Upgrade of Lateral Drains

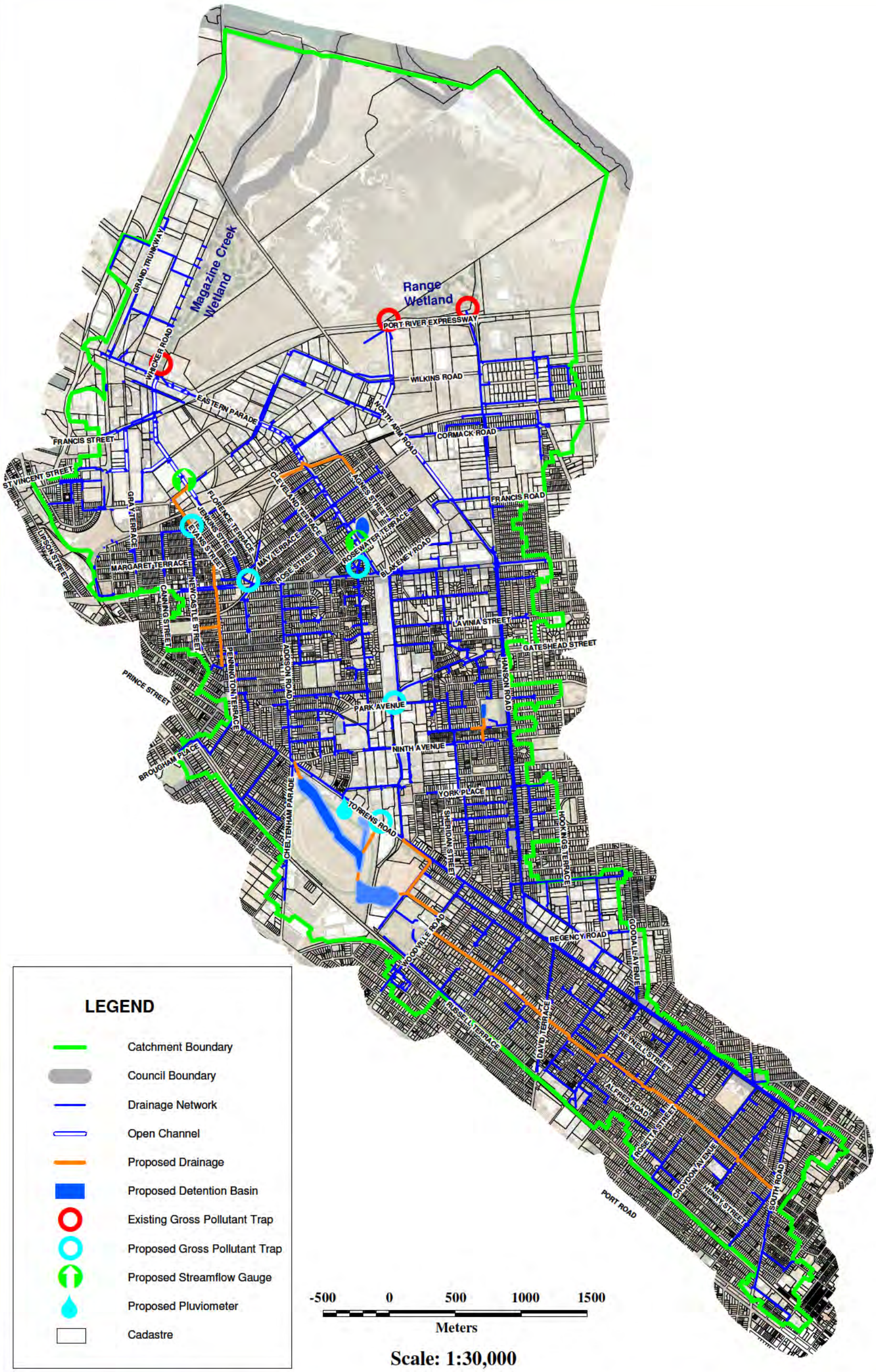
The original design of the Torrens Road Drain was to a 10 year standard, with lateral systems upgraded to a 5 year standard (based on the density of development envisaged at the time). The TUFLOW modelling carried out for this Plan has indicated that at present, the lateral systems feeding this drain limit flows in the system and the drain is not currently fully utilised.

There appears to be some potential for targeted upgrade of some lateral drains, if this is shown to be necessary in the future. The existing 5 year ARI floodplain maps show little flooding in this area currently. With future development, some areas of flooding become apparent, particularly in a 1 in100 year event. Specific locations include Rosetta Street, Chenoweth Avenue and the north end of Woodville Road. Targeted upgrades of drainage in these locations could be undertaken (depending on the future level of development).

If these works were to be carried out, a more detailed assessment of the spare capacity in the Torrens Road Drain and downstream systems will be required.

Strategy 3: Torrens Road Relief Drain

This option involves the construction of a relief drain, running parallel to and approximately half way between Torrens Road and the railway line as shown in Figure 7.1. Flows from the south-eastern part of the catchment would be intercepted by this drain, effectively halving the catchment draining to Torrens Road and thereby maintaining the standard of the existing Torrens Road drain.



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PROPOSED DRAINAGE NETWORK UPGRADES

Figure 7.1

The relief drain could originate from the Torrens Road splitter box, either directing flow into the Eastern Parade drain or the Cheltenham development. The construction of this drain would require utilising Cheltenham for stormwater detention to mitigate the impact of the additional flow on the downstream system (see Section 7.2.3, Strategy 3). In addition to utilising the Cheltenham Wetlands, the Brocas Ave playing fields could be lowered and utilised for additional stormwater detention. The relief drain could be designed to surcharge during larger storm events (greater than 5 or 10 year ARI), with high flows entering the playing fields directly from Actil Avenue. Modelling showed this to effectively detain high flows due to increased development and mitigate the impact on the downstream system.

The construction of a relief drain would eliminate the need to upgrade the existing lateral drains on the Torrens Road side of the relief drain. The drain could be built progressively in stages as development occurs.

This option has a high capital cost. It is proposed that these works only be carried out if the measures proposed under Strategy 4 below prove not to be effective, and Strategy 2 above is shown to have adverse downstream impacts.

Strategy 4: Development Control

As new development occurs there is the opportunity to implement controls that manage flood risk. These controls should include:

- A requirement for floor levels to be set above the 100 year flood level (long term); and
- A requirement for runoff to be managed on site to reduce the peak flow and volume to pre-development levels for a 5 year event.

These are similar to the current development controls that are implemented by each Council.

The first requirement will address the existing flood risk to properties in low lying areas of the catchment as re-development occurs over time. Providing a 1 in 100 year standard of protection throughout the catchment by means of formal drainage works is not considered to be feasible due to the size of trunk drainage systems that would be required, the distance to major stormwater outfalls and the lack of appropriately positioned open space, distributed throughout the catchment, for construction of regional and local scale detention facilities to manage peak flows in all sections of the trunk drainage network.

Provision of on-site measures to limit discharges from new development will protect the standard of downstream drainage systems, and by managing flow volumes will also protect the standard of downstream ponding basins and wetlands. In order to meet this requirement, systems such a rainwater tanks plumbed into the house and used to supplement garden watering or infiltration devices will be required.

Each Council's current development controls require the developed 100 year peak flow leaving the site to be detained to pre-development levels for a 5 year event. While this is quite effective in limiting peak runoff, it is also quite onerous on developers. An analysis of the floodplain maps shows that the long-term development scenario had a much more significant impact on the 5 year ARI floodplain than on the 100 year ARI floodplain. This is due to the bulk of the catchment contributing to the 100 year ARI runoff regardless of the land use. While further investigation is warranted, preliminary investigations would suggest that the 5 year ARI post-development flows should be detained back to the 5 year ARI pre-development rates, with the aim at protecting the standard of the existing underground drainage system.

This strategy is relatively straight forward to implement, and is of low cost to Council. However, there remains much debate regarding the ongoing effectiveness of such a strategy, primarily due to the devices being on private property with no means of control following completion of the development. Despite this, it is considered that this strategy provides the most appropriate solution for managing the impacts of development in this particular catchment, where considerable expenditure has already occurred in establishing a drainage network and the asset has a significant remaining.

Strategy 4 is therefore considered to be the most appropriate 'first response' for managing the impacts of development in this catchment. The limitations of this strategy in relation to the difficulty of controlling devices on private property to ensure their correct installation and ongoing effectiveness should be recognised. For this reason, monitoring of flows from the catchment is proposed to assess any ongoing changes in catchment response (refer Section 7.7). Should this monitoring show that these measures are less than effective in managing flows, Strategy 2 or 3 could be further investigated and implemented.

7.2.2 Hamilton Road Precinct

The area around Hamilton Road, Ninth Avenue and Hanson Road will become more prone to frequent flooding in a 5 year event following redevelopment of the upstream catchment in the longer term. The area is also subject to relatively significant flooding in a 100 year event.

There are two reserves in close proximity to this area that were identified as offering the opportunity to provide storage (in association with upgrading of upstream pipe systems) to mitigate this flooding.

These opportunities are discussed in more detail below.

Detention Basin in Sparrow Reserve

The catchment upstream of Hamilton Road is drained via an underground drainage network down Owen Street. Approximately 300 m upstream (south) of Hamilton Road is Sparrow Reserve. A detention basin having a volume of approximately 11ML could be incorporated into the reserve with flows directed into the basin from the Owen Street drain.

Provision of a basin in Sparrow Road was modelled in TUFLOW. The model results showed only a minor increase in flooding during a 100 year event upstream of the basin due to the drainage upgrades to direct flows into the system. There was little impact on flooding in the Hamilton Road area.

As a result, construction of a basin in Sparrow Reserve has not been considered further.

Detention Basin in Fawk Reserve

As an alternative to the Sparrow Reserve basin, it is recommended that the Fawk Reserve redevelopment include a stormwater detention basin to reduce the local flooding around Hamilton Road. The ponding volume is estimated to be 3,700 m^3. By including a stormwater detention basin in Fawk Reserve adjacent to Adele St, modelling predicted that the flooding level in Hamilton road could be reduced by 150 mm, significantly reducing the impact on the surrounding properties. The basin could be incorporated into the reserve redevelopment as a mixed use area that will only be inundated during larger storm events.

Alternatively, the oval in Fawk Reserve could be lowered to form a stormwater detention basin. Excavation of the oval would be required by between 1.5 and 2 m and would enable a detention basin having 22ML of storage to be formed. Such a basin will have a more significant impact

flooding in Hamilton Road and Ninth Avenue and would enable properties in the area to be protected from a 100 year flood event. The function of the basin would need to be configured such that flows would only spill into the area during more significant rainfall events to maintain the useability of the area for recreation. Lowering of the entire oval is unlikely to be economically viable or carried out in the short term, but may be considered in the long term as development increases.

This option would need to be further developed and consultation held with the community and oval users to prove its acceptability.

7.2.3 Jenkins Street Outfall Precinct

Strategy 1: Development Controls

As new development occurs there is the opportunity to implement controls that manage flood risk. These controls should include:

- A requirement for floor levels to be set above the 100 year flood level (long term); and
- A requirement for runoff to be managed on site to reduce the peak flow and volume to pre-development levels for a 5 year event.

The first requirement will address the existing flood risk to properties in low lying areas of the catchment a development occurs over time.

Provision of on-site measures to limit discharges from new development will protect the standard of downstream drainage systems, and by managing flow volumes, will also protect the standard of the downstream ponding basins and wetlands. In order to meet this requirement, systems such a rainwater tanks plumbed into the house or infiltration devices will be required.

Strategy 2: Utilising Cheltenham for Stormwater Detention

The Jenkins Street Drain takes receives flows from the Torrens Road splitter box during large storm events. The Jenkins Street drain currently has a 2 year ARI existing standard. If development is allowed to occur without controls on discharge and upstream drainage systems are upgraded, this standard is expected to reduce to less than a 1 year ARI standard in the 30 year time horizon.

Residential areas in and around Rosewater and Pennington are subject to significant flooding in a 100 year event. The possibility of utilising flood detention storage in Cheltenham to mitigate flows in the main drains in Addison Road and Jenkins Street has been investigated as a means of reducing this flooding.

Construction of the proposed wetland system within Cheltenham is currently underway.

The system will involve the installation of a pump in the splitter box at the intersection of Torrens Road and Audley Street. This pump will discharge into the upstream end of the wetland. The wetland has been designed with an area of approximately 6 ha and a permanent water level at 3.9mAHD, but allowing the wetland to rise to 4.3 mAHD for periods of a number of days to provide extended detention for recharge.

The lowest road level adjacent to the wetland is currently proposed to be 4.8 mAHD, with allotments filled to 5.1 mAHD. Assuming that some minor flooding of the road network is allowable, the effect of allowing a maximum flood storage level of up to 5.0 mAHD in the wetland has been assessed in this investigation.

The impact of this flood storage on the 100 year flood extent downstream of the wetland was assessed using TUFLOW. For the purposes of the modelling, flows were diverted into the wetland from the Torrens Road drain at varying thresholds and outflows from the wetland were also varied. In carrying out the modelling, it was also assumed that the Torrens Road Relief drain (Strategy2 in Section 7.2.1 above) was constructed and that development to the 30 year scenario had occurred in the upstream catchment.

The modelling showed that while the detention storage had some effect on flooding in the Pennington area (immediately north of Cheltenham), its impact further downstream in a 100 year event would be negligible. The reduction in flooding for a 100 year event is shown in Figure 7.2. As can be seen from the Figure, the reduction in flooding immediately downstream of the detention storage is apparent. Based on a visual inspection of floor levels in the area (which are generally 100 to 200 mm above footpath level) the use of Cheltenham for flood storage will result in the protection of properties in this area (with the exception of approximately 3 residences which are below road level and are unable to be drained) from flooding in a 1 in 100 year event.

Lowering the operating level of the wetland to provide additional flood storage did not achieve the same result, due to the high HGL level downstream of the wetland limiting the outflow.

Based on this assessment, the option of providing a higher storage level in the Cheltenham system should be pursued in the longer term to cater for the impacts of upstream development.

In addition to its impact on the 100 year flows, the Cheltenham storage will be required to mitigate the impacts of construction of the Torrens Road Relief drain, if it occurs. These impacts are associated with managing the 5 year ARI flow, so that it does not impact the downstream Jenkins Street Drain. Modelling of this scenario has not been undertaken to date.

Additional Storage in the Brocas Avenue Playing Fields

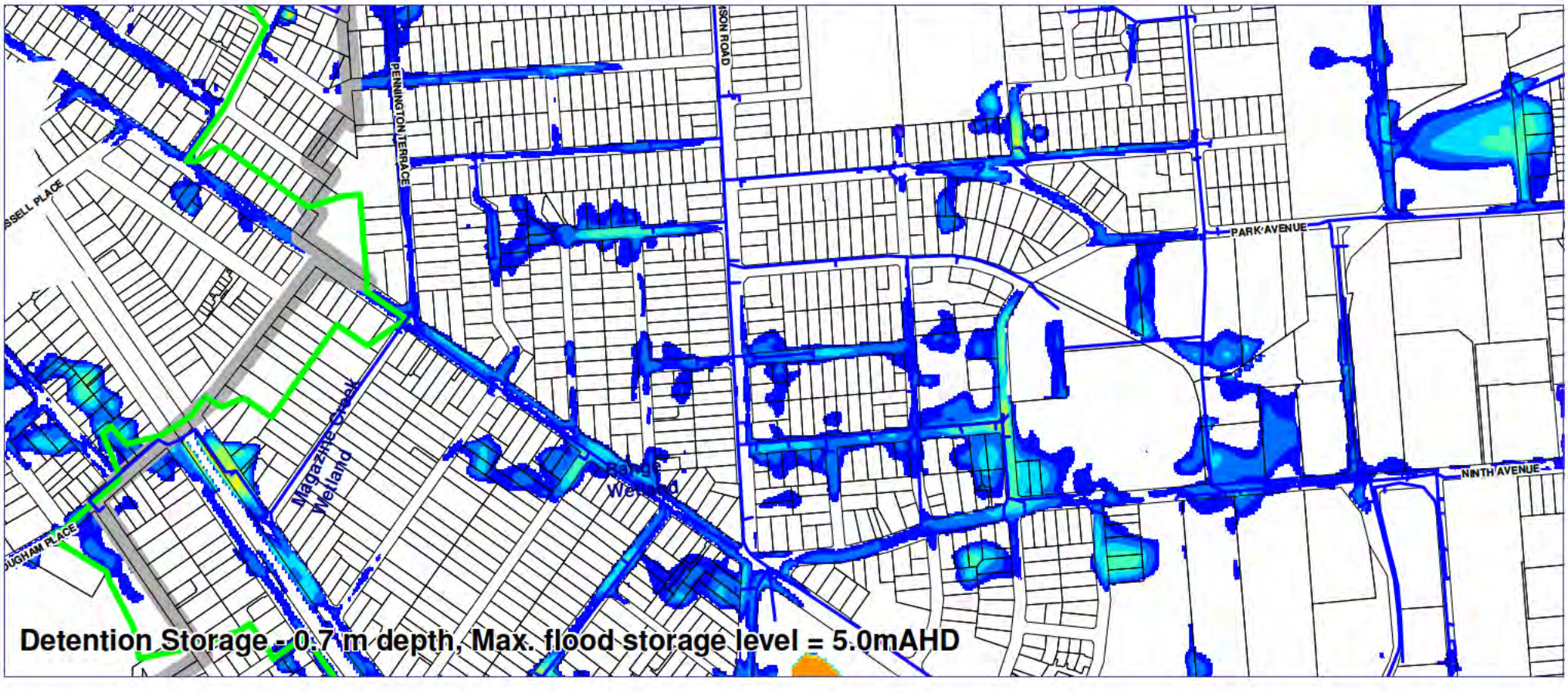
There is a further opportunity to increase the stormwater detention in Cheltenham by lowering the playing fields adjacent to the southern inlet pond (by Brocas Avenue). Even though only a shallow ponding depth could be achieved (approx 200 mm), the large area would allow for a maximum storage volume of approximately 8ML.

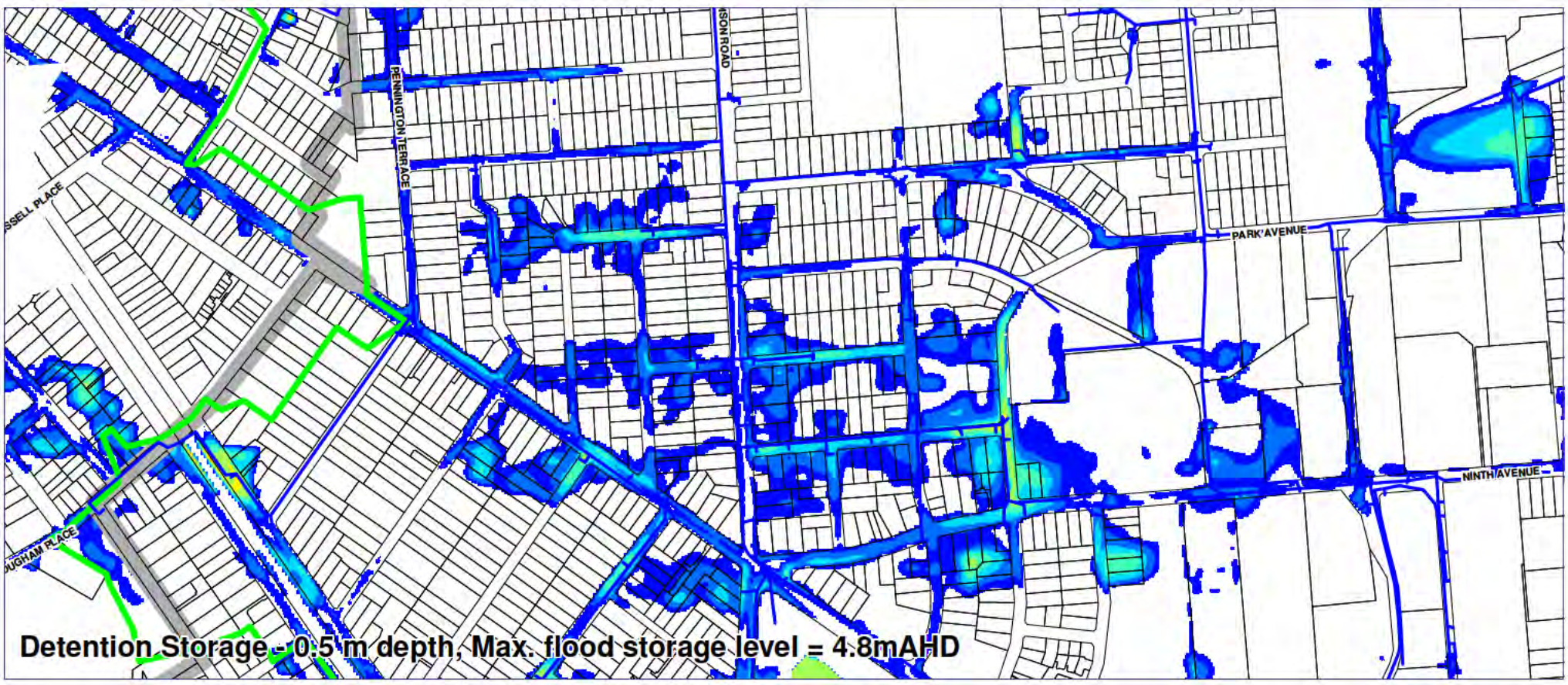
The lowering of the playing fields would be undertaken in conjunction with the construction of the Torrens Road Relief Drain, with high flows from the drain being directed through the playing fields from Actil Avenue during larger storm events (5 or 10 yr ARI). Modelling showed this to effectively detain high flows due to increased development and mitigate the impact on the downstream system.

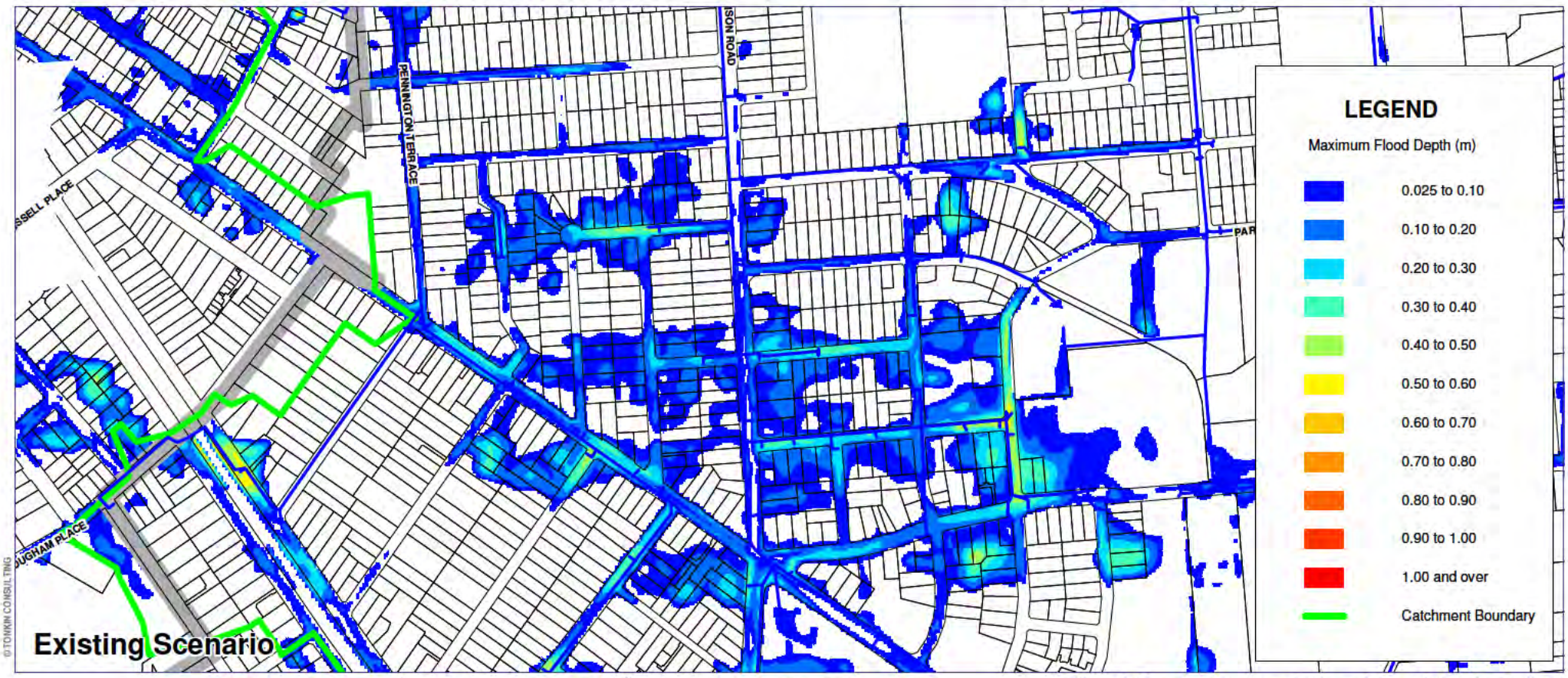
Strategy 3: Upgrade Eastbourne Terrace Drain

The floodplain maps show an area of significant flooding around Eastbourne Terrace at Rosewater during a 100 year event. The extent and depth of flooding and the number of properties affected would appear to warrant upgrading of the Eastbourne Terrace drainage system. Duplication of the existing drain from the outfall into the Jenkins Street drain at Bedford Street to south of the railway line at Rosewater would greatly reduce the extent of flooding for the 100 year ARI event.

Further investigation of the feasibility of this option, in particular drain alignment and services impacts is warranted.







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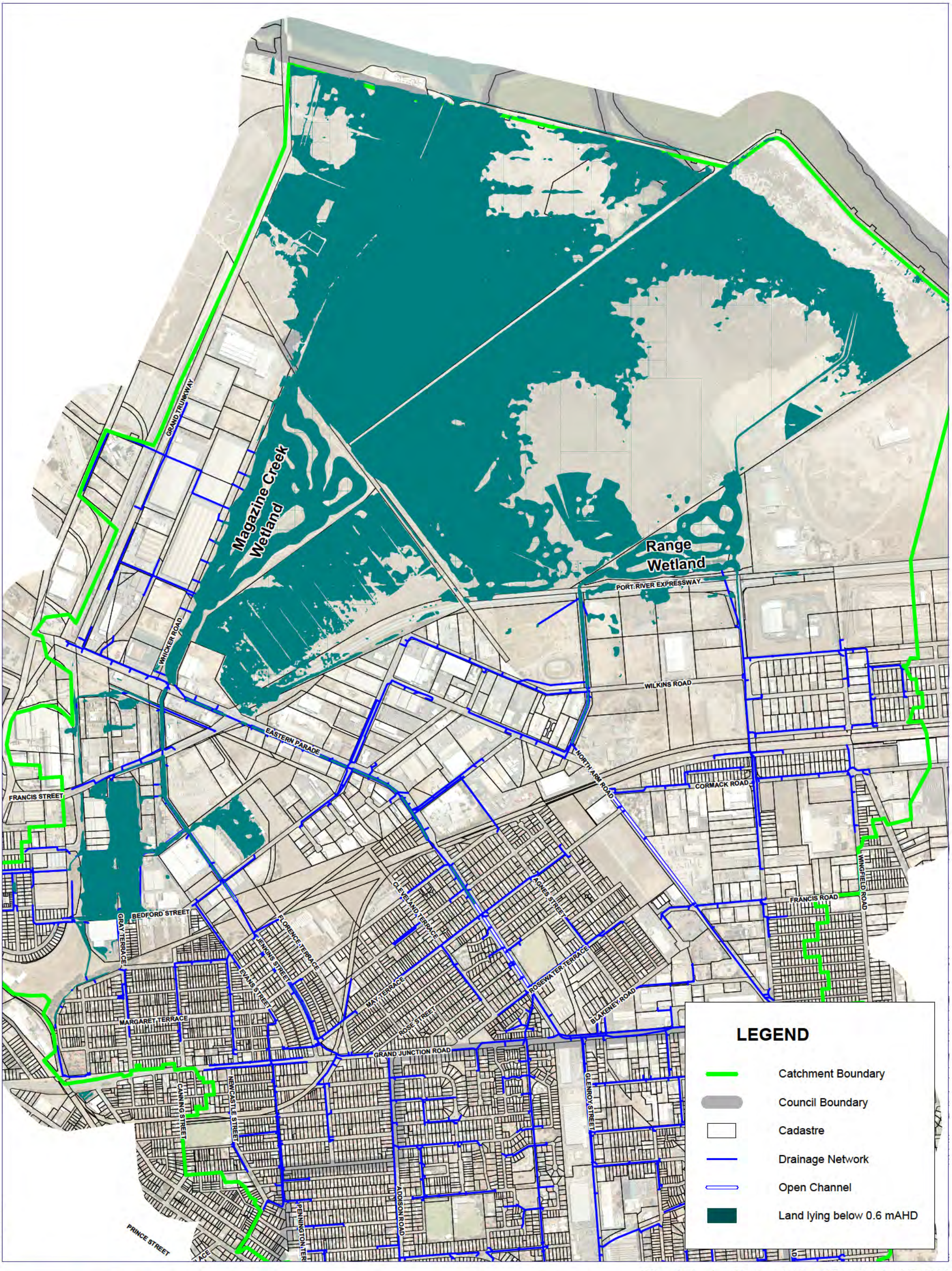
FLOOD INUNDATION BENEFITS OF CHELTENHAM STORAGE

Figure 7.2



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LOW LYING AREAS (below 0.6 mAHD)

Figure 7.3

7.2.4 Eastern Parade Outfall Precinct

Strategy 1: Development Controls

As new development occurs there is the opportunity to implement controls that manage flood risk. These controls should include:

- A requirement for floor levels to be set above the 100 year flood level (long term); and
- A requirement for runoff to be managed on site to reduce the peak flow and volume to pre-development levels for a 5 year event.

The first requirement will address the existing flood risk to properties in low lying areas of the catchment a development occurs over time.

Provision of on-site measures to limit discharges from new development will protect the standard of downstream drainage systems, and by managing flow volumes, will also protect the standard of the downstream ponding basins and wetlands. In order to meet this requirement, systems such a rainwater tanks plumbed into the house or infiltration devices will be required.

Strategy 2: Outfall Improvements - Ottoway

The 100 year floodplain maps show significant ponding to the east and west of the Eastern Parade Drain at Ottoway (Agnes Street and Cleveland Terrace areas respectively). Flooding of this area is partly caused by flows escaping the Eastern Parade Drain between Henry Street and May Terrace. In addition, the flooding is due to high water levels in the Eastern Parade drain preventing drainage of the lower lying areas on each side of the drain and the capacity of drains serving this area being insufficient to cater for major flows.

The extent and depth of flooding and the number of properties affected would appear to warrant a number of improvements to the system to address this issue. These are described below and shown in Figure 7.1.

Component 1: Walling Eastern Parade Channel

By walling the open channel part of Eastern Parade drain upstream (south) of Henry Street, a higher head of water can be achieved to push flow through the box culverts without causing flooding of Eastern Parade and the surrounding streets. In addition, the capacity of the channel is increased.

The Eastern Parade drain is a rectangular open channel 1.75 m deep between Rosewater Terrace and Henry Street. By extending the wall of the channel a further 600 mm in height, the 100 year ARI flows would be prevented from spilling into the adjacent areas.

There are a number of lateral drainage systems entering the Eastern Parade channel upstream of Henry Street. The most significant of these are systems entering at May Terrace and Rosewater Terrace. There are also a number of minor laterals which collect runoff from Eastern Parade and drain it to the channel.

Elevating the peak flood level in Eastern Parade has the potential to reduce the ability of these systems to drain to the channel during the flood peak. There is also the potential for flows to backflow through the drains and potentially exacerbate flooding. Both of these factors were therefore examined in more detail to assess the viability of this option and are discussed below.

- Ability of Systems to Drain at the Flood Peak

TUFLOW modelling has shown that the existing Eastern Parade outfall would be overtopped in the area downstream of May Terrace. From this it can be concluded that the peak flood level is slightly above the ground level on either side of the channel in this area. At May Terrace, the existing top of channel bank is approximately 1.95 mAHD. The lowest point drained by the May Terrace system is at a level of 1.85 mAHD. As a result, even with the current configuration, this system will be unable to drain at the flood peak. Similar conclusions can be drawn regarding the Rosewater Terrace system, and the minor systems draining Eastern Parade.

Raising of the channel sides will prevent overspill and have a positive impact on flooding of the surrounding area.

This behaviour has been confirmed by TUFLOW modelling of the proposed arrangement which shows a reduction in flooding in the area as a result of constructing the wall.

- Backflow Prevention

  In order to prevent backflow through the drainage system, flap gates will need to be installed on all outlets into the channel.

Component 2: Drain Cleveland Terrace and Agnes Street into Eastern Parade Further Downstream

To improve drainage of Cleveland Terrace and Agnes Street in a 100 year ARI event, new outfalls could be constructed running north and then turning along the old railway alignment to discharge into the Eastern Parade Drain further downstream. There is vacant land at the northern end of Cleveland Street and also Agnes Street that could be used to provide detention and reduce the size of the outfalls.

The ability of these systems to significantly impact flooding is affected by the high tail water level in the Eastern Parade Drain, and based on these levels the efficacy of these proposed drains is limited. However despite this, further investigation of these systems, particularly in combination with some detention in the railway reserve is considered to be warranted.

Strategy 3: Detention Basin in Eastern Parade Reserve

The possibility of providing detention storage for flows from the Eastern Parade Drain in the Eastern Parade Reserve / Oval was identified as a potential alternative to walling the channel. The function of such a basin would be to temporarily store the peak of the flood hydrograph, (reducing flows and flood level in the downstream channel) and then to release these flows once capacity in the channel becomes available. By reducing the downstream flood level, walling of the channel would no longer be necessary. The reduced flood level in the channel would have the added advantage of improving the performance of proposed drains from Cleveland Terrace and Agnes Street as the effectiveness of these proposed systems is currently limited by the high downstream flood levels.

In concept, this option will require a takeoff structure from the Eastern Parade drain just downstream of Rosewater Terrace, a transfer culvert beneath Eastern Parade and excavation and re-instatement of the existing oval at a lower level. Any flows above a certain threshold, would be diverted into the basin and stored until the flood level has lowered sufficiently for them to be discharged back into the channel.

The depth of flood storage that is able to be created on the oval is governed by the anticipated flood level in Eastern Parade and is most likely to be governed by groundwater levels in the area. For the purpose of this assessment it has been assumed (given these constraints) that a

flood storage depth of 1 m could be achieved, giving an available storage of approximately 15,000 m^3. To achieve this storage, lowering of the oval by at least 1.5 to 2.0 m will be required.

Provision of this storage will enable the peak 100 year ARI flow in Eastern Parade to be reduced to 15.5 m^3/s (cf. 22.1 m^3/s existing peak). Such a reduction in flow will reduce flood levels in the channel by approximately 300 mm, preventing overspilling in the area south of Henry Street and providing a lower tail water level to improve the function of proposed drains from Cleveland Terrace and Agnes Street. The frequency of spill into the basin is likely to be of the order of once every 10 years on average.

Given the above, further more detailed assessment of this option is considered to be warranted. In addition, consultation with the existing users of this reserve will be required.

The key issues to be addressed in any more detailed assessment should include:

- The time taken for the storage to fill and its effect on the safety of recreational users of the reserve;
- The likely duration of inundation and its impact on other uses of the reserve;
- The measures required to return the reserve to a useable playing surface following inundation (such as subsurface drainage).

Strategy 4: Upgrade Railway Culverts

The head loss through the railway culverts on Eastern Parade is between 200 and 300 mm (depending on the storm duration) for the 100 year ARI event. Upgrading the culverts will reduce this head loss, resulting in lower upstream flood levels. This option has been identified as a potential alternative to walling the upstream channel (Strategy 2 above).

It is considered to be unlikely that the head loss through the culvert could be reduced by more than 100 mm. Even with this reduction in level, spill from the channel will occur, requiring some walling.

No further assessment of this option has therefore been carried out.

Strategy 5: Covering the Eastern Parade Drain

The Eastern Parade Drain, particularly the section through the residential areas between Grand Junction Road and the railway is of poor amenity. The possibility of covering the drain and landscaping the area over it has been suggested as a project that would be highly desirable to the local community.

As discussed above, the floodplain mapping has shown that this section of channel overflows during a 100 year ARI event, contributing to inundation of the surrounding areas. Adding a roof to the existing channel will reduce its capacity due to two factors as follows:

- Any roof structure will have some thickness (possibly up to 300 mm due to the spans involved). If landscaping is to be placed over the structure, a minimum topsoil thickness of at least 400 mm is likely to be required over the roof to sustain any plantings. Assuming that the landscaping is to be at a level close to the existing top of kerbs along Eastern Parade, the above structure thicknesses will mean that the flow area of the channel is reduced, leading to a decrease in its capacity.
- Construction of a roof on the channel will mean that when the culvert is flowing full, the wetted perimeter (area of flow in contact with the channel sides and roof) will

increase. This will result in an increase in friction and a decrease in capacity. Typically, the increase in wetted perimeter associated with flows hitting the roof of culverts can lead to a decrease in capacity of between 10 and 15% compared to a channel without a roof.

As a result of the above, no further assessment of this option has been carried out.

7.2.5 Gillman Ponding Basins

Strategy 1: Ensure Development Maintains Basin Function

As a part of investigations conducted for development of the Gillman Masterplan for Renewal SA, modelling of stormwater ponding in the Gillman area was undertaken to ensure that the proposed development would not impact upstream flood levels. Flood levels for a 1 in 100 year event were calculated for a number of scenarios (all of which were based on runoff from a level of development within the catchment as contemplated in the30 year Plan for Greater Adelaide) including:

- Scenario A : Existing basin configuration with current sea levels
- Scenario B : Existing basin configuration with 1 m sea level rise
- Scenario C : Gillman Masterplan Development with current sea levels
- Scenario D : Gillman Masterplan Development with 1m sea level rise.

For Scenarios C and D, a number of flood management related works were proposed in association with the Gillman development including:

- Dividing the Range and Magazine Creek basins and providing separate outfalls
- Upgrading the Magazine Creek outlet gates
- Providing new gates and outlet from the Range Wetland basin
- Cutting a new channel downstream of the Magazine Creek wetland

provides a summary of the modelling results taken from the Masterplan report.

Table 7.1 Gillman Ponding Basin Flood Levels

Scenario	100 year ARI Flood Level (mAHD)	
	Magazine Creek at Eastern Parade	Downstream of Range Wetland
A	0.54	1.21
B	0.55	1.21
C	0.46	1.16
D	0.56	1.16

The peak flood levels calculated in the modelling undertaken for Renewal SA differ slightly from those calculated in earlier work for Ruan Consulting (Ruan, 2006) due to a number of factors, the most significant of which is likely to be the hydrological analysis. The more recent work uses inflow hydrographs calculated using TUFLOW, which models greater storage in the

upstream catchment, thereby reducing peak inflows to the wetland and resulting in lower flood levels.

The modelling showed that with current sea levels, the peak flood level following development as envisaged in the Gillman Masterplan (Scenario C) would be lower than the existing level (Scenario A). With 1 m sea level rise, the peak level with the development would be within 10 mm of the the level that would occur without the development.

The 1 in 100 year ARI flood level in the Magazine Creek wetland is expected to approach a level of 0.6 mAHD over the long term. Figure 7.3 highlights the low lying land that is below 0.6mAHD. This is mostly confined to Port Adelaide and Gillman. The floodplain maps show the extent of upstream inundation produced in a 100 year event with these ponding levels. The extent of inundation shown on the 'long term' map is similar to that show on the existing map and as a result, it has been concluded that the increase in the 100 year flood level does not have a significant impact on upstream systems and that the basins should perform satisfactorily over the 30 year planning horizon.

As discussed in Section 5.5.5 above, land at Gillman has been sold to a private consortium. It will be necessary to ensure that the final proposal for development of the site maintains the performance of the existing system, taking into account sea level rise and increased runoff from the upstream catchment. In addition to flood management, part of this review will need to include an assessment of the impact on the water quality improvement performance of the existing wetlands at Magazine Creek and the Range (if any re-configuration of these systems is proposed as a part of the development).

Strategy 2: Pumps and Tide Gate Modifications

At some point in the future, it is likely that the combined effects of increased inflows and sea level rise will compromise the performance of the wetlands and ponding basins. This is only expected to occur well outside the current planning period.

The most visible impact in relation to sea level rise will relate to the ability of the wetlands to drain to their normal operating level during low tides. This is likely to impact mostly on the Magazine Creek system which has a permanent water level at -0.6 mAHD. With increasing sea levels, it will become more difficult to sustain this level, due to the availability of shorter periods in which the tides are likely to be below -0.6 mAHD. Should this occur, the simplest solution would be to install low-lift high-flow pumps at the outlet to allow lowering of the wetlands during adverse conditions.

An alternative to the above strategy could involve the excavation of additional flood storage or installation of additional flood gates, to allow the discharge of floodwaters at a greater rate. Such a strategy could mitigate the impact of a smaller flood storage (produced as a result of higher wetland levels) but would need to be analysed in further detail to assess its feasibility.

7.3 Interaction with Adjoining Catchments

The Torrens Road catchment is situated adjacent to the Port Road catchment (to the south) and the Barker Inlet catchments (to the east).

While there are no direct connections of drainage infrastructure across these catchment boundaries, the floodplain mapping highlights that in some locations, the potential for some minor spilling of flows from one catchment to another exists.

The proposed development of the Cheltenham Racecourse site has attracted significant interest, particularly with regard to the opportunity to utilise portions of the site to achieve stormwater re-use on a scale that is significant in the context of the overall Torrens Road catchment. However, Cheltenham Racecourse is located within the upper portion of the Torrens Road catchment and only a relatively small portion of the overall catchment naturally drains through drains that pass around the perimeter of the site. In order to maximise the yield that can be achieved at this site, the opportunity to divert stormwater flows from other catchments into the upstream end of these drainage systems have previously been investigated. Options considered include diversion of flows from:

- Port Road Catchment
- Hindmarsh Enfield Prospect (HEP) Catchment
- River Torrens

The diversion from Port Road was found to not be economically or environmentally justifiable (URS, 2006), a decision which was adopted in the preparation of the Port Road Stormwater Management Plan (Connell Wagner & Tonkin Consulting, 2007).

A diversion from the HEP Catchment was proposed in early investigations for harvesting at the Cheltenham Racecourse site (Wallbridge & Gilbert, 2009b). This low flow diversion (from a main drain at the intersection of Torrens Road and Harrison Road) would increase the catchment area draining to the Cheltenham site from approximately 470ha to approximately 600ha.

Further investigation of this proposed diversion has shown that the existing level of the main drain in Harrison Road does not facilitate its diversion into Torrens Road. As a result, this diversion has not been constructed and is no longer proposed.

In addition to the above, a portion of the base flow from the River Torrens has been diverted into the system. This diversion is particularly effective in that it allows the harvesting scheme to capture and store flows on a continual basis through winter, between rainfall events.

The diversion involves pumping flows from the River Torrens at Bowden and discharge into the Torrens Road catchment systems that drain to the Cheltenham site.

No diversions are proposed to take water out of the Torrens Road catchment.

7.4 Water Quality Improvement

The Torrens Road catchment drains into the Magazine Creek and Range wetlands. These wetlands were designed and constructed to protect the North Arm from impacts associated with stormwater discharges. The design criterion of a 10 day detention time was aimed at achieving sediment (and heavy metal) removal rates of 90% and nutrient removals of approximately 70%. Monitoring of the performance of the Barker Inlet, Range and Magazine Creek systems was undertaken in the late 1990's. The Range and Magazine Creek systems were only newly constructed, but results from the Barker Inlet system (which was designed to the same criterion) showed removal rates in line with or better than anticipated. From this it can be inferred that the Range and Magazine Creek systems are now also achieving similar results, despite monitoring not having been recently undertaken.

The Magazine Creek and Range systems have been partly impacted by saline conditions and the growth of vegetation in parts of the wetland is poorer than may have been expected. Monitoring of their existing performance is therefore warranted.

Construction of the proposed Cheltenham Wetland will augment the performance of the existing Magazine Creek system. It is therefore not considered necessary to provide any more catchment scale facilities of this nature.

However, as noted in Section 5.7, there is some benefit in providing smaller scale water quality improvement infrastructure throughout the catchment to provide a 'treatment train' and minimise maintenance associated with these large systems.

Strategy 1: Interception of Gross Pollutants at Strategic Sites

At present the only gross pollutant traps in the catchment are located at the inlet to the various wetlands. These gross pollutant traps are net (or basket) structures.

The gross pollutant trap at the inlet to the Magazine Creek system in particular, is located at the downstream end of a large catchment. While there is no data available regarding the quantity of gross pollutants bypassing the existing structure, the size of the catchment would indicate that additional capture capacity is desirable.

A number of potential additional gross pollutant trap sites have been identified in the Magazine Creek catchment. These sites are shown in Figure 7.1 and have been selected at locations where the underground drainage system runs adjacent to small reserves, in order that an offline system can be constructed to intercept low flows and where access for maintenance can be provided.

The locations are as follows:

- Audley Street Drain at Park Terrace
- Arthur Street Drain immediately south of Grand Junction Road
- Jenkins Street Drain at Florence Terrace
- Eastbourne Terrace Drain at Evans Street (north)

Strategy 2: Manage Key Pollutant Point Sources

Any large commercial or industrial development should be required to provide devices to treat runoff from paved surfaces to remove coarse sediment and oils, and in the case of commercial developments to intercept litter.Requirements to provide for this are incorporated into each of the catchment Council's Development Plans. Implementation of this strategy could be facilitated by the adoption of water sensitive urban design principles in these developments.

There is also an opportunity to incorporate water sensitive urban design treatments into the design of new road works in the catchment, to treat runoff from road surfaces and, where possible, to provide for infiltration and minimisation of runoff.

7.5 Water Reuse

7.5.1 Catchment Scale Stormwater Harvesting

As discussed in Section 5.6, investigation and design of a system to harvest stormwater at the former Cheltenham Racecourse is well underway. When completed, this scheme will harvest approximately 1.3GL/annum.

The possibility of harvesting water from the Magazine Creek and Range Wetlands has been identified but uncertainty as to the salinity of the water would necessitate further investigation

of the feasibility of such a scheme. Due to this uncertainty, it has not been included in the works proposed as part of this Plan.

7.5.2 On Site Stormwater Use

This Plan includes a key strategy for management of flows from re-development which requires the retention on-site of additional flows produced by development for events up to a 5 year ARI. The disposal of this water could be by infiltration, as soils across much of the catchment appear to be suitable for this purpose. However, in house (or out of house) use of this water is also a possible means of disposal.

Implementation of this strategy in areas upstream of the proposed Cheltenham Scheme will not comprise the feasibility of the project, as release of flows up to the pre-development level is proposed.

7.6 Amenity, Recreation & Environmental Protection & Enhancement

The built-up nature of the Torrens Road catchment offers few opportunities for improvement of amenity, recreation and environmental enhancement in association with existing or proposed drainage infrastructure.

Due to the built up nature, new development and streetscape upgrades should give priority to environmental enhancement, using WSUD principles to increase biodiversity and create green corridors where possible.

The proposed wetland system within Cheltenham will be situated in a landscaped reserve that will provide amenity and environmental enhancement.

Should it be feasible to construct detention basins at the northern end of Cleveland Terrace and Agnes Street, these systems could also be planted and established to improve the character and environment of the surrounding development.

7.7 Monitoring

7.7.1 Drain Condition Assessment

Each of the catchment Councils has a program for management of their assets. The design life of underground drainage systems is normally expected to be in excess of 80 to 100 years. The systems serving the Torrens Road catchment are well below this age.

Despite this, monitoring of the condition of the underground assets by CCTV inspection, in particular box culverts, is recommended given the low lying nature of parts of the catchment and the saline groundwater conditions present.

7.7.2 Flow and Rainfall Monitoring

A number of the strategies described in this Plan, rely on understanding the impact of redevelopment on peak flows and volumes. The Plan recommends a strategy that in the first instance involves the construction of on-site measures for management of the impacts of redevelopment.

In order to ascertain the effectiveness of this strategy, continuous and reliable monitoring of flows and rainfall is required. In particular, most redevelopment is projected to occur in the catchment of the Magazine Creek wetland. As a result, monitoring flows and gaining a good understanding of the rainfall patterns generating these flows is considered to be of greatest priority.

At present there are no stream flow gauges in the catchment. It is proposed that two flow gauges be established in the catchment as follows:

- Eastern Parade Drain downstream of the outlet of the Henry Street culvert
- Jenkins Street Drain just downstream of Bedford Street

These gauges are situated at the northern boundary of the residential areas in the catchment.

In addition, a pluviometer should be installed near the catchment centroid (at the Cheltenham wetland site) to provide a continuous measurement of rainfall intensity.

7.7.3 Quality Monitoring

Water quality monitoring stations could be established on the Magazine Creek and Range Wetlands. These would assess the performance of the wetlands and quality of water discharged to the Barker Inlet. This would provide the information necessary to determine the steps required for developing a comprehensive management strategy for the wetlands, to ascertain whether any re-configuration of the wetlands are required and to ensure the quality of the water being discharged to the Barker Inlet is appropriate.

8 Costs, Benefits and Funding

8.1 Costs and Benefits

Costs and benefits for each component of the proposed Plan are set out below. The costs provided are indicative. Further design development will be required to provide greater confidence with the estimates.

8.1.1 Drainage Upgrades

The order of capital cost for each of the proposed drainage upgrades are set out in Table 8.1 below together with the benefits that will accrue for each scheme.

Table 8.1 Drainage Upgrade Capital Costs

Component	Order of Capital Cost	Benefit
Eastbourne Terrace Drain	$4.5 million	Protection of 65 existing flood prone residences from inundation in a 100 year ARI event and a reduction in the extent of flooding to a number of other properties in a 100 year ARI event.
Eastern Parade Channel Raising *(This would be undertaken in conjunction with the Cleveland Terrace & Agnes Street Drains)*	$1.3 million	Contributes to the protection of 12 flood prone residences in the vicinity of Cleveland Terrace and Agnes Street and a reduction in the spread of flooding over a number of other allotments in a 100 year ARI event.
Eastern Parade Reserve Basin	$ 2.0 million	Contributes to the protection of 12 flood prone residences in the vicinity of Cleveland Terrace and Agnes Street and a reduction in the spread of flooding over a number of other allotments in a 100 year ARI event. Improves the effectiveness of Cleveland Terrace and Agnes Street outfalls.
Cleveland Terrace Drain	$1.8 million	Contributes to the protection of flood prone residences in the vicinity of Cleveland Terrace.
Agnes Street Drain	$1.4 million	Contributes to the protection of flood prone residences in the vicinity of Agnes Street.
Fawk Reserve Basin and Upstream Pipework	$0.6 million	Protection of 17 existing flood prone residences from flooding in a 100 year ARI event.
Cheltenham Diversion and Flood Storage	$1 million	Protection of 4 flood prone residences and a reduction in the extent of flooding during a 100 year event to a number of other properties in the Pennington Area. The basin is required to mitigate the impact of additional flows resulting from the construction of the Torrens Road Relief Drain.
Torrens Road Relief Drain *(this would only be constructed after the Cheltenham Diversion and Flood Storage was completed)*	$10 – 12 million	Only required if development controls prove to be ineffective.
Utilising Brocas Ave playing fields for additional Cheltenham Flood	$4 million	The basin mitigates the impact of additional flows resulting from the construction of the

Storage *(in conjunction with the Torrens Rd Relief Drain)*		Torrens Road Relief Drain and future development. May be required in the 30yr timeframe.

In describing the benefit to be gained from each of the above schemes, a residence has been assessed as being protected from flooding where an allotment is changed from having a flood depth in excess of 200 mm to being less than 200 mm. Maps showing the post upgrade floodplain maps are attached in Appendix C.

8.1.2 Gross Pollutant Traps

The capital cost of gross pollutant traps at each of the nominated locations will be highly dependent on the extent and nature of ancillary works necessary to accommodate the devices. The estimated capital costs are provided in Table 8.2 below.

Table 8.2 Gross Pollutant Trap Costs

Location	Capital Cost	Annual Cleaning Cost
Audley Street	$200,000	$3,200
Arthur Street	$350,000	$2,200
Jenkins Street	$300,000	$4,600
Eastbourne Terrace	$250,000	$4,300
Total	**$1,100,000**	**$14,300**

In addition, annual cleaning costs have been estimated at each trap. These costs have been based on 70% capture of gross pollutants from the various catchments, an average gross pollutant generation rate of 0.1 tonnes/ha/yr and cleaning cost of $500/tonne.

The benefit associated with construction of these traps will be a greater capture of gross pollutants, minimising future maintenance of the Magazine Creek wetlands and the export of materials potentially dangerous to marine animals into the North Arm.

8.1.3 Flow and Rainfall Monitoring

Flow monitoring stations could be established on the Eastern Parade and Jenkins Street Drains for a cost of between $20,000 and $30,000 for each site. A pluviometer station could be installed for a cost of between $5,000 and $7,000.

Annual monitoring costs are likely to be of the order to $7,000 to $12,000 total. This cost will depend on the organisation engaged to carry out the monitoring. If these sites could be rolled into a wider monitoring program, a lower annual cost is likely.

8.1.4 Quality Monitoring

Water quality monitoring stations could be established on the Magazine Creek and Range Wetlands. These would assess key indicators in the performance of the wetlands and quality of water discharged to the Barker Inlet. The costs would depend on the number of parameters monitored. The establishment costs could be expected to be in the order of $2,000 to $4,000 per parameter for each site (with nitrogen and phosphorus up to $10,000 each). These are indicative costs only. A monitoring program would need to be developed to determine the appropriate parameters to monitor and therefore to provide more accurate costs.

8.2 Funding Sources

8.2.1 Drainage Upgrades

Funding sources for drainage upgrade works are well established as are methods of cost allocation.

The Stormwater Management Authority has been established to prioritise the State Governments commitments to stormwater management. The Stormwater Management Authority has a defined annual budget of $4 Million to be administered on a priority basis for stormwater management projects. Funding from the Stormwater Management Authority is offered on a shared basis, namely 50% shared with local government, or a reduced percentage where Federal Government Contributions are available.

For projects involving flood management, the SMA will contribute to projects serving a catchment area of greater than 40 hectares. Of the projects listed in Table 8.1 the only projects which would qualify for this 50% funding are:

- Cheltenham Diversion
- Eastern Parade Channel Raising
- Torrens Road Relief Drain

The remaining projects would need to be funded entirely be the Cities of Charles Sturt and Port Adelaide Enfield. A cost sharing formula, most likely based on catchment imperviousness, would need to be established for the Eastbourne Terrace Scheme and the Eastern Parade Channel raising.

The remaining schemes lie entirely within single Council areas.

8.2.2 Gross Pollutant Traps

Funding for the construction of gross pollutant traps has traditionally been sourced from the relevant NRM Board and Councils. The model has generally been for the NRM Board to jointly fund design and construction with Council on a 50 / 50 basis and then for the Council to take responsibility for maintenance. In the case of the traps within the Torrens Road Catchment, a cost sharing formula for maintenance, presumably based on impervious area, will need to be agreed between the relevant Councils.

8.2.3 Flow and Rainfall Monitoring

There is no current body responsible for stream flow gauging of urban catchments within South Australia. Responsibility for collection of rainfall data generally lies with the Bureau of Meteorology.

The data to be collected from the proposed gauging stations is of value to the catchment Councils as a means of assessing the effectiveness of their development policies. However, the data is also of value to the wider community.

It is most likely that the cost of establishing the stations and collecting data will need to be borne by the Cities of Port Adelaide Enfield and Charles Sturt. However, funding partners may be able to be found through the Department of Environment Water and Natural Resources and the Bureau of Meteorology.

9 Priorities, Timeframes and Responsibilities

9.1 Priorities and Timeframes

Priorities have been established for various elements of the strategy, taking into consideration the likely impact of these strategies and the benefits to be gained by their implementation. The elements are listed in order below, together with a proposed timeframe for implementation.

Highest Priority (1 to 2 year timeframe)

- Establish changes where needed to Development Controls to provide for retention of flows on-site for residential redevelopment, to ensure that the peak and volume of discharge matches pre-redevelopment levels.
- Establish flow monitoring stations on the Eastern Parade and Jenkins Street Outfalls and a pluviometer at Cheltenham Wetland.
- Establish quality monitoring stations on the Magazine Creek and Range Wetlands, as the first step towards developing a comprehensive management plan for the wetlands and assessing the need for any reconfiguration.
- Ensure the proposed development at Gillman includes measures to maintain its performance in providing storage of stormwater during high tide with sea level rise and treatment of stormwater.

Next Highest Priority (2 to 5 year timeframe)

- Investigate the Fawk Reserve works
- Investigate the Eastbourne Terrace Outfall
- Investigate and Consult on Eastern Parade Reserve Basin
- Investigate the Cleveland Terrace Outfall
- Investigate the Agnes Street Outfall
- Investigate the Eastern Parade Channel Raising Works (if the Eastern Parade Basin is not feasible)
- Investigate, design and construct Gross Pollutant Traps

Medium Priority (5 to 10 year timeframe)

- Design and construct Eastbourne Terrace Outfall
- Design and Construct the Eastern Parade Reserve Basin (subject to consultation)
- Design and construct the Cleveland Terrace Outfall
- Design and construct the Agnes Street Outfall
- Design and construct the Eastern Parade Channel Raising Works (if Eastern Parade Basin does not proceed)
- Design and construct Fawk Reserve works
- Investigate, design and construct Gross Pollutant Traps

Longer Term Priority (10+ year timeframe)

- Investigate, design and construct the Cheltenham flow diversion

- Investigate, design and construct the Torrens Road Relief Drain, if required by redeveloped flows

9.2 Responsibilities

The Stormwater Management Plan provides the roadmap for the mitigation of flooding and management of stormwater for the Torrens Road Catchment. The Steering Group which has overseen the development of the Stormwater Management Plan comprises representatives of key stakeholder organizations that have responsibility for implementing the Stormwater Management Plan.

Given the catchment extends across Council boundaries, the cooperative relationship between the City of Charles Sturt and the City of Port Adelaide Enfield has been important in developing this Stormwater Management Plan.

Responsibilities for leading and funding investigation and capital works projects, as well as operation and maintenance is set out below.

9.2.1 Investigation and Capital Works Projects

Responsibilities for funding of investigations and capital works projects have been discussed in Section 8.2 above. While funding may come from a number of sources, each project has been assigned a lead organisation or 'champion' to facilitate its implementation. In most cases, the Council within which work is to be undertaken has been identified as the appropriate leader.

Table 9.1 below sets out the envisaged responsibilities.

Table 9.1 Project Responsibilities

Component	Lead Organisation	Funding Organisations
Development Controls	City of Charles Sturt City of Port Adelaide Enfield	City of Charles Sturt City of Port Adelaide Enfield
Flow and Rainfall Monitoring	City of Port Adelaide Enfield	City of Charles Sturt City of Port Adelaide Enfield
Eastbourne Terrace	City of Port Adelaide Enfield	City of Charles Sturt City of Port Adelaide Enfield
Cleveland Terrace	City of Port Adelaide Enfield	City of Port Adelaide Enfield
Agnes Street	City of Port Adelaide Enfield	City of Port Adelaide Enfield
Eastern Parade Channel Raising	City of Port Adelaide Enfield	SMA City of Charles Sturt City of Port Adelaide Enfield
Gross Pollutant Trap Construction	City of Charles Sturt (3 of) City of Port Adelaide Enfield (Eastbourne)	NRM Board City of Charles Sturt City of Port Adelaide Enfield
Fawk Reserve	City of Charles Sturt	City of Charles Sturt
Cheltenham Diversion	City of Charles Sturt	SMA City of Charles Sturt
Torrens Road Relief Drain	City of Charles Sturt	SMA City of Charles Sturt

9.2.2 Operation and Maintenance

Within South Australia, normal practice has been that, once constructed, the responsibility for operation and maintenance of stormwater infrastructure vests in the Council within which the works have been constructed. It is anticipated that this practice will continue to be adopted in the Torrens Road catchment for flood management works such as pipes, channels and basins during the timeframe covered by this Plan.

A slightly different set of responsibilities has been applied to the operation and maintenance of gross pollutant traps and other water quality improvement devices. Operation and maintenance of these devices is carried out by the Council in which the device exists, but responsibility for the cost of maintenance is shared as described in Section 8.2.2 above. It is anticipated that this approach will continue to be adopted during the timeframe covered by this Plan.

To date, responsibility for the operation and maintenance of the Magazine Creek and Range Wetlands (outside the gross pollutant traps) has been entirely vested in the City of Port Adelaide Enfield. It is anticipated that this approach will continue during the life of this plan.

9.3 Cost Apportionment between Councils for Capital Works

9.3.1 Background

In 2004, KBR undertook a study for the Local Government Association of South Australia and the State Government of South Australia entitled Metropolitan Adelaide Stormwater Management Study (KBR, July 2004). Part C of the report prepared for that study dealt with the issue of apportionment of Council costs and explored a number of options for allocating the cost of stormwater infrastructure where the catchments extend across more than one Council.

The report includes a comprehensive discussion about the complexity of the factors that could be taken account of in the determination of equitable cost apportionment between Councils for stormwater infrastructure. Fundamentally, the report concludes that all areas that contribute stormwater as a result of urbanisation, bear some responsibility for the cost of the stormwater infrastructure required to convey that stormwater safely to the sea, but it also recognises the benefits that reducing flood risk in downstream areas has on the ability of those areas to allow urbanisation.

The report considers three cost apportionment models being:

- Option 1: A simple model where the costs are apportioned simply on the basis of contribution to flows measured in terms of impervious areas within each Council area. This option is suitable where the costs and the benefits are relatively uniformly distributed across the catchment, but is less attractive when most of the benefits fall in one area only.
- Option 2: A more complex model that attributes a part of the cost (x%) based on the proportion that each Council contributes to the flows, and attributes the balance (1-x%) based on the proportion that each Council benefits from future costs avoided by the reduction in damage as a result of flood risk reduction.
- Option 3: A yet more complex model that builds on Option 2 by introducing a third factor (y%) that takes account of the proportion of local benefits such as opportunities for water re-use, aesthetic and recreational outcomes that each Council enjoys as a result of infrastructure.

KBR's report does not make any recommendation in relation to the quantum of the percentages x or y.

The works proposed in this management plan fall into the following categories:

1. Upgrades to major drains such as the Eastern Parade channel, and outfalls from Eastbourne Terrace, Agnes Street and Cleveland Terrace.
2. Detention and WSUD measures on private developments.
3. WSUD measures on Council roads and open spaces.
4. Water quality improvement devices (GPTs).

9.3.2 Cost Share for Major Drainage System Upgrades

The upgrades proposed for the major drainage system are exclusively to reduce the flood risk to properties in trapped low points behind the coastal dune system. The benefits are limited to flood risk reduction at those locations. It is proposed that the Cities of Charles Sturt and Port Adelaide Enfield will apportion costs for upgrades to the major drainage system in accordance with Option 2 set out previously with a 50/50 weighting applied to contribution/benefit. As an example, if 60% of the stormwater was sourced in the City of Charles Sturt, and 40% in the City of Port Adelaide Enfield, and all the benefit accrued in the City of Port Adelaide Enfield for a project with a combined Council contribution of $C, the contributions from the Councils would be calculated as follows:

Contribution by the City of Charles Sturt = (0.5 x 0.6 + 0.5 x 0.0) x C = 0.3 x C

Contribution from the City of Port Adelaide Enfield (0.5 x 0.4 + 0.5 x 1.0) x C = 0.7 x C

Note: It is anticipated that the State Government may partially fund this project and therefore the combined Council contributions would be the cost of the project less any other contributions.

Given that the two Council areas are relatively homogenous and that they have similar development policies in place, it is proposed that the calculation of contribution to flows be based on impervious areas calculated with reference to current zoning provisions in relation to minimum allotment sizes but not including land zoned as open space. This avoids the need to actually quantify the current imperviousness and anticipates a fully developed catchment.

9.3.3 Cost Share for WSUD Measures on Private Developments

It is proposed that stormwater detention and other WSUD measures on private property be funded by the developers of private property without any Council contribution.

9.3.4 Cost Share for WSUD Measures on Council Roads and Open Spaces

It is proposed that the cost of the Council contributions to WSUD measures on Council roads and open spaces be funded in proportion to the contribution of flows to the device. The logic for this is that the benefits of improved stormwater quality are shared across the broader community, and that the burden for implementing WSUD should similarly be shared in proportion to contribution. This is consistent with the cost share set out for major drainage system, but simply apportions benefits in the same proportion as contributions. As for the minor drainage system, it is considered that in most cases the costs and the benefits will both occur in Council areas only.

9.3.5 Cost Share for Water Quality Improvement Devices (GPTs)

As for WSUD measures, more generally it is considered that the benefits of improved water quality on the Barker Inlet are a benefit to the broader community and costs ought to be shared in proportion to contribution.

10 Consultation

Consultation on the Draft Stormwater Management Plan has been undertaken via a number of forums. This consultation included:

- A joint presentation to elected members of the City of Charles Sturt and City of Port Adelaide Enfield held in April 2013;
- An information session and presentation for members of the general public held at the City of Port Adelaide Enfield in December 2013, together with public display of the plan document; and
- Writing to key state government agencies seeking comment on the Draft document.

Following this consultation process, written responses were received from a number of organisations as follows:

- SA Water
- Renewal SA
- Department of Planning Transport and Infrastructure (DPTI)
- Environment Protection Agency (EPA)
- Adelaide and Mount Lofty Ranges NRM Board
- Cheltenham Park Residents Association (CPRA)

A summary of the responses is provided below, together with commentary on the changes made to the Draft Plan. Copies of the written submissions are contained in Appendix D.

Table 10.1 Summary of Responses

Organisation	Response	Comment / Action
SA Water	Concern regarding diversion of flows from the HEP system into the TRDA catchment due to its impact on the Barker Inlet harvesting scheme.	The diversion described is no longer proposed. Reference to the diversion has been removed from Section 7.3.
	Commentary on the need to consider pressurisation of the aquifer in any recharge scheme.	Noted.
	Commentary on the effectiveness of grass lined channels in reducing sediment loads to the downstream wetlands.	Noted. There are three main concrete lined outfall channels in the catchment. Conversion of these channels to grass lined systems is constrained by land availability.
	Comment on desirability of utilising stormwater to water street trees.	Strategy has been added relating to use of water sensitive urban design in public works.
Renewal SA	Concern at language used to infer that development at Gillman is 'bad'.	The wording used in the document was not intended to portray development at Gillman as either good or bad, simply to reflect the fact that the development needs to be properly investigated to ensure that it

Organisation	Response	Comment / Action
		does not have a negative effect. The timing of preparation and issue of drafts of this Plan also overlaps some of the investigations at Gillman. The wording has been reviewed where appropriate to more closely reflect the current status of this land, while still ensuring that reference to appropriate investigations is maintained.
	Land use descriptions in Section 2 need to be adjusted to reflect the current status of land in the Gillman area and Figure 2.2 needs to be adjusted to properly reflect land use.	Wording in Sections 2.2and 2.3 have been adjusted and the associated Figures and Tables modified.
	Reference to the Structure and Master Plans fo the Gillman area should be included.	The work undertaken by Jensen Planning and design in 2009 and 2013 associated with planning in the Gillman area has been added to Section 3.
	Description of development potential of SAHT land and Gillman needs to be modified to reflect current status.	Wording of Section 4 adjusted in relation to SAHT land and Figure 4.2 changed to show development at Gillman within 10 years,
	Labelling of TRDA Basin in Figure 5.1	Noted and amended.
	Queried assumption that flows are to be discharged by gravity to sea.	There has been an underlying assumption in the development of the Plan that flows are to be discharged by gravity to sea. This is due to the magnitude of flood flows involved (in terms of both peak and volume) which cannot be practically cater for by pumping. No change.
	Suggestion that a trade-off between standard and value generated by development might be possible where party receiving the benefit covers the risk..	Noted. In most instances these parties are not the same. No change.
	Clarification as to what is being proposed for on-site detention / retention, and relationship to Council's current practices.	The design criteria for site discharge has been clearly articulated in the Plan. The Plan has been deliberate in not recommending particular approaches to the on-site management of runoff to achieve the design criteria described. It is anticipated that the stated criteria will be achieved by a variety of methods, depending on the constraints of specific sites. The development of a tool to assist developers in determining requirements is noted below. (DPTI response)
DPTI	Commentary on importance of managing increased runoff from redevelopment, but concerned at the current manner in which this is able to be undertaken through Council's planning processes, the	Proposal added to develop tool for calculation of pre-development flow rates and for assessment of proposed detention / retention measures associated with development.

Organisation	Response	Comment / Action
	approach.	limited capacity of lateral systems feeding these drains. The Plan proposes that where upgrades to street drainage occur, that these be to a 2 to 5 year standard. The Plan also includes an objective of maintaining the standard of the main drains. This is largely achieved by limiting the areas in which upgrade of laterals is proposed. The recommended standard for limiting flow from development is aimed at reducing impacts on the lateral systems (5 year ARI design standard). Due to the flat nature of the area, floodwaters tend to be stored throughout the catchment, with only small increases in flood level noted for a 100 year event with redevelopment. Setting of discharge criteria from development is a balance between practicality / cost and impact. It is considered that the 5 year standard referred to in the plan is appropriate, and will not result in the function of the main drains being compromised due to the other factors described above.
	Commentary on impact of sea level rise on the Gillman stormwater ponding basins, and suggestion that impacts beyond 2100 be considered in any review of the Gillman basins.	The latest IPCC Assessment Report, released in 2013 provides ranges of potential sea level rise for various emission scenarios. The upper bound of predictions for the worst scenario indicates a rise of close to 1 m by 2010, with a most likely rise of approximately 0.75 m. The most likely range predicted by the remaining three of the four emissions scenarios examined is between 0.4 and 0.6 m by 2100. Current Coast Protection Board Policy requires a consideration of the ability of development to be modified to cater for 1 m rise by 2100 which, based on the above appears to be a reasonable (and conservative approach). It is agreed that development in the Gillman area needs to consider the implication and recommendations of the latest IPCC report and the wording of this section has been modified to include a discussion of work undertaken to model the impact of a 1 m sea level rise.
EPA	Support the need for monitoring of the Magazine Creek and Range Wetlands	Noted.
	Responsibility for care and maintenance of the wetlands needs to be clearly articulated in the Plan.	Added Section 9.2.2 to set out responsibilities for operation and maintenance, including the wetlands.

Organisation	Response	Comment / Action
	Recommend that further strategies be added to address water quality from future development, including site controls and water sensitive urban design.	Strategy has been added concerning water sensitive urban design in public works.. The description of proposed on-site strategies dealing with commercial and industrial development has also been amended to refer to water sensitive urban design. Specific strategies have not been specified as a part of the Plan, as various on site treatment techniques are possible.
	Need for a wetland management strategy to be included in the Stormwater Master Plan for Gillman	Added comment to Section 7.2.5 in relation to assessing the need for any re-configuration on the water quality improvement performance of these systems..
	Noted that the Development Potential report pre-dated 30 year Plan.	The Jensen Report does pre-date the 30 year plan. However, flood modelling work undertaken using TUFLOW did consider increased imperviousness within 800 m of rail lines and at proposed Transit Oriented Developments as envisaged in the 30 year Plan as noted in Section 4.6. No change made to document.
	Errors in Section 9.3.	Errors have been corrected.
NRM Board	Suggested that a summary of flood prone properties is required.	Information on numbers of flood prone properties is included in Table 8.1.
	Queried basis of references to the good existing performance of the wetlands	Reference is in fact to performance of Barker Inlet wetland, which has the same design criteria. Wording has been changed in Section 5.7.
	Suggested that there should be an action for undertaking improvements to the Magazine Creek and Range wetlands.	Section 7.7.3 refers to the monitoring programme providing information that might leda to a review of the wetland management strategy or re-configuration.
	Queried whether the two Council's were supportive of installing additional gross pollutant traps.	Both Councils have reviewed the content of the Plan and have not queried the proposed action to provide these gross pollutant traps.
	Suggested that an Executive Summery be added.	Executive Summary has been added.
CPRA	A lengthy submission has been provided by the Cheltenham Park Residents Association in relation to the Plan. Much of the submission deals with the development of Cheltenham and its perceived impact. The main concern expressed in the summary to the response deals with a perceived lack of proposed works within the Charles Sturt area.	The flood management works proposed in the Plan have been targeted at those areas which flooding was the most severe in a 1 in 100 year event, and which were closest outfalls that could be upgraded at a cost commensurate with the envisaged flood damages.

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Appendix A

Development Potential Report

TORRENS ROAD CATCHMENT-STORMWATER MANAGEMENT PLAN

DEVELOPMENT POTENTIAL OF SITES WITHIN THE CATCHMENT

Prepared for
Tonkin Consulting

By

Jensen
PLANNING
& DESIGN

June 2009

TABLE OF CONTENTS

1 INTRODUCTION

The City of Charles Sturt and Port Adelaide Enfield Council have identified the need to develop a final Stormwater Management Plan for the Torrens Road catchment. The existing underground drainage system is ageing and has a limited capacity to cope with the current levels of development. Future development within the catchment will place additional strain on the drainage system and therefore the need to plan for and manage stormwater run-off will be intensified.

Jensen Planning & Design has been engaged by Tonkin Consulting to identify future development potential within the Torrens Road Catchment to assist in identifying changes in the profile of impervious areas. These changes are identified in this report in short term (10 years) and long term periods (20 years).

The analysis of future development potential has been undertaken through:

- Liaison with the City of Charles Sturt and Port Adelaide Enfield Council to identify any significant policy changes that may be in train and which may influence future development potential.
- Liaison with Housing SA to identify any proposals for regeneration of Housing SA stock within the catchment area and expected development outcomes and timelines;
- Liaison with the Department for Transport, Energy and Infrastructure (DTEI) to identify any changes in transport infrastructure which may affect development;
- Liaison with the proponents of the Cheltenham/Sheridan and Westwood residential development projects to determine likely development outcomes and timelines;
- Liaison with Planning SA personnel involved with the Greater Adelaide Plan investigations to identify any implications for the Torrens Road Catchment area;
- The review of any relevant documentation including the *Residential Metropolitan Development Program* by Planning SA, *Gillman Structure Plan* by Jensen Planning & Design*, Cheltenham and Environs Master Plan* by GHD, *Industrial Land Study* by Colliers*, The City of Charles Sturt Open Space Strategy* by Hassell;
- A review of site value - capital value data to determine the likelihood for redevelopment when correlated with current (and possible future) development policy; and
- The review of ABS data to determine historical development trends.

2 CHARACTERISTICS OF THE CATCHMENT

2.1 Location

The Torrens Road (TRDA) Catchment is approximately 2345 hectares in area. The area north of Grand Junction Road is within Port Adelaide Enfield Council (PAEC) and south of Grand Junction Road, the majority of the catchment is within the City of Charles Sturt, although part of the area falls within Port Adelaide Enfield along the east and west boundaries.

2.2 Residential Land Use

In the PAEC area of the TRDA Catchment the majority of the housing stock is very old, apart from some small pockets of housing redevelopment that occurred between 1981 and 1998 primarily north of Grand Junction Road and scattered throughout the remainder of the Catchment.

The majority of the housing in the suburb of Ottoway is circa 1946 to 1960 (valuer General Database 1998), although in Rosewater to the west some housing dates back to pre-1900. South of Grand Junction Road the majority of the housing is circa 1901 to 1945, although there are examples of housing developed between 1946 and 1998 scattered throughout the area.

Residential densities tend to vary, although generally speaking low density residential development characterises the living areas in the City of Charles Sturt and in PAEC residential densities range from low to low-medium. There is a high proportion of Housing SA developed residential areas in the Catchment, although only a relatively small number of houses are still owned by Housing SA.

2.3 Industrial / Commercial Land Uses

In the north of the Catchment in the suburbs of Port Adelaide, Wingfield and Gillman the majority of the land is zoned for industrial use.

The Industry Zone extends into Charles Sturt Council in the suburbs of Athol Park and Woodville North. North of Torrens Road and east of Hanson Road in Kilkenny the Catchment is developed with a range of commercial / industrial uses.

Vacant industrial allotments are located throughout the Catchment, but the majority are found north of Grand Junction Road. Large parts of the MFP zoned land at Gillman have been identified for potential industrial development (refer Section 4.2.1), together with large areas allocated for stormwater management and environmental purposes.

2.4 Public Open Space / Recreational Uses

Apart from formal sports and recreation grounds, such as those associated with schools or clubs and other formal recreation uses such as bowling greens and the Cheltenham Racecourse, open space is generally limited to relatively small areas of local public open space and a few local neighbourhood public reserves such as Finsbury Reserve (Woodville North), Fawk Reserve (Athol Park) and the Eastern Parade Reserve (Ottoway).

Areas in the far north of the catchment in the MFP Zone have the character of open space (ie undeveloped land) and include various wetlands for stormwater detention.

Although Planning SA's land use categories indicate approximately 33% of the catchment is open space, the calculation includes vacant land. Planning SA's Parklands 21 Strategy identifies the majority of the area comprises between 1-5% open space, the lowest of six categories.

3 STRATEGIC CONTEXT

3.1 Development Plan Analysis

3.1.1 Zoning Provisions Relating to Density

Port Adelaide Enfield Council

The Rosewater North and Rosewater South area has been included in the Residential Code Character submissions as PAEC would like to retain the low to low-medium density nature and character of these areas. Whilst PAEC wishes to retain the existing character dwellings, the zoning of the area currently allows the poorer quality housing stock to be replaced at medium densities. Therefore, it is likely that in some parts of these areas there may be a slight increase in density.

The majority of the residential areas within the centre of PAEC have a built form character which is protected by Policy Area 8 of Council's Development Plan and therefore the area will not be subject to unsympathetic redevelopment. Whilst the area to the north of Grand Junction Road does not typically have character areas, Policy Area 13 only allows for low to medium densities in these areas. Given this zoning there is only likely to be small amounts of infill development in appropriate locations around Port Adelaide that will slightly increase the overall density in these areas.

The catchment encompasses small areas to the east of Hanson Road which fall within Policy Areas 43 and 44 of the PAEC Development Plan. The Housing SA sites located within Mansfield Park and Woodville Gardens (Policy Area 44) are encouraged (through zoning provisions) to be redeveloped at higher densities where public transport nodes and shopping centres are nearby. Other housing

within Woodville Gardens (Policy Area 43) is encouraged to be retained at low densities, retaining the single storey nature of the area.

There is no specific site cover requirements in the Port Adelaide Enfield Development Plan, as run off is managed according to the availability of wetlands or other stormwater management systems in a given area. There are, however, private open space requirements that provide some development controls and limit the areas of land which can be built upon. The PAEC require 25% of allotments greater than 250sqm in area and 50sqm for allotments less than or equal to 250sqm in area to be designated as private open space.

City of Charles Sturt

Charles Sturt does not state any maximum site cover requirements in the Development Plan. However, there are minimum requirements for private open space which are generally 25% within the Torrens Road Catchment area. This is a loose control over the amount of impervious surface on an allotment, as private open space may still incorporate roofed areas such as verandahs, balconies and also includes paving. It could therefore be estimated that impervious surfaces and roofed areas typically comprise approximately 80% of the site area for new development.

The City of Charles Sturt has undertaken a Ministerial PAR (Gazetted 25 January 2007) for the former Actil/Sheridan industrial site which has rezoned the site to enable residential use. A Cheltenham Racecourse DPA (Gazetted 14 August 2008) has rezoned the 49 hectare Cheltenham Racecourse site at Woodville to predominantly residential and open space/wetlands. This allows for medium to high density residential development to be undertaken on the former Cheltenham Racecourse and Sheridan sites. Details of future development potential of these sites are covered in Section 4.2.1 and illustrated in **Appendix 2** - **Cheltenham Concept Plans**.

A large proportion of residential land along Torrens Road is within the Residential Mid Suburban Policy Area 2 of the Charles Sturt Development Plan, which allows medium density development up to two storeys on a minimum lot size of 250 square metres. This area has potential for infill development due to the proximity to transport nodes and zoning which encourages medium density development.

The development trends within the last five years have indicated that there have been very few residential flat buildings constructed, with detached dwellings (generally on small lots) being overwhelmingly the most predominant form of development occurring within the City of Charles Sturt (more detail is provided in Section 4.1.1).This may be due to the fact that detached dwellings can be constructed on relatively small allotments. The Development Plan requires that allotments are 400-500sqm in site area for detached dwellings compared to 300-350sqm for residential flat buildings in the majority of areas within the catchment (ie not a sufficient differential in density to encourage medium densities).

There are also three Historic (Conservation) Zones within an 800 metre radius of Port Road and Torrens Road which will provide some limitations to infill development within these areas of the catchment:

1. The Cheltenham West Policy Area 19 controls land at the western end of the catchment and is clustered to the south of Torrens Road.
2. The Croydon / West Croydon Policy Area 10 controls a large pocket of land at the eastern end of the catchment and within the 800 metre radius of both the Torrens Road and Port Road growth corridors.
3. The Pre World War One Policy Area 12 is located in Pennington and to the north of Torrens Road.

All three Historic (Conservation) Zones have stringent guidelines and only allow for medium density development that complements the existing character of the area.

The Historic (Conservation) Zones have been subject to scattered infill development where there are no or few contributory places. The zoning allows for all dwelling types and a minimum allotment area of 300sqm in some zones. Considering that many allotments within the Historic (Conservation) zones are larger and more traditional in size, there are still opportunities to redevelop many sites within these areas, including sites that comprise contributory places.

3.1.2 Stormwater Management Policies

The current relevant Development Plans are lacking in detail regarding the identification of areas of flood prone land. Terms such as "poorly drained land" and "land liable to floodwaters" are used (although PAEC has a specific principle referring to a plan showing low lying area).

In both Development Plans provisions relating to public open space acknowledge that such areas may "enable effective stormwater management where required". However, in most circumstances the Development Plans do not adequately identify those areas where effective stormwater management is required.

3.1.3 Draft Development Plan Amendments (DPA's)

Port Adelaide Enfield Council

The PAEC is currently undertaking a Port Adelaide Centre DPA which incorporates the Woolstores Historic (Conservation) Policy Area which aims to protect existing heritage buildings within the Woolstores area. PAEC may allow residential development within the Woolstores area in the longer term (10-15 years) depending on what DTEI has planned for road networks and access.

There is currently a Draft Industry Zones DPA which includes a Deferred Industry and Coastal Management Zone over the land in the northern part of the catchment (currently MFP Zone). Changes in

policy will encourage landscaping, stormwater treatment and aquifer recharge for appropriate industrial sites that are not subject to contamination.

There have been a number of PAR's altering industrial zones within PAEC since 2003, however, no residential PAR's or DPA's have been conducted that will influence future density.

City of Charles Sturt

The City of Charles Sturt is currently undertaking a Residential Strategy aimed at identifying future residential growth opportunities throughout the Council area, taking into account the State Governments overall metropolitan growth strategy. Jensen Planning + Design is leading the consultant team, with the study expected to be concluded later this year.

As part of this broader Study Council has identified the opportunity to promote transit oriented development and improve the quality of the physical environment and liveability around the Kilkenny Station, with the view to implementing a DPA for the area in the future (at the time of writing a separate study of this area has been commenced). The DPA will consider replacing some of the industrial zoned land with mixed use and high density residential zoning. This site is discussed in greater detail in Section 4.2.1.

3.2 Other Council Policies

The City of Port Adelaide Enfield requires that all new greenfield or regeneration development sites provide additional open space to manage the stormwater on site. This is an 'in-house' requirement and not supported by any Development Plan policies and therefore difficult to enforce.

Some dwellings on sites which have development potential may be demolished and replaced with new, larger dwellings or existing dwellings may be extended rather than the subdivision of land occurring. These sites will increase the amount of impervious surface and subsequently stormwater runoff within the catchment. Council policies do not require stormwater detention on site and increases in run off from these sites will ultimately be unmanaged unless instigated by individual owners.

There are zoning controls over industrial sites in the City of Charles Sturt which require on-site stormwater detention. This is assessed by Council's engineering department on a site by site basis.

It is unknown what affect the drought will have on stormwater run-off. Some individual home owners are replacing grassed areas with paving to cope with dying lawns as a result of the water restrictions. This will increase the amount of impervious surface areas and as a result increase the amount of run off from yard areas. There are no development controls in place to monitor the amount of paving on individual established allotments and no means of monitoring past

trends (other than aerial photo history). It is therefore difficult to make an assumption on how many allotments will increase impervious surface areas in either the short or long term.

3.3 Department of Planning and Local Government

3.3.1 30 Year Plan for Greater Adelaide

The 30 Year Plan for Greater Adelaide will not be released until the middle of 2009 and therefore accurate information regarding growth targets is not yet available. The Directions document is currently available and outlines key growth strategies along transport corridors, Transit Oriented Developments (TOD) and growth investigation areas.

Discussions with the Department of Planning and Local Government have indicated that the following Western Regional Targets (part of the City of Port Adelaide Enfield, the City of Charles Sturt and the City of West Torrens) can be used as a guide to growth areas. However the information is subject to change and may not be accurate when the Plan is publicly released.

"Development is likely to intensify within 800 metres of transport corridors, particularly along Port Road and Torrens Road, with these corridors accommodating 36,500 dwellings and 72,000 people. Council's structure planning will need to determine whether the current land use and zoning is appropriate and alterations to zoning made accordingly. However, all Historic Conservation zones will remain as they are, to protect the character of development within these areas."

There are three areas targeted by the Directions document for TODs along the Port Adelaide to City railway line at Port Adelaide, Woodville and Bowden/Brompton. These will become key areas for housing regeneration and infill development.

The population targets for the Western Regional area propose an increase of 91,000 people and 46,000 new dwellings over the next 30 years.

3.3.2 Residential Metropolitan Development Program

Future development in the inner-west region will mainly occur as a result of demolition of the older housing stock and re-subdivision and increased densities. Councils in this region are responsive to the likelihood of increased densities and the City of Charles Sturt has amended its Development Plan to accommodate a potential 27,500 additional dwellings. Other housing stock is likely to be developed through (limited) supplies of surplus Government land and Housing SA infill projects.

4 ANALYSIS OF DEVELOPMENT POTENTIAL

4.1 Data Analysis

4.1.1 Review of Previous Analysis of Planning and Development Issues

A background report was undertaken for Tonkin Consulting by Jensen Planning and Design in 2003 which analysed Planning and Development Issues for the Torrens Road Drain Catchment. This report provided a quantitative analysis of the 2001 GIS data taken from the capital to site value ratios when overlayed by the zoning analysis (ability to subdivide land based on current zoning restrictions). The findings in this report are still considered to be relevant and have been included as an attachment to this report (refer to Appendix 1 - **Initial Urban Stormwater Master Plans, Planning and Development Issues (Chapter 5)**).

The Department of Planning and Local Government has suggested that the data has not allowed for market fluctuations that have occurred since 2001 which have significantly increased the site value whilst the capital value has remained relatively dormant. The Department has therefore suggested that the ratio used for the purposes of any future analysis should be adjusted from 1.2 to between 1.3 and 1.5 to allow for the dramatic increases in site values.

The capital value to site value and zoning analysis has not been undertaken by the State Government since 2001 and is not likely to be updated until later in 2009. Consequently it has not been possible to undertake the same type of detailed analysis that was undertaken in the 2003 background report.

4.1.2 Historical Development Trends

City of Charles Sturt

In 2006, Census counts returned 42,476 occupied private dwellings in the City of Charles Sturt (refer to **Table 1**). The majority of the dwellings (72% or 30,782 dwellings) are separate houses. One storey semi-detached, row and town houses represent 12% of the occupied stock, followed by flats, units and apartments of generally one or two stories.

Since 1996 there has been a shift in occupied dwellings towards separate houses (+10%) and units in one or two storey blocks (+12%) while there has been a drop in the number of occupied semi-detached, row, terrace and townhouses (-13%). The drop in numbers of semi-detached, row, terrace and townhouses indicates that 16% of these types of dwellings have been demolished and replaced with detached dwellings or flats, units or apartments since 1996.

Separate houses are the dominant dwelling structure among most household types, representing 72% of the total housing stock. In Charles Sturt, the stock of occupied separate houses has increased

by 10% between 1996 and 2006. During that same period, the overall stock of private occupied dwellings increased by 4% from 40,795 in 1996 to 42,476 (ABS, 1996-2006 time series).

This information is based on an analysis of historical development trends within the whole of the Charles Sturt Council area and it is likely that a similar trend would have been demonstrated within adjacent council areas. PAEC was not independently analysed as only a small portion of the council area falls within the Torrens Road catchment.

The previous Planning and Development Issues Report (see Appendix 1) projected a 5.1% increase in dwellings being constructed within the catchment over the then short term (10 years). It was estimated that 49 new dwellings per annum (taking into account demolitions) would be constructed within the 10 year period. The City of Charles Sturt has recorded a 4% increase of new dwellings constructed over the last 10 years which is slightly lower that what was previously estimated. Using the historical trends data (4%), it can be projected that there will be an increase of 39 dwellings per annum over the short term (ten years) rather than the 49 dwellings previously projected.

Table 1 Dwellings Types in Charles Sturt, 1996 - 2006

Dwelling Type	2006	% of Total Dwellings	2001	1996	96-06 % change
Separate house	30,782	72%	29,373	28,100	+10%
Semi-detached, row, terrace, town house					
-single storey	5,137	12%	6,122	6,110	-16%
-Two or more storeys	1,369	3%	1,220	1,328	+3%
Sub-total	6,506	15%	7,342	7,438	-13%
Flat, unit or apartment					
-In a one or two-storey block	4,394	10%	4,204	3,917	+12%
-In a three-storey block	326	1%	361	362	-10%
-In a four or more storey block	215	1%	174	182	+18%
-Attached to a house	37	0%	76	122	-70%
Sub-total	4,972	12%	4,815	4,583	+8%
TOTAL	42,260	99%	41,530	40,121	5%
Other dwelling (caravan, cabin, houseboat, improvised, house attached to shop)	216	1%	265	231	-6%
Dwelling structure not stated	0	0%	158	443	-100%
TOTAL	42,476	100%	41,953	40,795	4%

Source: ABS Census, time series 1996-2006

4.2 Current Development Proposals and Opportunities

4.2.1 Land Management Corporation (LMC) / Adelaide City Council (ACC)

Gillman / Dry Creek

The LMC and ACC own approximately 550 hectares of future industrial land at Gillman and Dry Creek, zoned MFP. Currently the Zone envisages urban development which accommodates 30,000 to 50,000 people. Redeveloping this land for industrial uses will require rezoning from MFP to Industrial. This site is being considered for industrial development (potentially 250 hectares) and stormwater and tidal management beginning in the short term and extending over 15-20 years in stages (refer to **Figures 1 and 2** extracted from the Final Gillman Structure Plan Report prepared by Jensen Planning & Design (and others)). There are opportunities for this land to become a stormwater harvesting factory through the inclusion of wetlands supporting aquifer recharge.

Figure 1: Gillman land able to be developed in the short term

Figure 2: Final Structure Plan (longer term - 15 - 20 years)

Other Sites

In the longer term (approximately 20 years) the LMC considers that the land on the northern side of Torrens Road at Woodville North nearby the Cheltenham site will experience urban infill development. This would be subject to zoning changes within the City of Charles Sturt as the area is currently primarily industrial with residential areas either side. If this transpires impervious site coverage is likely to decrease. However Council is currently committed to retaining this area for industrial usage.

The LMC has not identified any disused school sites or other areas that will be potentially available in the short or longer term.

4.2.2 Cheltenham Racecourse / Former Sheridan Site / St. Clair Reserve

The former Sheridan site adjacent to the railway line in Woodville is currently being redeveloped into a total of 190 housing lots.

The northern section of the Sheridan site has a total of 150 lots with:

- 41 lots released at Stage 1 (completion date – May 2009)
- Stage 2 will release 76 lots (Aug 2009)
- Stage 3 will release 33 lots (Oct 2009)

The southern section, separated by an open space area, will then provide the remaining 40 lots. Dates for the release of this land are yet to be determined.

While the Sheridan site proposes 190 new housing lots which replace an industrial site, it is noted that the previous industrial buildings and car parking constituted 100 percent site cover. The new development proposed on this site will represent a decreased amount of impervious surface in comparison to the previous use.

The former Cheltenham Racecourse is a site comprising 49 hectares of land which is currently vacant. Over 8 years the land will be developed to include densities of 20 dwellings per hectare, resulting in 980 new dwellings (refer to **Appendix 2 - Cheltenham Concept Plans**). Buildings on individual allotments will be allowed to cover 60-70% of the site. There are some sections where higher density developments are envisaged, that will only require 25 square metres of private open space.

The stormwater is proposed to be redirected away from Audley Street and into 6 hectares of wetland to be managed within the Cheltenham/Sheridan site. 35% of the Cheltenham site will be allocated to public open space and wetland areas.

The City of Charles Sturt is investigating whether land adjacent to the Woodville Railway station and encroaching into the St Clair Reserve could be developed into a TOD with medium-high density development. This area would link into the Sheridan and Cheltenham sites through the inclusion of open space areas through the southern central section of the Sheridan and Cheltenham land.

4.2.3 Housing SA

The Housing SA owned housing comprises a variety of housing stock including:

- Double unit sites (all north of Torrens Road):
  - Pennington
  - Woodville North
  - Athol Park
  - Woodville Gardens
  - Mansfield Park.
- Attached houses scattered throughout / some grouped.
- Some flats, single units.

There is a portion of Housing SA land in Pennington, within the Residential Historic (Conservation) Zone (Early Housing Trust Policy Area 9) that currently comprises double units. These dwellings were constructed around the 1940's and are the earliest double units built

by the (then) Housing Trust. The units are small, housing one to two people and are considered low density forms of development.

This Zoning allows for sensitive infill or regeneration of allotments outside the areas most worthy of retention in their existing form. A Review of the Historic (Conservation) Zones (report undertaken by Jensen Planning & Design for the City of Charles Sturt) has identified Bell Street, parts of Tulloch Street, and the area fronting on to and including Sinclair Square as areas most worthy of retention in their existing form.

Housing SA would like to redevelop some portions of the Pennington land to include some medium density development. Having consideration to the areas which are worthy of retention listed above, there is an opportunity to provide an additional 20-40 new dwellings within the Pennington area.

It is likely that the Sinclair Reserve area will have some form of underground stormwater detention and retention capacity for re-use on the Reserve. It is still very early in the design stage of this future project to determine exact detail of stormwater management on the site.

However, the very latest advice from Housing SA is that, due to the receipt of a further Heritage report on the area, no redevelopment of this area will be undertaken.

The Westwood redevelopment project is currently being undertaken with an expected completion date of approximately 2-3 years (refer to **Appendix 3** - **Westwood Plans**). This is a large project that includes land in Athol Park, along the central and eastern side of the Torrens Road catchment area. Precinct 6 is located within the City of Charles Sturt and has released sites for 406 new dwellings which replace 301 existing dwellings. Precinct 5 is located within the PAEC (only taking into consideration the dwellings within the Torrens Road Catchment) and has replaced 51 dwellings with 168 potential dwelling sites. The increased numbers assume that the proposed medium density sites will include at least 1 dwelling per 250 square metres of land. However, Precinct 6 includes a proposal of 51 multi storey apartment dwellings over some of the mixed use and medium density land. In these cases, roof area and run off area is not increased given the multi storey nature.

The Westwood project has two detention basins located within or just outside of the catchment. One is to be located along the Gateshead Street corridor which will become a passive recreation area, with the other detention basin proposed within the Cambridge Reserve. The stormwater that is stored in the detention basins will be re-used on the open space areas.

Housing SA avoids running more than one medium-large-redevelopment project concurrently with another to prevent strain on their housing supply. Tenants need to be relocated from the future development site to dwellings nearby so that they are not dislocated

from social networks, schools etc. The timing of Housing SA land redevelopment is crucial to avoid a short supply occurring in a given area.

Considering that the Westwood project is still underway and will not be completed for another 2-3 years, the Pennington project will not commence immediately. This will allow for the relocation of Housing SA tenants to the nearby locality. Housing SA believes that it will take up to 10 years to commence the Pennington project, possibly longer.

There is a number of Housing SA sites scattered throughout the catchment and discussions with Housing SA staff indicate that there are no plans to redevelop these other sites. In the longer term, it is likely that a majority of these sites will be redeveloped due to the deterioration of the housing stock.

4.2.4 Department for Transport Energy and Infrastructure (DTEI)

Discussions with DTEI have indicated that an electrified railway which extends from the city to Outer Harbour will be completed by 2016. The new rail system will have stops with a bus integrated park and ride service at Port Adelaide, Woodville and Bowden Entertainment Centre Precinct. This new, faster service from Port Adelaide into the City will result in greater usage and intensification of activities adjacent to the individual stops.

There are currently no plans to extend or create road links to the Port River Expressway, other than a possible eastern bypass link from Commercial Road through to the Port River Expressway (PRExy). However, PRExy is expected to increase traffic generation through the Port Adelaide industrial areas, making it more accessible for freight and consequently more attractive for industrial development.

4.2.5 Potential Development along New or Existing Transport Infrastructure

There is an opportunity for a mini-TOD to be located adjacent the Kilkenny Railway station and a general regeneration of sites within a 400 metre radius. The area encompasses several zones including Historic Conservation, industrial, mixed use, local centre and residential zones. This area has potential for medium-high density development due to its proximity to transport and shopping centres, subject to re-zoning.

The Industrial Land Review has identified approximately 4 hectares of land on the northern side of the railway line at Kilkenny as land that could be rezoned for residential purposes. There is an opportunity for the residual industrial land to be converted to a mixed use zone and allow for medium to high density housing adjacent the Kilkenny train stop. The buildings and impervious surfaces currently constitute 100% of the site cover. Therefore, a change in use is likely to decrease the site cover and run off from these sites.

For the last six years the zoning in the Charles Sturt area has encouraged higher density development to occur along main roads. However, the development trends indicate that the redevelopment of sites into higher density (1 lot into 2 or 1 lot into 3 or possibly more) has been scattered throughout **all** of the Council area. Larger, high density flats and multi-storey apartments which are encouraged along main roads have not been occurring or proposed by developers. Planning staff at the City of Charles Sturt believe that developers, investors and ultimately purchasers are concerned about the reduced level of amenity associated with living on main roads and have avoided these sites.

The implementation of the 30 Year Plan for Greater Adelaide is hoped to increase redevelopment along and within an 800 metre radius of main roads. Taking this into consideration, an increase in dwelling numbers and density is likely to occur along Port Road and to the north of some parts of Torrens Road over the long term.

The redevelopment of the Gillman/Dry Creek site will result in substantial increases in heavy freight traffic through parts of Port Adelaide and along the Port River Expressway.

A general increase in traffic and residential density resulting from infill development will be apparent within a 5 kilometre radius of the centre of Port Adelaide.

4.2.6 Other Potential Development Sites

There is currently a Buddhist temple located on North Arm Road, Gillman which is surrounded by large portions of vacant residential land. There are four allotments (including the temple site) which have a total site area of 11.4 hectares. This site has the potential for future residential development as it is within the Residential Policy Area 13 which allows for dwellings at low to medium densities. Based on the zoning principles, there is the potential to replace the four existing allotments with approximately 250 dwellings on this site.

The existing areas of PAEC owned public reserves are to be retained and there are likely to be small increases in the size and/or number of these areas. The areas used as sporting grounds or areas that are highly frequented justify the cost involved in the installation of underground stormwater storage and reuse facilities. The PAEC is likely to consider installation of underground systems for these larger sites only.

The land opposite the Cheltenham site, on the northern side of Torrens Road in Woodville North, has been identified by Council as core industrial land. This area is likely to increase in activity.

However, currently the site cover of land in this area combined with car parking and manoeuvring areas results in almost 100% site cover on existing industrial sites. There are now zoning controls which require new industrial development to provide at least 10% landscaping on the site. The renewal of sites with landscaped areas

will provide an increased scope for on-site stormwater detention and a slight decrease in run off from these sites.

Windsor Avenue Reserve, Pennington and Fawk Reserve adjacent Westwood will be provided with localised detention within a 3-5 year period to cater for increasing densities in the surrounding locality.

5 CONCLUSION

Discussions with key stakeholders has revealed several development sites which were not apparent during the investigations undertaken as part of the 2003 Initial Urban Stormwater Master Plans, Planning and Development Issues Report. The Cheltenham/Sheridan site, Gillman land, Westwood redevelopment project and the incorporation of TOD's along transport corridors will each contribute large portions of redevelopment land in the short term.

The longer term development of sites is difficult to determine and a more quantitative approach is required using historical trends (ABS data) and the 2001 Department of Planning GIS data. The 2003 Initial Urban Stormwater Master Plans, Planning and Development Issues Report has been included as an attachment to assist in projecting longer term development potential.

With the release of the 30 Year Plan for Metropolitan Adelaide it can be expected that residential densities will increase to allow for sufficient housing to accommodate population growth. Infill development is generally market driven due to private ownership of the majority of sites and is likely to be scattered in a more random manner over the longer term.

Sites that are not redeveloped for higher density housing that contain older dwellings in poor repair will gradually be replaced by larger dwellings (increasing site cover and subsequently run off) or will be renovated and extended.

The previous estimations of around 39 - 48 additional dwellings per year is still accurate for new development in the catchment in the long term (refer Section 4.1.2). However these previous estimates did not factor in Sheridan / Cheltenham / St Clair which should generate approximately 50-100 dwellings per annum in the short term.

The actual number of additional dwellings per annum is likely to be greater due to:

(a) the intensification of development at major new housing projects such as Cheltenham/Sheridan and Westwood;
(b) the likelihood of new concentrated development along transport nodes which incorporate TOD's (such as Kilkenny and the flow on effect into the surrounding areas); and
(c) a general increase in medium density housing throughout the catchment, but particularly close to transport corridors / railway stations and centres, as the general market acceptance of well located medium density housing increases.

In summary, it is expected that the increase in dwelling numbers in the Torrens Road catchment for the short term (10 years) could be in the order of 150 - 300 per annum.

APPENDIX 1 - INITIAL URBAN STORMWATER MASTER PLANS
Planning and Development Issues (Chapter 5)

5. TORRENS ROAD DRAIN CATCHMENT

5.1 Catchment Characteristics

5.1.1 Location

The Torrens Road (TRDA) Catchment is approximately 2345 hectares in area. The area north of Grand Junction Road is within PAEC and south of Grand Junction Road the majority of the catchment is within the City of Charles Sturt although part of the area falls within Port Adelaide Enfield along the east and west boundaries (refer **Figure …**).

5.1.2 Residential Land Use

In the PAEC area of the TRDA Catchment the majority of the housing stock is very old apart from some small pockets of housing redevelopment that occurred between 1981 and 1998 primarily north of Grand Junction Road and scattered throughout the remainder of the Catchment.

The majority of the housing in the suburb of Ottoway is circa 1946 to 1960 (valuer General Database 1998) although in Rosewater to the west some housing dates back to pre-1900. South of Grand Junction Road the majority of the housing is circa 1901 to 1945 although there are examples of housing developed between 1946 and 1998 scattered throughout.

Residential density varies throughout, although generally speaking, low density residential development characterises the living areas in the City of Charles Sturt and in PAEC residential density ranges from low to low-medium. There is a high proportion of SAHT developed residential areas in the Catchment although only a small number of houses are still owned by the SAHT (refer Section 5.2.1).

5.1.3 Industrial / Commercial Land Uses

In the north of the Catchment in the suburbs of Port Adelaide, Wingfield and Gillman the majority of the land is zoned for industrial use.

The Industry Zone extends into Charles Sturt Council in the suburbs of Athol Park and Woodville North.

North of Torrens Road and east of Hanson Road in Kilkenny the Catchment is developed with a range of commercial / industrial uses.

Vacant industrial allotments are located throughout the Catchment, but the majority are found north of Grand Junction Road. The MFP zoned land has been identified for potential industrial development (refer Section 5.2.1), notwithstanding the sensitivity of adjacent land uses, and that eco-system protection and regional open space objectives require further investigation.

5.1.4 Public Open Space / Recreational Uses

Apart from formal sports and recreation grounds, such as those associated with schools or clubs and other formal recreation uses such as bowling greens and the Cheltenham Racecourse, open space is generally limited to relatively small areas of local public open space and a few "neighbourhood" public reserves such as Finsbury

Reserve (Woodville North), Fawk Reserve (Athol Park) and the Eastern Parade Reserve (Ottoway).

Areas in the far north of the catchment in the MFP Zone have the character of open space (ie undeveloped land) and include various wetlands for stormwater detention.

Although Planning SA's land use categories indicate approximately 33% of the catchment is open space, the calculation includes vacant land. Planning SA's Parklands 21 Strategy identifies the majority of the area comprises between 1-5% open space, the lowest of six categories.

5.2 Analysis of Development Potential

5.2.1 Future Development Trends / Potential

LMC Holdings and Proposals

There are no LMC interests in residential areas but LMC holdings in the Gillman area (still zoned "Multi-function Polis") are considered medium - long term sites for industrial / port related development. Land in the north-east of the catchment (north and south of the proposed "Port River Expressway" in the vicinity of the Wingfield Waste Management Centre) is being investigated for development associated with waste resource recovery activities and complementary industries (eg "Eco Industrial Precinct").

SAHT Holdings and Proposals

SAHT owned housing identified in **Figure** … comprises a variety of housing stock including:

- Double unit sites (all north of Torrens Road):
  - Pennington
  - Woodville North
  - Athol Park
  - Woodville Gardens
  - Mansfield Park.
- Attached houses scattered throughout / some grouped.
- Some flats, single units.

The following Table presents SAHT's expectation of redevelopment outcomes based on current programs and priorities. Within each redevelopment area the increase in dwelling numbers is compared with those determined using the GIS analysis of the Planning SA data. The higher density has been adopted for the analysis of impact of runoff.

SAHT Area (Refer Plan)	Priority	Existing Dwellings	Planning SA Estimate (approx.)	SAHT Estimate (approx.)	Estimate
Area A (Historic Conservation)	Not Specified	150	+6	-	OK
Area B	2	265	+148	-	OK
Area C	2	56	+3	Assume same increase as Westwood (+23%)	Change*
Area D	2	55	+3	Assume same increase as Westwood (+23%)	Change*
Area E	2	34	+17	+3 (10%)	OK

Note: Priority 1 - 0 - 4 years
Priority 2 - 5 - 10 years
Priority 3 - >10 years

* *ie, should be considered as additional to development potential estimated in GIS analysis.*

Based on the above estimates, Areas C and D may achieve greater dwelling density than estimated under the current Development Plan, subject to approval by the relevant authority.

5.2.2 GIS Analysis of Development Potential

Short Term Theoretical Development Scenario

For the purpose of this analysis, allotments considered developable in the "short term" are those with a CV-SV ratio of <1.2 and are considered likely to be developed in the next 5-10 years.

Figure …(Plot 1) illustrates the distribution of allotments with 'short term' development potential based on Charles Sturt Council's draft residential policies in its General Plan Amendment Report and the current PAEC Development Plan.

Development potential in this Catchment in the short term is negligible in terms of additional residential development. An area within Woodville North bound by Ninth Avenue, Hanson Road and Torrens Road is the only locality where there is a small concentration of infill potential.

Long Term Theoretical Development Scenario

Figures …(Plot 2) and …(Plot 3) illustrate development potential in a theoretical 50 year planning horizon, Plot 2 depicting 60% of the theoretical total based on the draft zoning criteria, and Plot 3 the ultimate theoretical development potential.

Table .. below summarises the three theoretical development potential scenarios.

TORRENS ROAD DRAIN CATCHMENT*			
	Number Of New Dwellings	**Number of replacement dwellings**	**Number of dwellings within multi-dwelling sites (>2 dwellings) excluded from analysis**
Short term	499 (5.1%)	72 (0.7%)	1708 (17.3%)
50 year horizon (at 60% of maximum)	**2439** (24.7%)	353 (3.6%)	1708 (17.3%)
Ultimate theoretical development scenario	4065 (41.2%)	661 (6.5%)	1708 (17.3%)
( ) = % increase of existing total dwellings			

* Total existing dwellings 9,859

Figures … and …. illustrate that the development potential in Residential Zones is spread across the Catchment. Based on the scenario depicted in **Figure** … (Plot 2) the potential for infill is most pronounced in:

- Rosewater (particularly in the west of the suburb between Eric Sutton Oval and Addison Road);
- Woodville North, which includes SAHT redevelopment Area E (refer **Figure ….**);
- Woodville Gardens;
- West Croydon (particularly the north and north-west areas immediately south of Torrens Road); and
- to a lesser extent, the suburbs of Kilkenny (south of Torrens Road), Woodville Park, Woodville, Cheltenham, Pennington (north).

The concentration of SAHT owned allotments in Pennington (Area A in **Figure** …) would make that locality suitable for a comprehensive redevelopment project.

However the Historic Conservation zoning proposed for this area is likely to restrict the potential for infill.

Based on the above estimates the rate of new infill development is anticipated to be constant given the figures indicate potential for:

- a 24% increase in dwellings assuming 60% of the "ultimate" residential infill development is realised, which equates to an average of 49 dwellings per annum over 50 years; and
- based on the short/long term scenarios, approximately 50 dwellings per annum for the first 10 years, followed by an average of 48 dwellings per annum for the subsequent 40 years.

5.3 Strategic Issues and Opportunities

Issues

1. The Torrens Road Catchment has the second highest estimated residential infill development potential of all six catchments reviewed in this study, possibly as a consequence of the combination of both allotment size and age of housing.

2. Notwithstanding the overall total estimated infill development potential, the short term (5 - 10 years) and long term (at 60%) scenarios are both estimated to be around 50 dwellings per year which is considered negligible in terms of new development.

3. The long term scenario involves potential residential infill on predominantly private property where on-site detention options are more limited.

4. The existing and potential industrial areas are concentrated in the north (downstream end) of the Catchment which is also affected by the proposed Port River Expressway.

5. Based on the long term scenario, there is a concentration of development potential of both replacement and infill residential development west of Cheltenham racecourse. The Cheltenham Racecourse Wetlands Investigation (PPK Pty Ltd) which involved preparation of a concept plan for the construction of a system of wetlands for water quality improvement and water harvesting is still being considered for development.

Opportunities

1. The suburbs of Rosewater, Woodville North and West Croydon have the highest concentrations of residential infill development potential in the TRDA Catchment however only Woodville North includes and is immediately adjacent three SAHT urban renewal areas.. This locational advantage may provide an opportunity for a more effective/comprehensive stormwater management scheme to supplement the existing system in this locality.

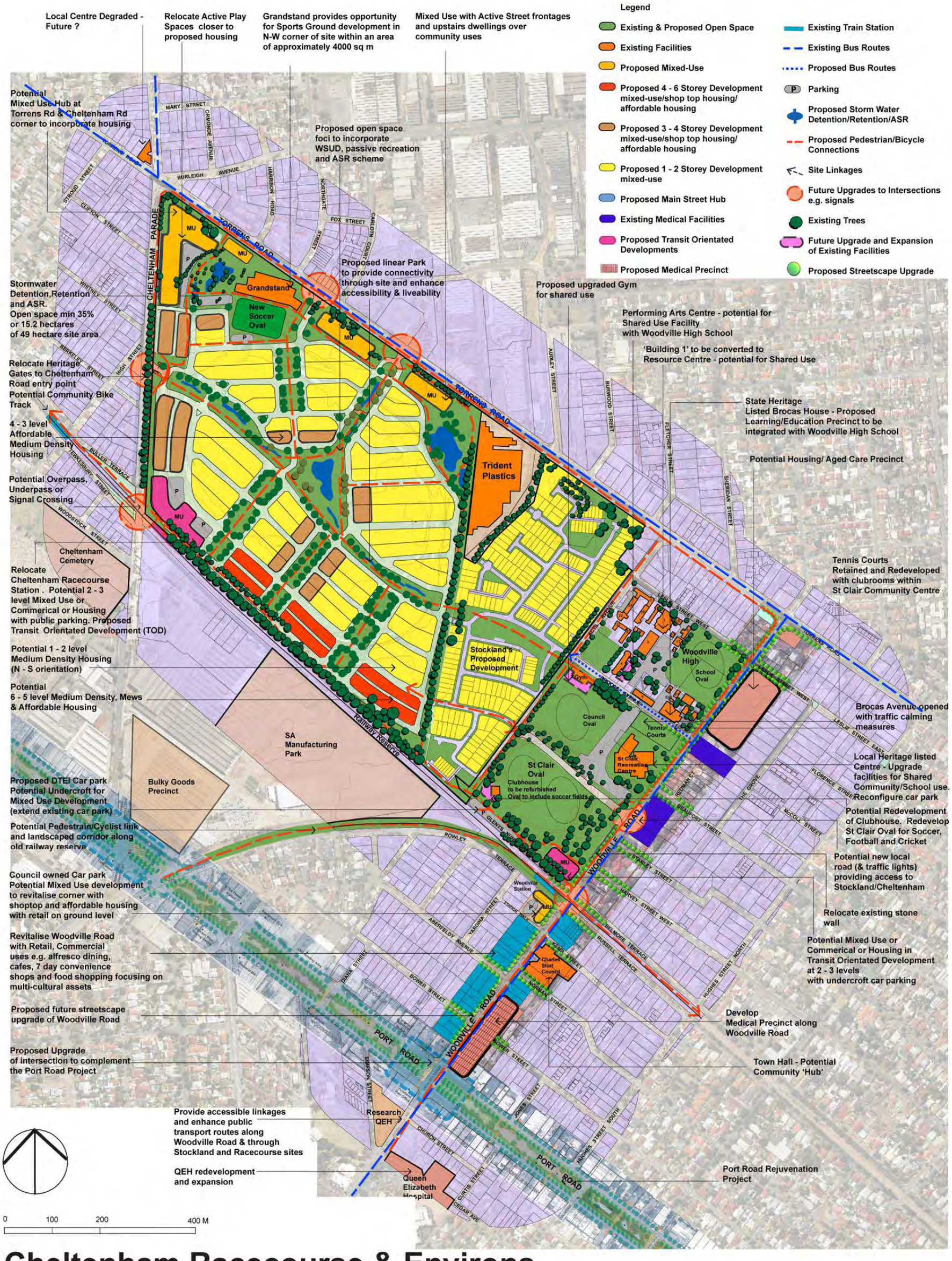
2. The Cheltenham Racecourse Wetlands Investigation (PPK Pty Ltd) could be revisited if there is still a need to address stormwater management issues in this area of the catchment.

3. If the total estimated residential infill development scenario has serious implications for stormwater management, one strategy is to review minimum allotment sizes after 5 - 10 years to reduce infill potential across the Catchment or in specified areas.

4. The existing and proposed industrial areas in the north of the Catchment could be targeted to encourage improvements in water quality and new development particularly on large sites, should be encouraged to treat and re-use stormwater on site (or any new zone could incorporate a concept plan for stormwater management on a zone-wide basis).

5. A strategy / policy that requires retention / management on site (ie, no impact on external stormwater system) or maintains existing flows without increasing loads after development should be considered. The next stage of investigations could consider where such a strategy / policy should always apply (ie, only specific areas / zones or subject to size of development / number of dwellings / number of allotments created, etc).

APPENDIX 2 - CHELTENHAM CONCEPT PLANS

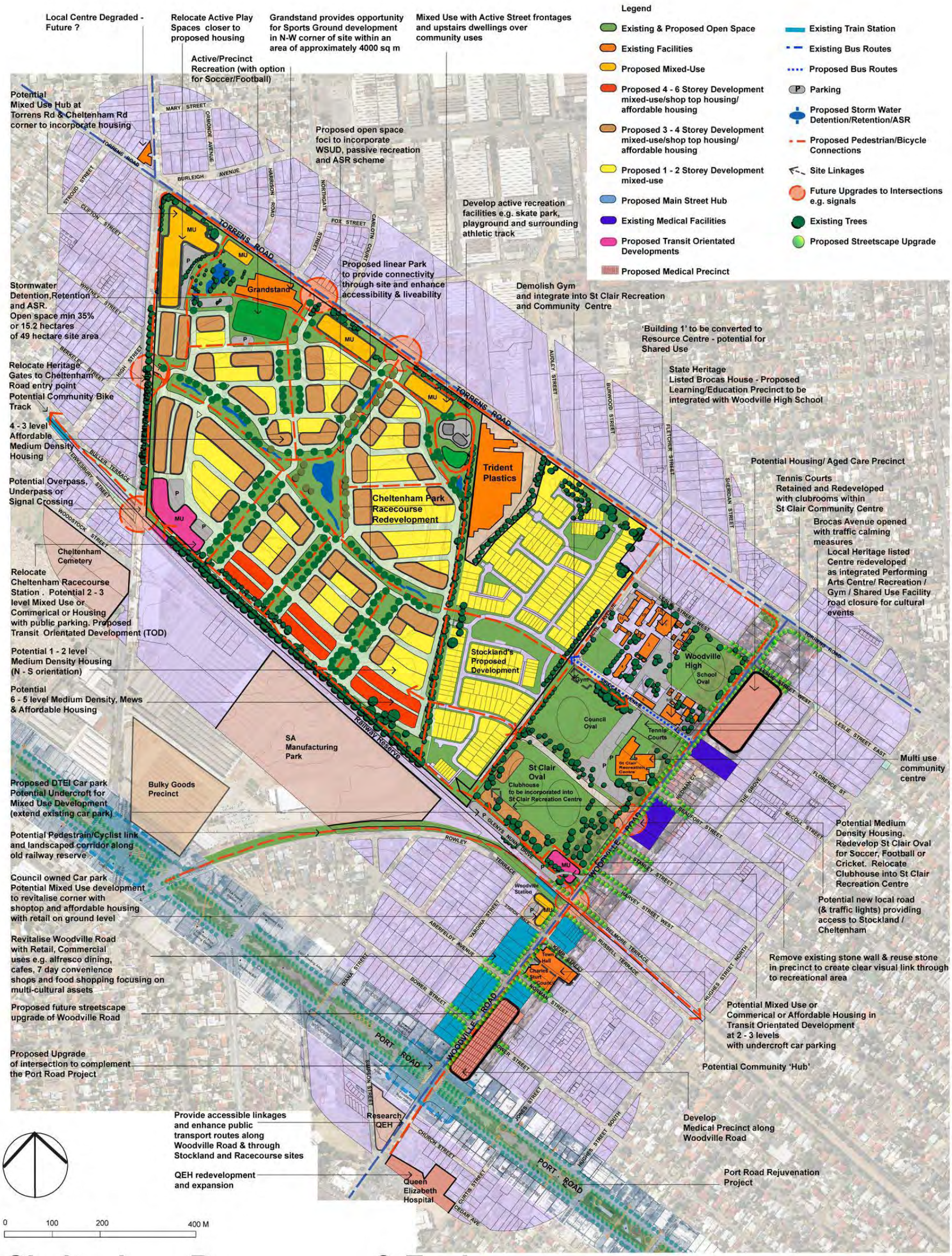


Cheltenham Racecourse & Environs

Concept Plan 1

3314082 - SK - 02 Rev 5 30.10.2007

Level 8 68 Grenfell Street Adelaide SA 5000 | T 61 8 8235 6600 | F 61 8 8235 6694 | http://www.ghd.com.au



Cheltenham Racecourse & Environs

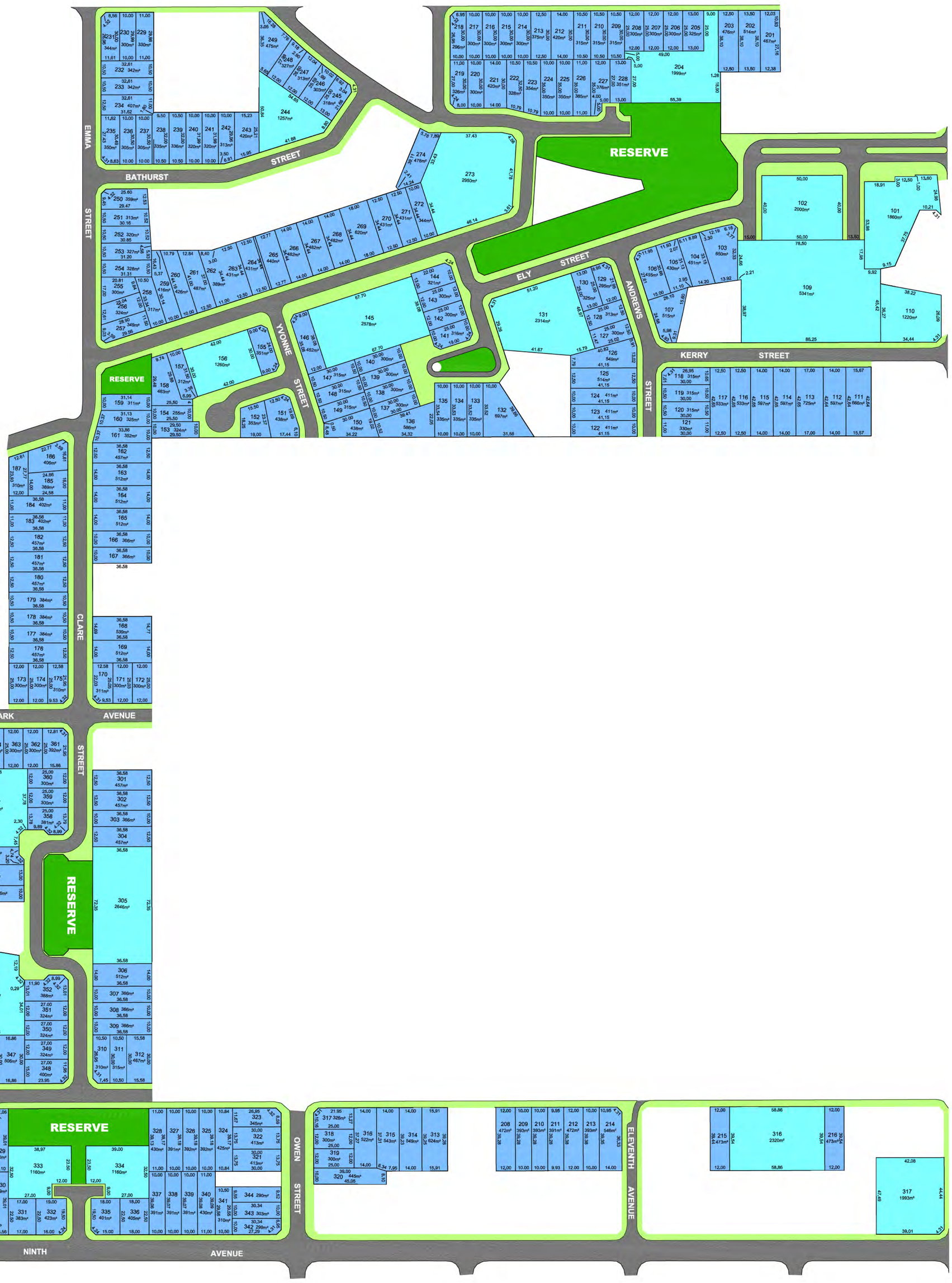
Concept Plan 2

3314082 - SK - 03 Rev 5 30.10.2007

Level 8 68 Grenfell Street Adelaide SA 5000 | T 61 8 8235 6600 | F 61 8 8235 6694 | http://www.ghd.com.au

APPENDIX 3 - WESTWOOD PLANS

WESTWOOD


EMMA STREET
BATHURST STREET
RESERVE
ELY STREET
ANDREWS STREET
KERRY STREET
YVONNE STREET
CLARE STREET
PARK AVENUE
OWEN STREET
ELEVENTH AVENUE
NINTH AVENUE
RESERVE
RESERVE
RESERVE
RESERVE

PRECINCT 5 OVERALL PROPOSAL

WESTWOOD

- Dev. No. 040/D352/08
- Dev. No. 040/D353/08
- Dev. No. 040/D354/08
- Dev. No. 040/D372/08
- Dev. No. 040/D373/08
- Dev. No. 040/D374/08
- Dev. No. 040/D375/08
- Dev. No. 040/D377/08
- TO BE SOLD AS IS

SIGNIFICANT TREE FROM SURVEY

R REFURB

SAHT

P PRIVATE SALE (UPL)

UrbanPacific
inspired thinking inspirational places

352 ALLOTMENTS
+ 5 ALLOTMENTS TO BE SOLD (NOT UNDER D.A)

ROAD PAVEMENT LAYOUT SHOWN OBTAINED FROM HASSELL PLANNERS AND IS SUBJECT TO ENGINEERING DESIGN

Alexander Symonds

Appendix B

ASR Investigation

Torrens Road Catchment ASR Investigation

Introduction

Australian Groundwater Technologies (AGT) was commissioned by Tonkin Consulting to undertake investigation into the viability of large scale Aquifer Storage and Recovery (ASR) scheme in the Torrens Road Catchment as part of the Torrens Road Stormwater Management Plan for City of Charles Sturt.

The current report provides a summary of the findings of the hydrogeological assessment based on desktop evaluation of available information as per agreed scope of works.

Hydrogeological Assessment

The numerous shallow aquifers occur at depths ranging from 5m to some 80m below ground. They vary greatly in thickness (from 1m to 18m), lithology and permeability, have high salinity (from 2,000mg/L to 5,000mg/L) and generally low yields (less than 2L/s). Accordingly they are considered unsuitable for the scale of ASR envisaged.

The deep aquifer systems beneath the study area comprise of Tertiary aquifers of the Port Willunga Formation. The Tertiary aquifers include T1 and T2 aquifers, composed dominantly of limestone, and are separated by the Munno Para Clay. They are both extensive and well developed in the general area and are the preferred target aquifers for large-scale ASR due to:

- high aquifer transmissivity and well yield; and
- high storage capacity

Table 1 below summarised the geology and hydrogeology of the Torrens Road Catchment based on the reports by Gerges (1987, 1996) and Hodgkin (2004) and information available in the Department of Water, Land and Biodiversity Conservation (DWLBC) database.

The DWLBC database Drillhole Enquiry System (DES) was interrogated to identify groundwater users in the T1 and T2 aquifers in and around the Torrens Road Catchment. The major limitation of DES is that much of data is in excess of 15 years of age and may not reflect the current status of groundwater users.

Whilst the area has been prescribed under the *Natural Resources Act 2004*, information on licensed existing users is not in the public domain. However, where additional information

was available, the data from DES were updated to present most recent status of groundwater users.

Figure 1 below is a well location plan, displaying the location of wells completed in the T1 and T2 aquifers, and Figure 3 presents the status of the wells based on DES database.

Depth to the top	Aquifers/aquitards	Thickness	Distribution	Lithology	Depth to Water	Typical Yield	Effective Transmissvity	Storativity	Salinity	ASR Injection Head Limits
0m	Q1 - Q4 - Superficial Deposits and Hindmarsh Clay of Quaternary Aquifer System	80 - 90m		Blue grey silty clay (Gerges, 1987)	Water strike at 9m in Wingfield (Gerges, 1987)	<2 L/s	-	-	64,200 mg/l in superficial deposit (Gerges, 1987). 500 Up to 45,000 mg/l in Quaternary aquifers (Gerges,1996)	-
80 - 90m	T1A - Carisbrook Sand	5 - 20m		slightly calcareous sand	Standing water level 10.5m in Wingfield (Gerges, 1987)		-	-	3585 mg/l at Wingfield (Geregs, 1987)	-
85 - 110m	T1A - Hallet Cove Sandstone, Dry Creek Sand, Croyden Facies	45 - 60m	Thins to NE	Interbedded layers of sand, silt and shell fragments.	10 - 15m in metropolitan area. 20 - 30m in abstraction centres (Hodgkin 2004, Gerges, 1996)		39 –189 m2/d based on test results in 20 wells	-	1000 - 3500mg/l. Decreases to SW (Hodgkin 2004, Gerges,1996, 1987)	5 - 15m for subartesian (2 mbgl) and 60 - 80m for artesian (Hodgkin 2004)
130 -180m	T1B - Upper Port Willunga Formation	25m - 40m	Thins to NW	Fossiliferous sand and limestone		8 - 10 L/s		3.4E-6 to 4.7E-5 based on test results in 9 wells (Hodgkin 2004)		
155 - 220m	Munno Para Clay	10m		Stiff, blue, grey calcareous clay			-	-		
165 - 230m	T2 - Lower Port Willunga Limestone comprising T2A, T2B and T2C sub-aquifers.	100m	Uniform thickness	Interbedded, well cemented limestone and sandstone/sand	<5m in metropolitan area (Hodgkin 2004, Gerges, 1996)	10 - 15 L/s	>100 - 200 m2/d	3.2E-6 to 8.6E-5 based on 5 assessments (Hodgkin 2004)	1500 - 4500mg/l. Decreases to S (Hodgkin 2004, Gerges, 1996)	10 - 15m for subartesian (2mngl) and 90 - 120m for artesian (Hodgkin 2004)

Gerges (1987) - Report.BK.No. 82/66 Metropolitan Area – Groundwater Investigation. Wingfield Well Completion Report. Department of Mines and Energy, South Australia.
Gerges (1996) - Report Book 97/3 Primary Industries and Resources SA, Overview of the Hydrogeology of the Adelaide Metropolitan Area
Hodgkin(2004) - Report DWLBC 2004/47, Aquifer Storage Capacities of the Adelaide Region

Table 1 Geology and hydrogeology of Adelaide Plain Sub Basin and Torrens Road Catchment

Figure 2 is a schematic cross-section of the hydrogeology across the Torrens Road Catchment. The line of cross-section is indicated in Figure 1 and is extended beyond the edge of the Torrens Road Catchment to include a network of wells to the northwest. The schematic cross-section was constructed using a combination of borehole log data in DES and contours of depth to aquifers presented in Gerges (1996) and Hodgkin (2004).

There is a gentle regional dip in the depth to top of the aquifers towards the southeast, with a southward increase in the thickness of Hindmarsh clay (Quaternary aquifer system) and T1 aquifer (from approximately 70m to 100m). The thickness of the T2 aquifer, comprising the lower Port Willunga limestone, is generally consistent at 100m across the whole area of the catchment.

The thickness of the Munno Para clay (10m on average) is sufficiently thick to hydraulically isolate the T1 and T2 aquifers.

The T1 aquifer comprises of two sub-aquifers, T1A and T1B. The T1A sub-aquifer (Carisbrook Sand, Hallet Cove Sandstone/Dry Creek Sand) is generally considered unsuitable for ASR due to the unconsolidated nature of the aquifer that renders well completion, development and maintenance problematic. The more consolidated T1B sub-aquifer (Upper Port Willunga Formation) enables open-hole well completion and has better potential for ASR.

Injection rates in the T1B sub-aquifer are expected to range typically between 8-10 L/s against an injection head of some 80m, assuming no clogging. In the T2 aquifer, injection rates between 10 to 15 L/s are anticipated.

Salinity in the T1 aquifer is generally lower than in the T2 aquifer. Furthermore, there is a conclusive evidence of salinity stratification in the T2 aquifer, which suggests the presence of sub-aquifers. This has been observed not only at the Coopers Brewery site, but also at Wingfield, Regency Park Golf Club and the Riverside Golf Club wells. In the well at Wingfield (well 6628-11479), salinity in the upper part of the aquifer at 186m depth is 3,550mg/L, whereas at 205m it is 4,800mg/L. In the well at the Regency Park Golf Club, salinity increased from 2,700mg/L when drilled in 1976, to 3,700mg/L after a few years of operation (up coning of more saline groundwater from depth). The well has not been used since the early 1990's due to the rising salinity.

In the context of ASR, this salinity stratification is not considered to be a "fatal flaw"- but the impact on the recovery efficiency (recovery efficiency is the volume of water extracted with a salinity suitable for the intended use, expressed as a percentage of the volume of water injected) needs to be further evaluated.

The standing water level of the T2 aquifer is generally shallower than the T1 aquifer (4 m bgl compared to 14 m bgl) resulting in a potentially higher injection head, although this is more than compensated by greater injection specific capacity. Greater storage capacity also means that fewer ASR wells are needed to accommodate storage of available water, thereby reducing the capital cost.

For a large scale ASR scheme, where large volume of water is available to harvest, the T2 aquifer is therefore preferred over T1B due to following reasons:

- greater aquifer thickness, transmissivity and well yields; and
- greater storage capacity

However, one of the constraints of completing an ASR well in the T2 aquifer is the potential presence of sand layers at depth within the lower Port Willunga limestone. AGT's experience in the general area indicates that where sand is encountered, significant airlift may be needed to adequately develop the well. This could prolong the well completion schedule (and the cost) although this is somewhat compensated by the resulting higher yield. Whilst experience in the T2 aquifer at operational sites in the City of Salisbury has shown that extensive airlift development has generally been successful in managing the production of fine sands, there is no guarantee that this will be the case in this region

The presence of low permeability Munno Para Clay provides an effective hydraulic separation between the T1 and T2 aquifers. There is a potential to utilise both the T2 and T1B aquifers concurrently, with T1B providing additional storage required to accommodate excess water.

The available information on groundwater salinity and aquifer hydraulic properties are summarised in Figure 4. The salinity data from DES database may not represent the true concentration of native groundwater and should be treated as a reference only, as salinity may change during pumping due to the known salinity stratification in the T2 aquifer.

Existing groundwater users

There are several major industrial groundwater users in the vicinity of the Torrens Road Catchment, including Penrice Soda (salt pan) to the northeast (T1), Penrice Osborne to the northwest (T1 and T2) and Coopers Brewery to the East. Currently no abstraction data is available in the public domain for surrounding industrial users with the exception of 1982 to 1984 abstraction record (after Edwards et al, 1987 and referenced in Hodgkin 2004). This data is presented in Figure 5. Although the record is in excess of 20 years of age, the relative volume of abstraction provides indication of the location of main groundwater users. For example, some 546 ML/year and 940 ML/year extraction was recorded between 1982 and

1984 at Penrice Osborne and Penrice Soda (salt pan) respectively. More recently, 300 to 400 ML/year abstraction from the T2 aquifer was reported at Coopers Brewery (Hodgkin, 2004).

Ranking of potential ASR sites

From the perspective of the T1 and T2 aquifer properties, there are no standout factors for the siting of ASR schemes.

Siting of the ASR wellfields will therefore depend on the availability of land for balancing storage and passive treatment and distance to stormwater drains.

From groundwater resource management considerations and potential demand for the low salinity injected water, there may also be some additional benefit in locating ASR sites near the existing large industrial users.

Hydrogeological Field Investigations

The hydrogeological properties of both the T1 and T2 aquifers within the study area are generally well characterised, and additional hydrogeological investigations per se are not considered to be warranted.

ASR investigations have already been successfully carried out in the T1 aquifer near the Cheltenham Racecourse (PIRSA Report 2000/29) and in the upper part of the T2 aquifer at the Barker Inlet wetlands.

The full sequence of the T2 aquifer has not however been tested in the study area, both in terms of yield and recovery efficiency.

Based on the operational experience at T2 ASR sites in the City of Salisbury, the yields from fully penetrating wells are significantly greater (>25L/s) than from wells completed only in the upper part of the aquifer. Airlift development in excess of 7 days has however been required to produce sand free water.

A fully penetrating T2 well at Coopers Brewery also has a significantly greater specific capacity than other partially penetrating T2 production wells. However, it produces very fine sands when the discharge rate is greater than some 15L/s.

The drilling and testing of a well fully penetrating the T2 aquifer at the Cheltenham Racecourse therefore warrants consideration. It is anticipated that the well would require at least a few days of airlift development. As such, the disposal of the saline airlifted water will need to be addressed in the planning stages of the investigation.

The following program of work is envisaged:

1. drill, case and cement 200mm casing to top of the T2 aquifer, estimated to be about 210m. Further drill to 260m depth to complete an open-hole section in the T2 aquifer;
2. airlift the well until sand free water is produced. This is expected to take some 7 days. There is however a risk that the well may not develop;
3. subject to the production of sand free water, undertake step discharge test to determine the well efficiency and the well specific capacity;
4. undertake an injection test with mains water for a duration of at least 3 days;
5. extract the water at a constant rate (as a constant discharge test) for at least 48 hr duration; and
6. analyse data, including numerical modelling.

This program of work will be firmed up and costed as part of the next stage of work.

References

Gerges (1987) - Metropolitan Area – Groundwater Investigation. Wingfield Well Completion Report. Department of Mines and Energy, South Australia. Report.BK.No. 82/66

Gerges (1996) - Overview of the Hydrogeology of the Adelaide Metropolitan Area, Primary Industries and Resources SA. Report Book 97/3.

Hodgkin(2004) - Aquifer Storage Capacities of the Adelaide Region, Report DWLBC 2004/47.

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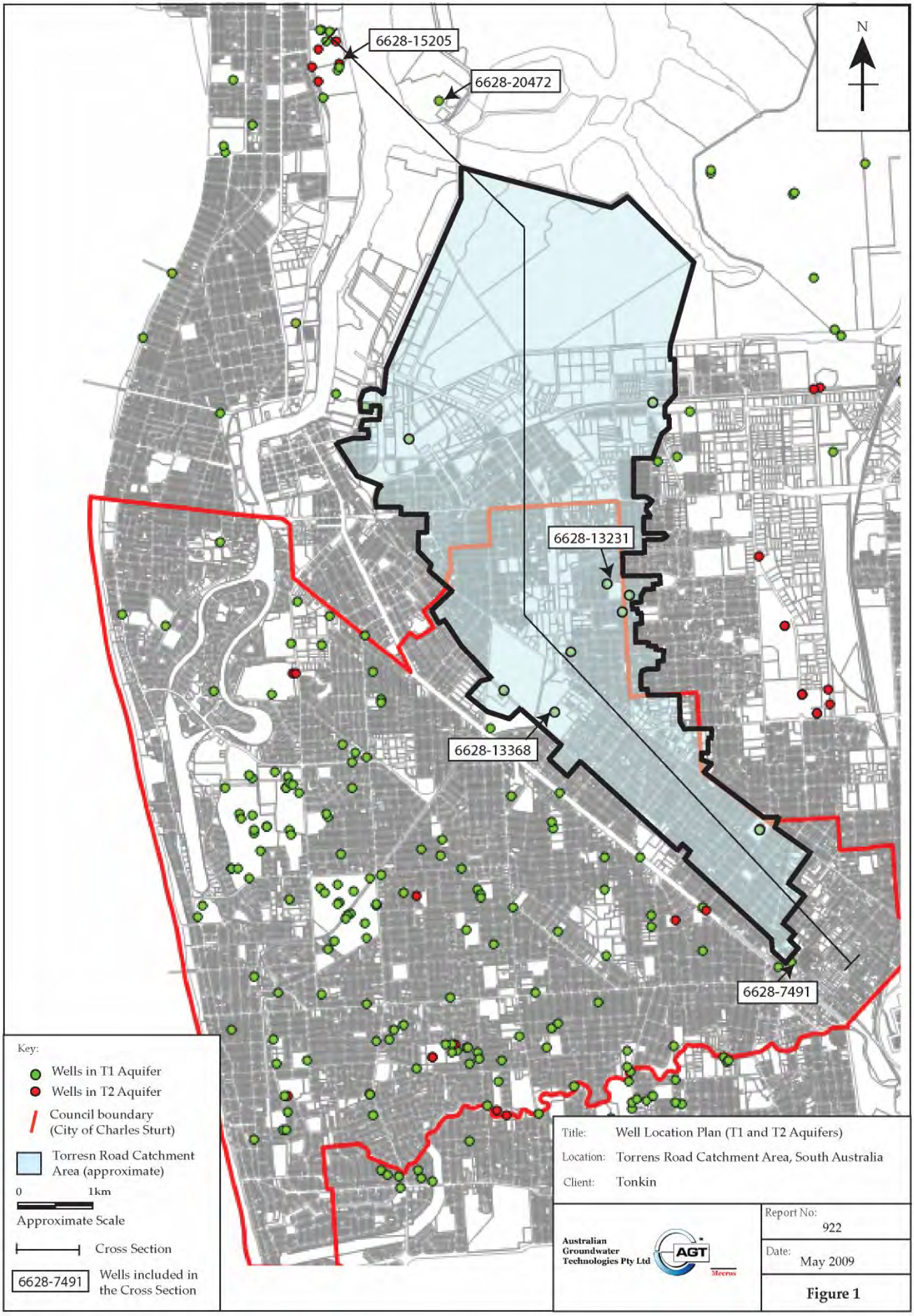


Title: Well Location Plan (T1 and T2 Aquifers)

Location: Torrens Road Catchment Area, South Australia

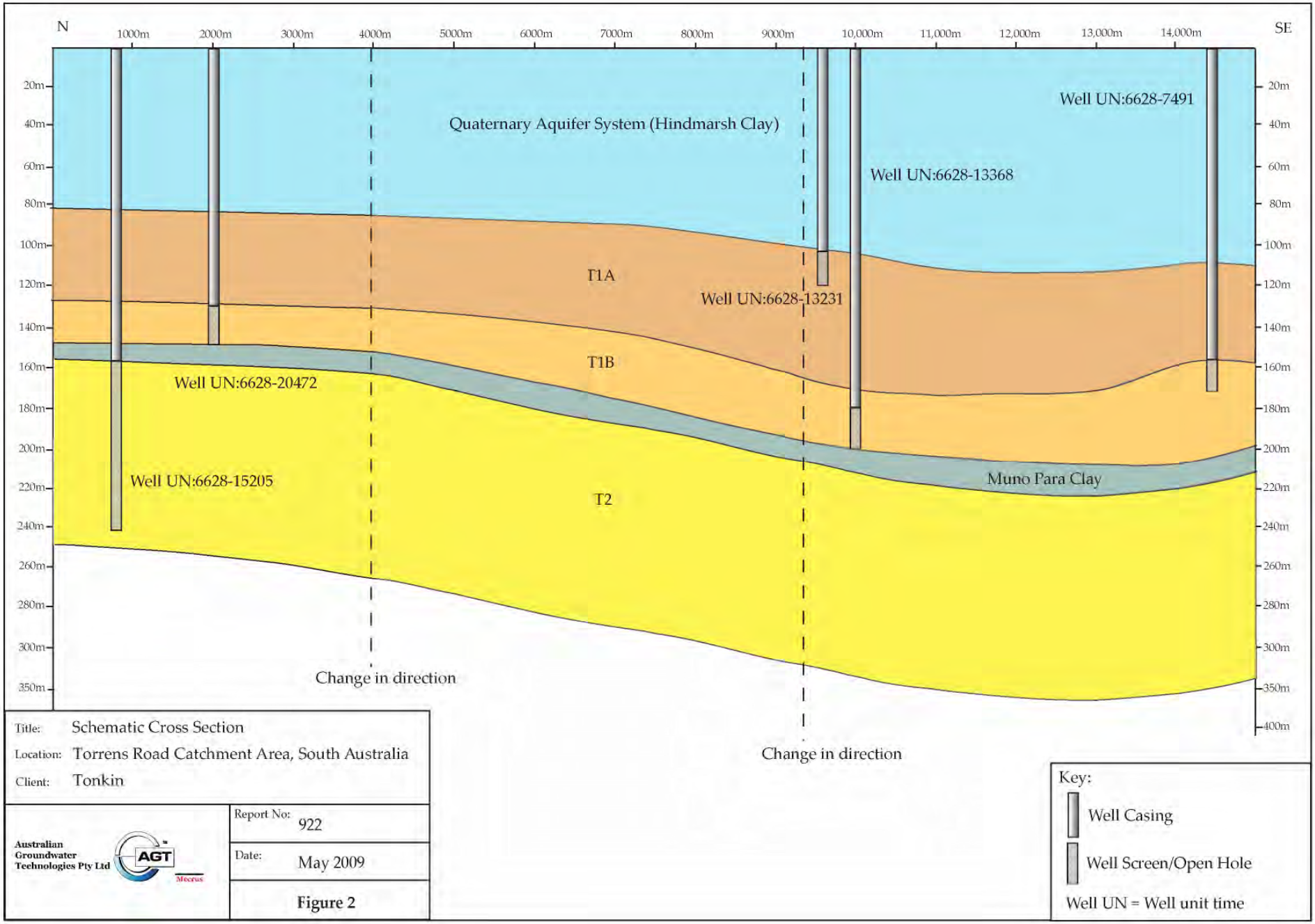
Client: Tonkin

Australian Groundwater Technologies Pty Ltd

Report No: 922

Date: May 2009

Figure 1


N
SE
1000m
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3000m
4000m
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6000m
7000m
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13,000m
14,000m
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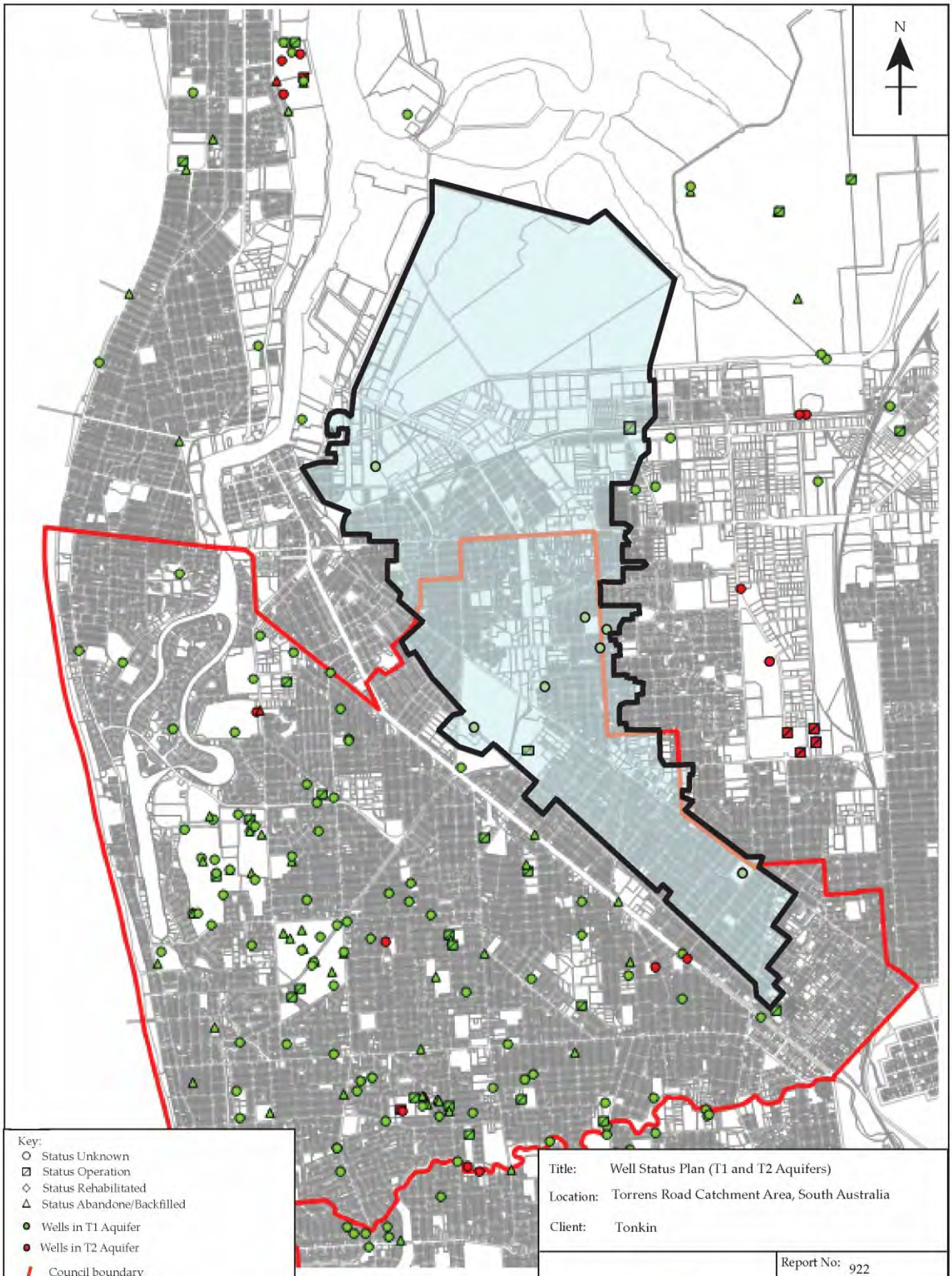
40m
60m
80m
100m
120m
140m
160m
180m
200m
220m
240m
260m
280m
300m
350m
400m
Quaternary Aquifer System (Hindmarsh Clay)
Well UN:6628-7491
Well UN:6628-13368
T1A
Well UN:6628-13231
T1B
Well UN:6628-20472
Well UN:6628-15205
Muno Para Clay
T2
Change in direction
Change in direction
Title: Schematic Cross Section
Location: Torrens Road Catchment Area, South Australia
Client: Tonkin
Report No: 922
Date: May 2009
Figure 2
Australian Groundwater Technologies Pty Ltd
AGT
Mecrus
Key:
Well Casing
Well Screen/Open Hole
Well UN = Well unit time

Australian Groundwater Technologies Pty Ltd

AGT

Meerus



Title: Well Status Plan (T1 and T2 Aquifers)

Location: Torrens Road Catchment Area, South Australia

Client: Tonkin

Australian Groundwater Technologies Pty Ltd

AGT

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Report No: 922

Date: May 2009

Figure 3

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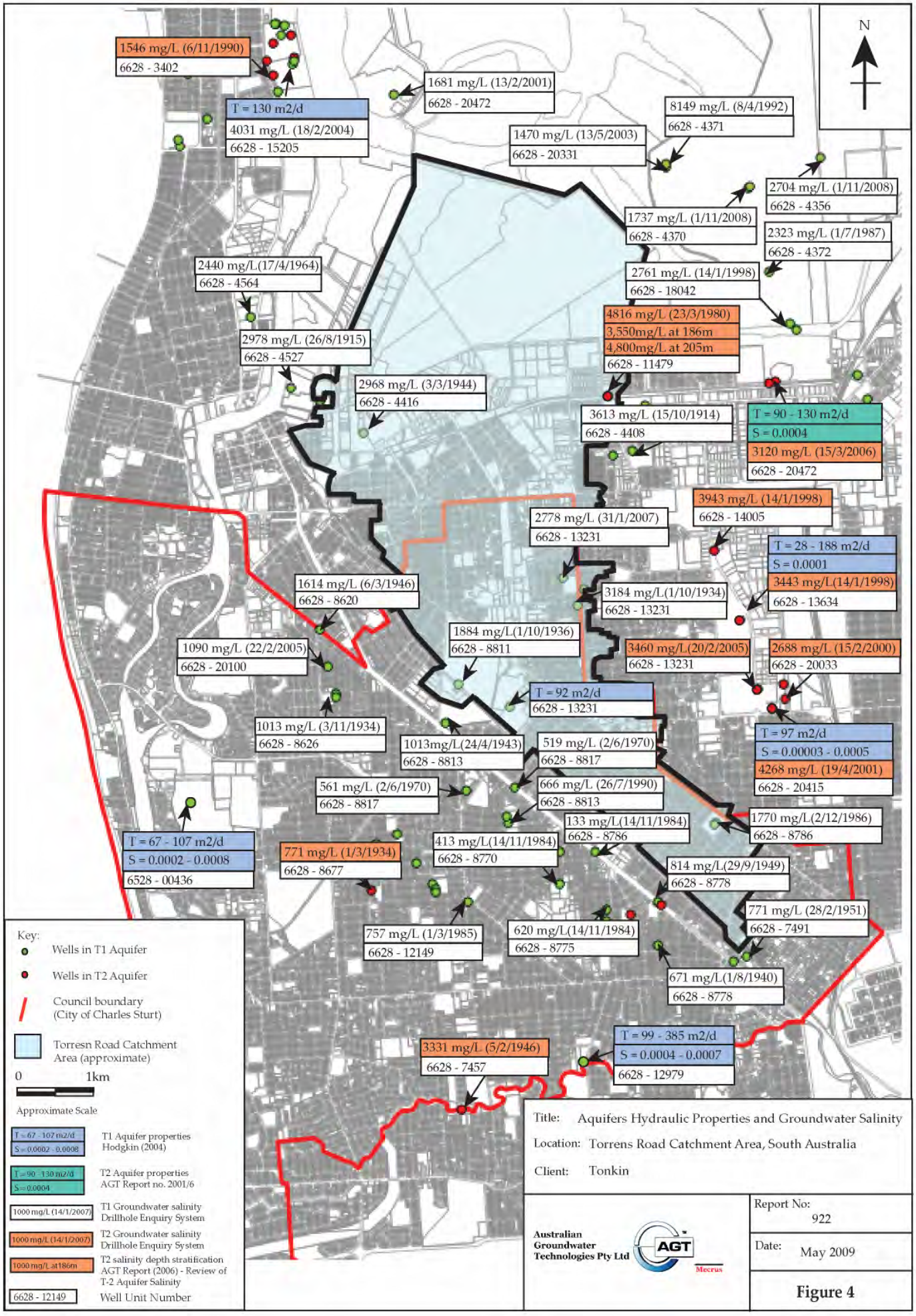


Title: Aquifers Hydraulic Properties and Groundwater Salinity

Location: Torrens Road Catchment Area, South Australia

Client: Tonkin

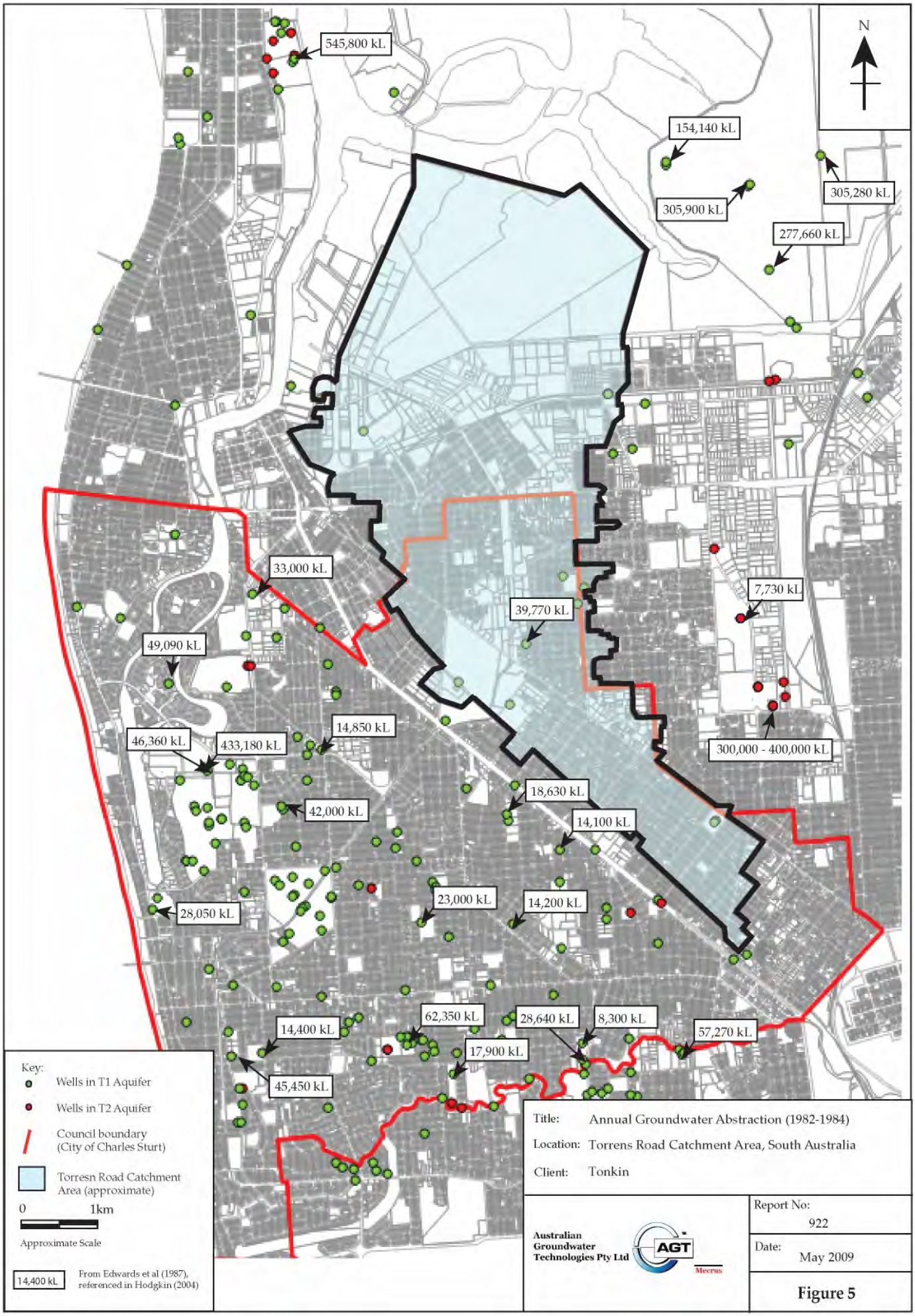
Australian Groundwater Technologies Pty Ltd

Report No: 922

Date: May 2009

Figure 4

Australian Groundwater Technologies Pty Ltd



Title: Annual Groundwater Abstraction (1982-1984)

Location: Torrens Road Catchment Area, South Australia

Client: Tonkin

Australian Groundwater Technologies Pty Ltd

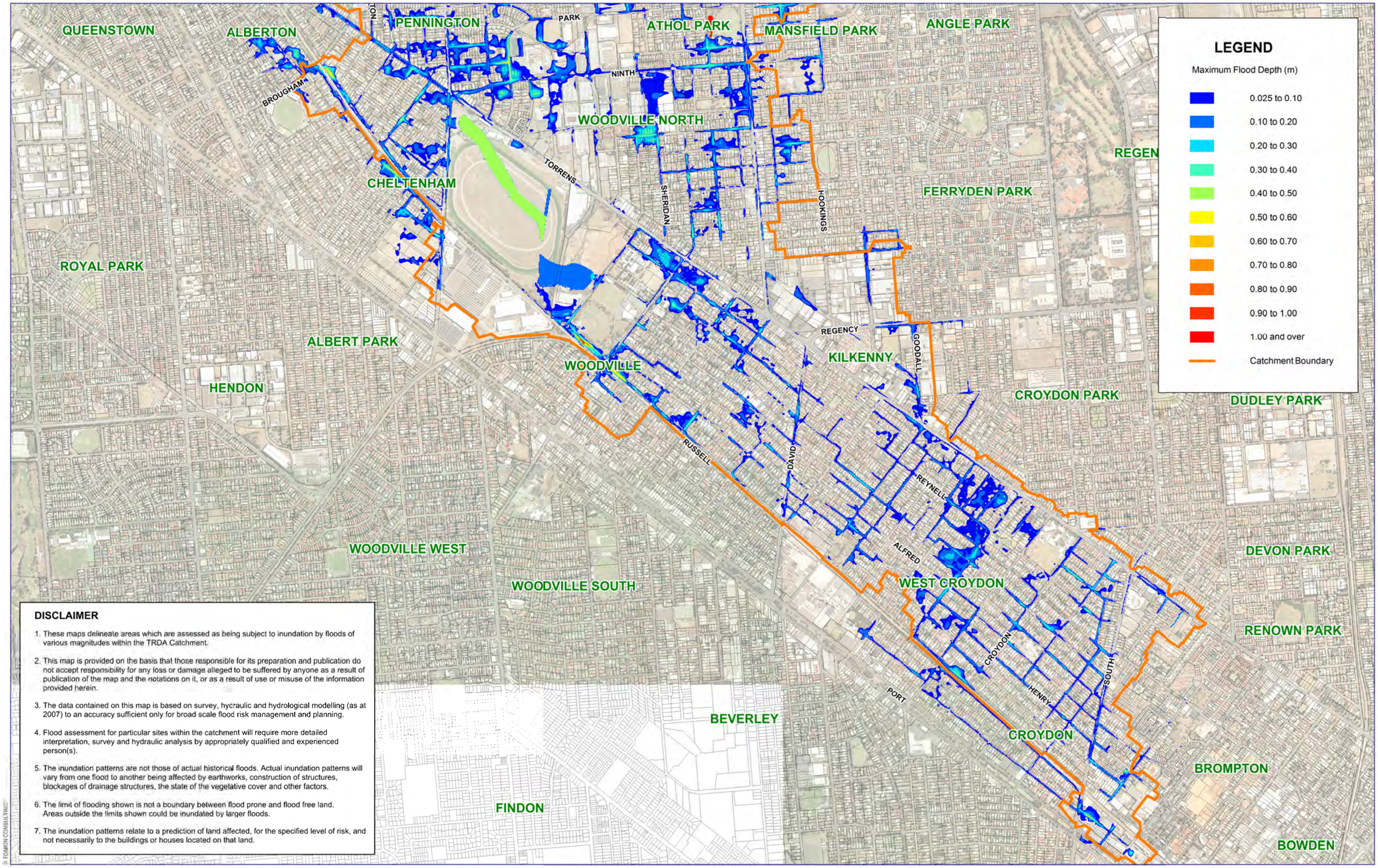
Report No: 922

Date: May 2009

Figure 5

Appendix C

Floodplain Maps



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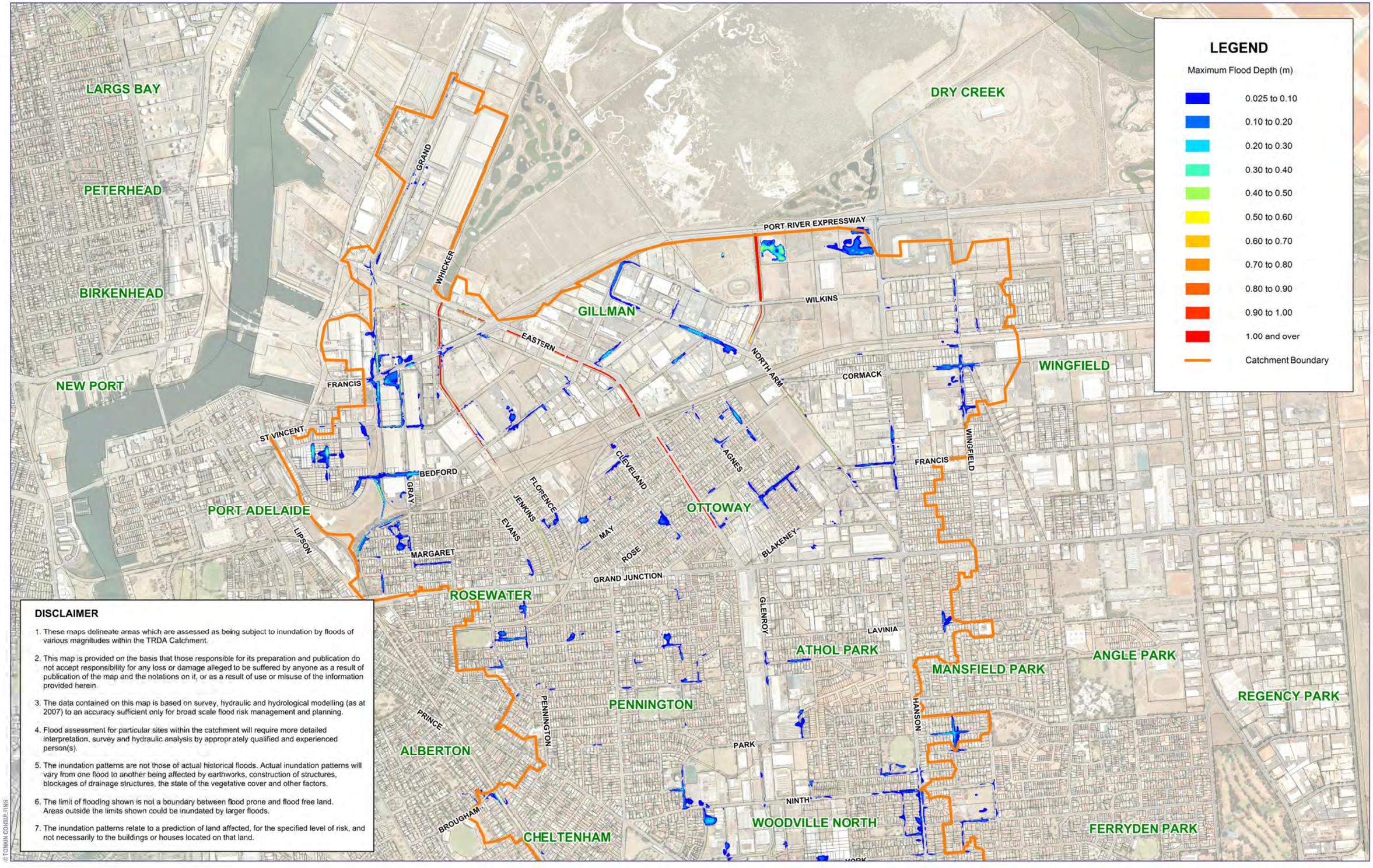
TORRENS ROAD CATCHMENT SMP
100 YEAR ARI LONG-TERM FLOOD INUNDATION - UPGRADES ASSESSMENT

Figure C.10



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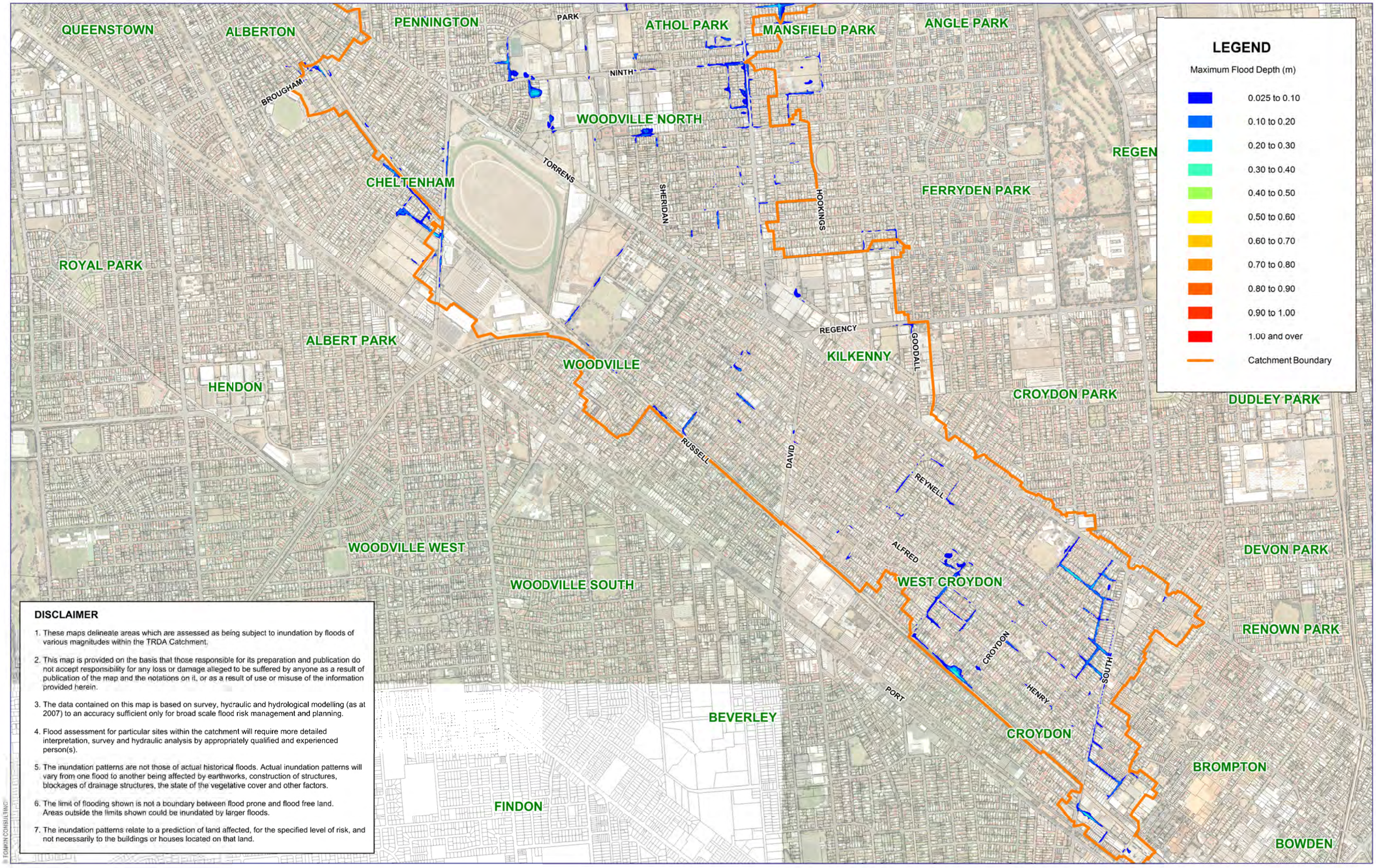
TORRENS ROAD CATCHMENT SMP
5 YEAR ARI EXISTING FLOOD INUNDATION

Figure C.1



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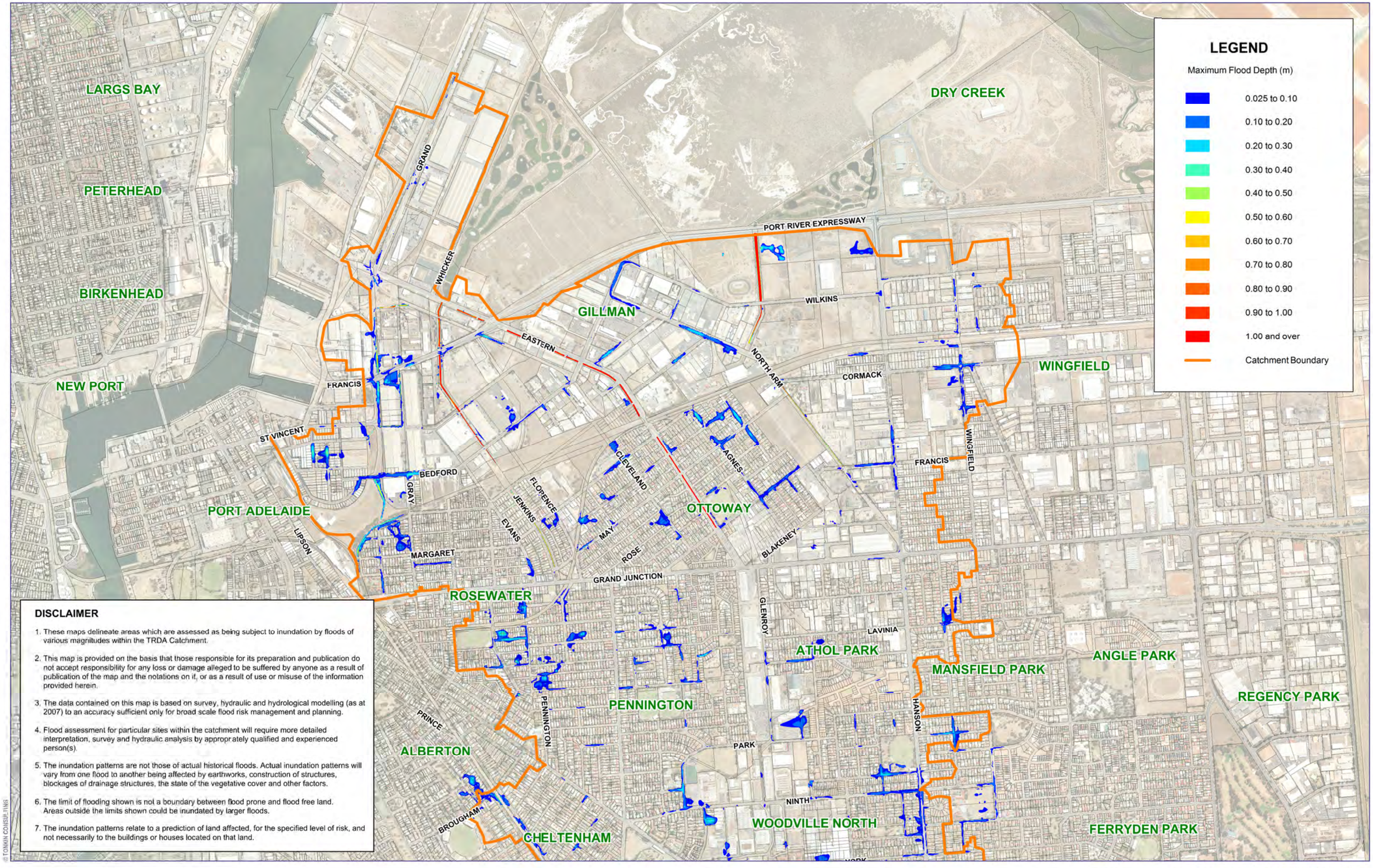
TORRENS ROAD CATCHMENT SMP
5 YEAR ARI EXISTING FLOOD INUNDATION

Figure C.2



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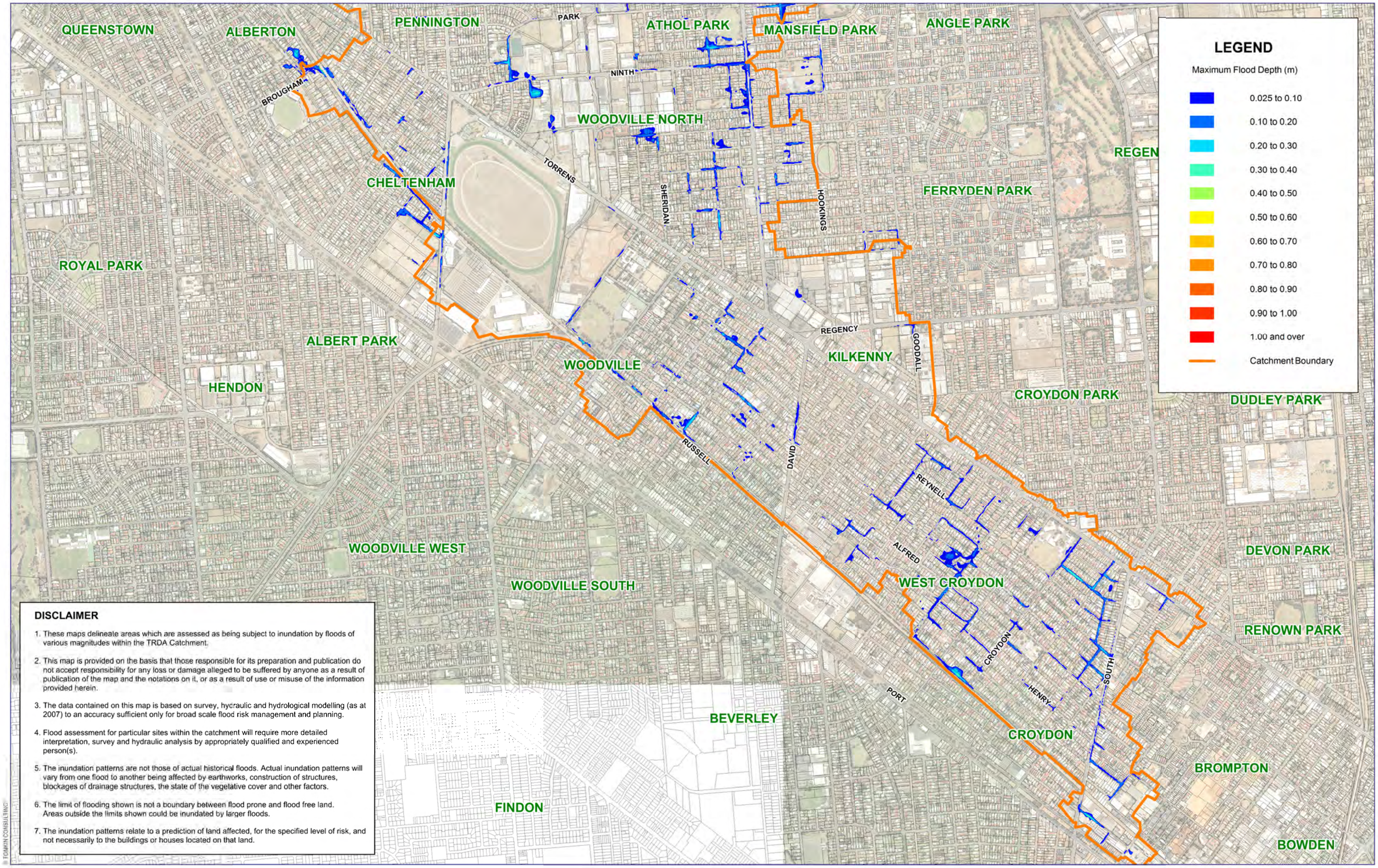
TORRENS ROAD CATCHMENT SMP
5 YEAR ARI LONG-TERM FLOOD INUNDATION

Figure C.3



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TORRENS ROAD CATCHMENT SMP
5 YEAR ARI LONG-TERM FLOOD INUNDATION

Figure C.4

LARGS BAY
PETERHEAD
BIRKENHEAD
NEW PORT
PORT ADELAIDE
DRY CREEK
GILLMAN
WINGFIELD
ROSEWATER
OTTOWAY
ATHOL PARK
MANSFIELD PARK
ANGLE PARK
REGENCY PARK
PENNINGTON
ALBERTON
WOODVILLE NORTH
FERRYDEN PARK
CHELTENHAM

GRAND
WHICKER
PORT RIVER EXPRESSWAY
WILKINS
EASTERN
NORTH ARM
CORMACK
FRANCIS
ST VINCENT
BEDFORD
GRAY
JENKINS
FLORENCE
EVANS
MAY
ROSE
MARGARET
LIPSON
CLEVELAND
AGNES
BLAKENEY
GRAND JUNCTION
GLENROY
LAVINIA
HANSON
PENNINGTON
PRINCE
PARK
NINTH
BROUGHAM
WINGFIELD

LEGEND

Maximum Flood Depth (m)

- 0.025 to 0.10
- 0.10 to 0.20
- 0.20 to 0.30
- 0.30 to 0.40
- 0.40 to 0.50
- 0.50 to 0.60
- 0.60 to 0.70
- 0.70 to 0.80
- 0.80 to 0.90
- 0.90 to 1.00
- 1.00 and over
- Catchment Boundary

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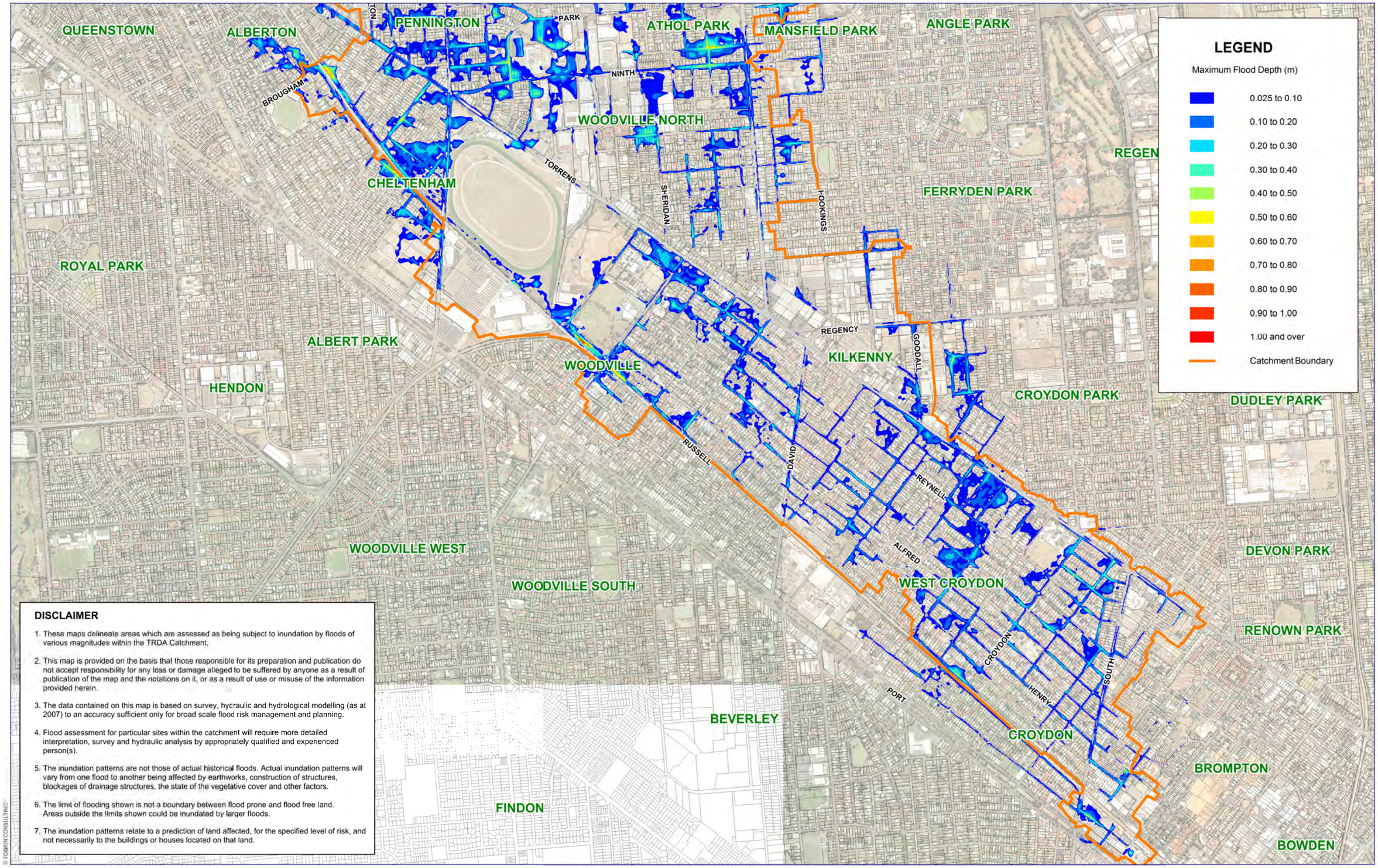
Cities of Charles Sturt & Port Adelaide Enfield

TORRENS ROAD CATCHMENT SMP
100 YEAR ARI EXISTING FLOOD INUNDATION

Figure C.5



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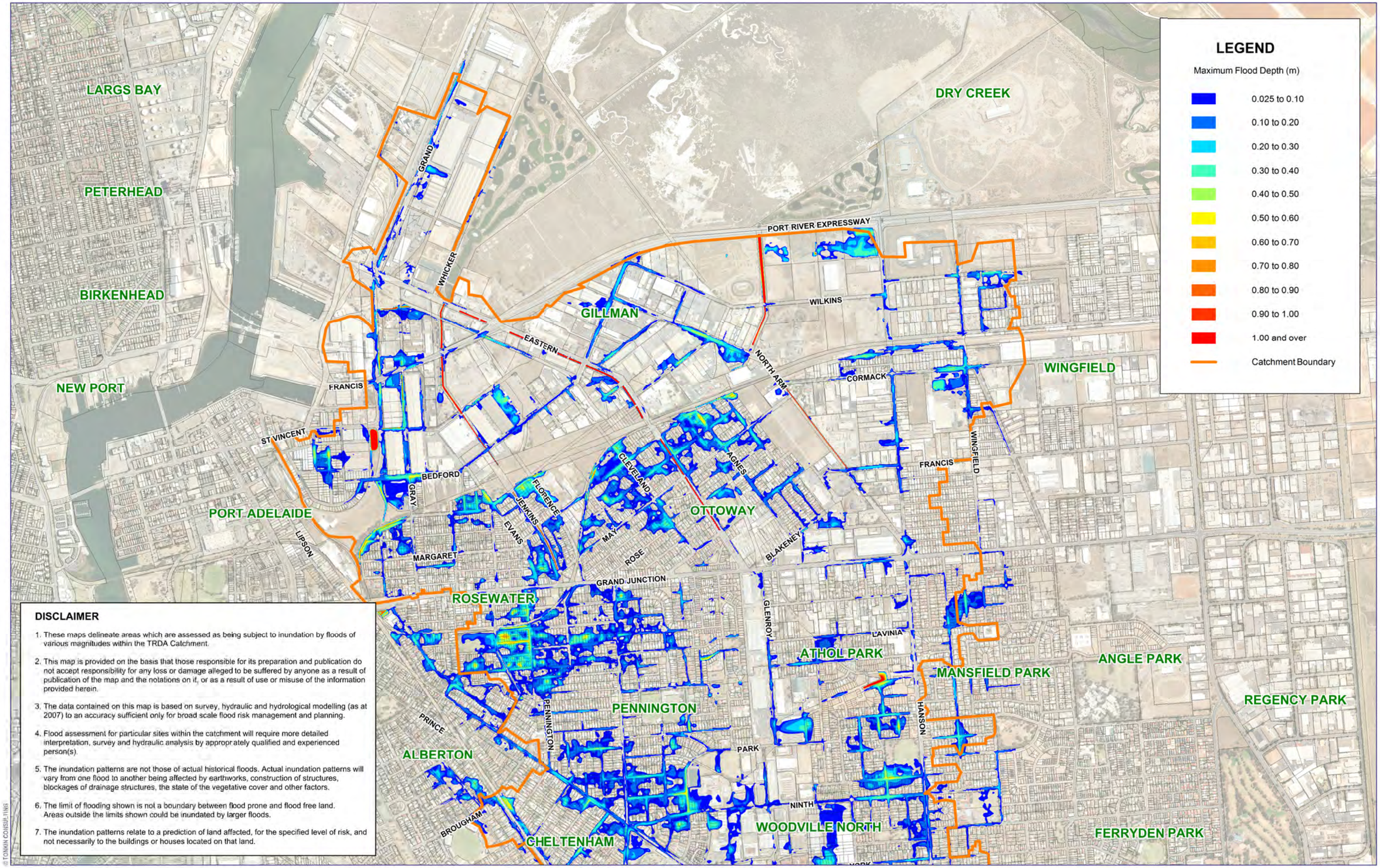
100 YEAR ARI EXISTING FLOOD INUNDATION

Figure C.6



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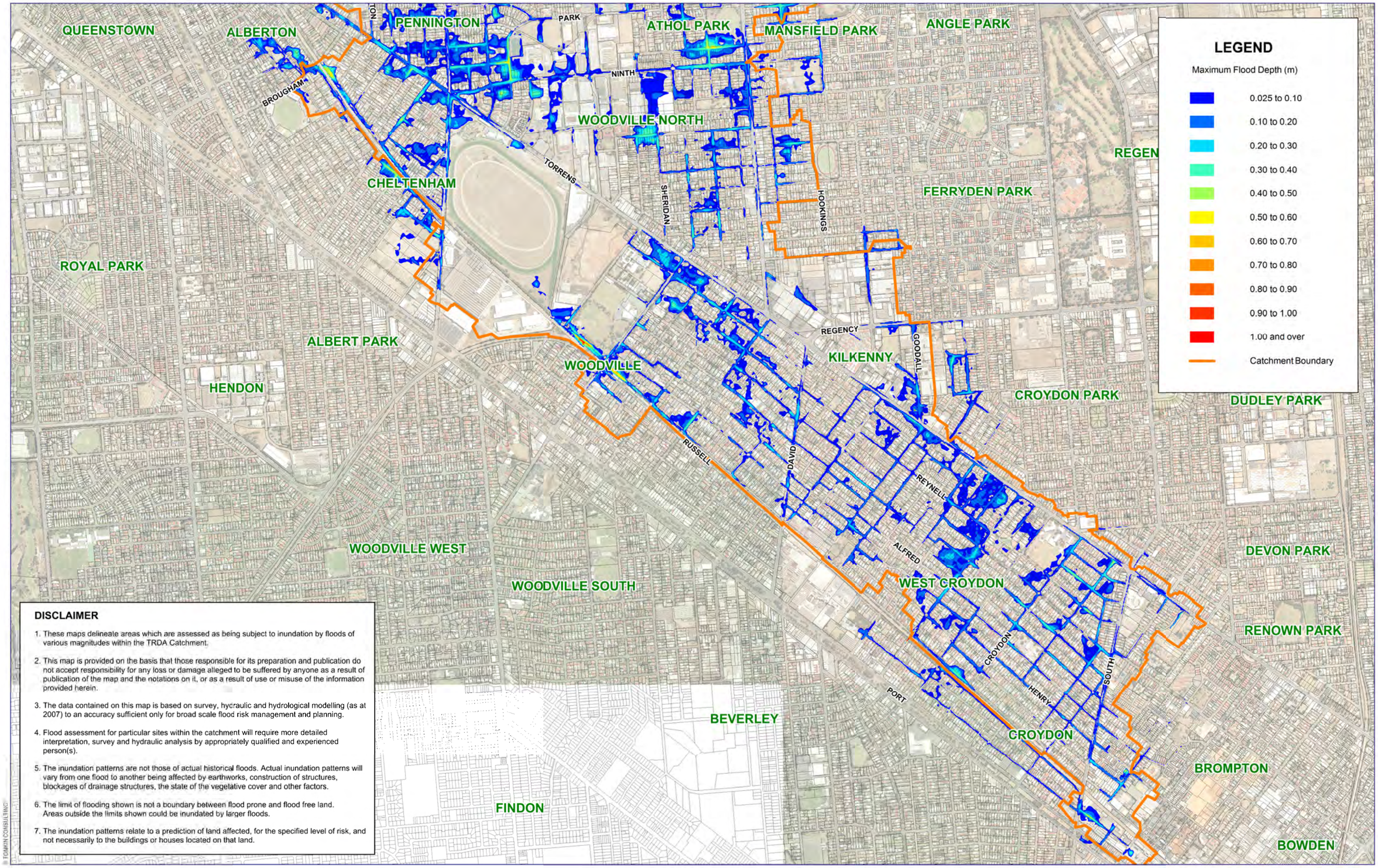
TORRENS ROAD CATCHMENT SMP
100 YEAR ARI LONG-TERM FLOOD INUNDATION

Figure C.7



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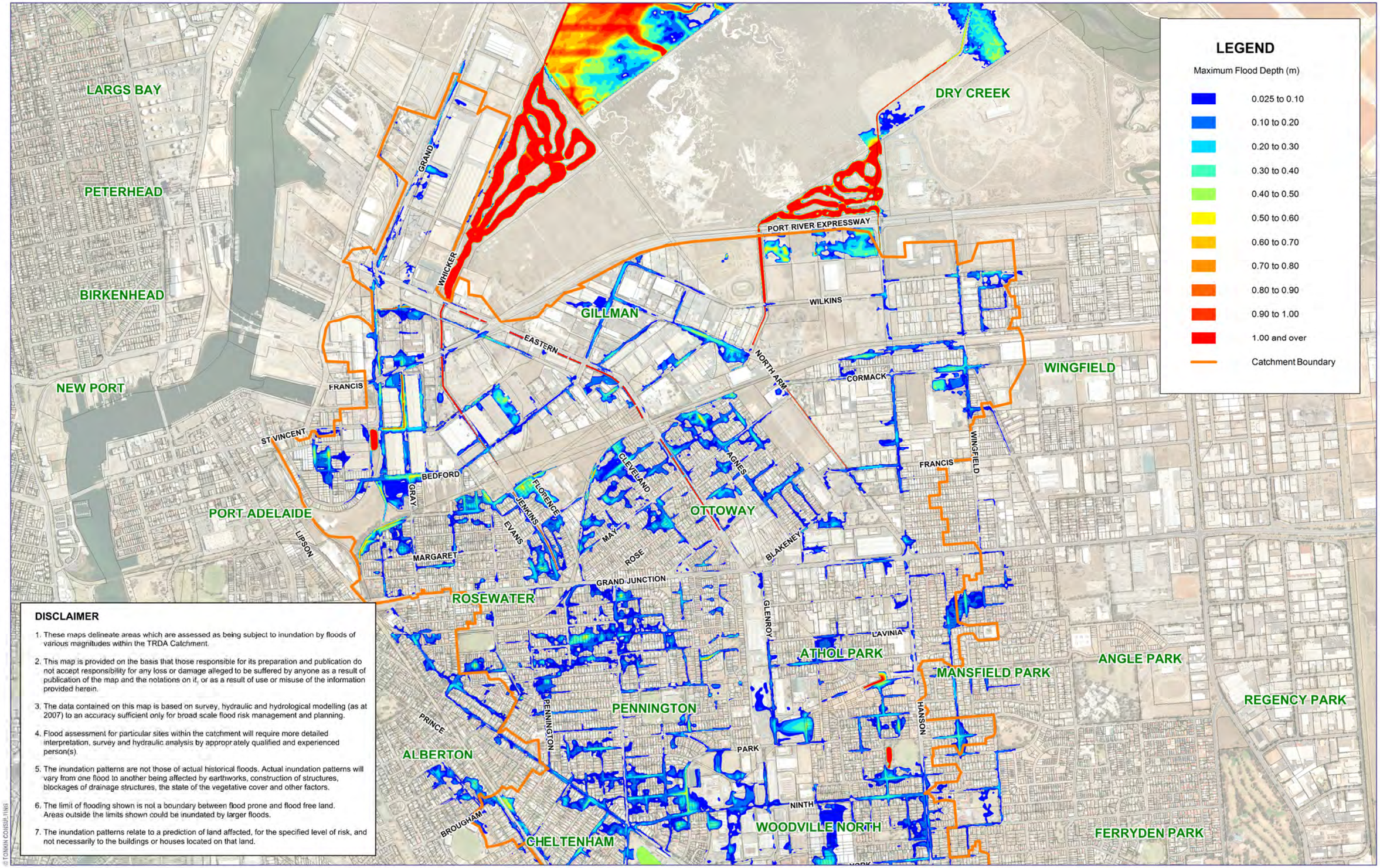
100 YEAR ARI LONG-TERM FLOOD INUNDATION

Figure C.8



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Cities of Charles Sturt & Port Adelaide Enfield

TORRENS ROAD CATCHMENT SMP
100 YEAR ARI LONG-TERM FLOOD INUNDATION - UPGRADES ASSESSMENT

Figure C.9

Appendix D

Consultation Responses

SA Water

Our Ref AC32461

SOUTH AUSTRALIAN
WATER CORPORATION

SA Water House
250 Victoria Square,
Adelaide South Australia 5000

GPO Box 1751
Adelaide SA 5001

Telephone +61 8 8204 1000

ABN 69 336 525 019

26 November 2013

Murali K G
Co-ordinator Water Projects
City of Charles Sturt
PO Box 1
WOODVILLE SA 5011

Dear Murali

SA Water comments on Torrens Road Draft Stormwater Management Plan

Thank you for the opportunity to comment on the draft stormwater management plan for the Torrens Road catchment and drainage system. SA Water has the following comments in relation to the draft plan. The comments are divided into two sections, with the first being in relation to aspects of the draft plan that may directly affect/influence SA Water, and the second section being guidance on certain issues where SA Water has had some experience which may be transferable to the delivery of the draft plan.

The aspects of the plan that have a direct relationship with SA Water activities are as follows:

- Co-ordination of infrastructure upgrade and maintenance activities to take advantage of works being undertaken by either agency. SA Water has a Local Government Liaison Manager responsible for co-ordinating such activities (Phil Jones – 7424 2161);
- Section 7.3 of the draft plan mentions investigations into a low flow diversion from the HEP drainage system into the Cheltenham Racecourse site. As mentioned in the draft plan, there is an ASR stormwater scheme at the end of the HEP drainage system, which is owned and operated by SA Water. Whilst the conclusion of this section of the draft plan states that a Stormwater Management Plan has not yet been developed for the HEP catchment, SA Water would be keen to be involved in discussions regarding the diversion of water out of the HEP drainage system if a diversion is being proposed.

The aspects of the draft plan where SA Water may provide guidance are described below:

- There is discussion throughout the draft plan regarding the use of ASR to provide storage of stormwater (for summer irrigation or industrial end use) to intercept flows and reduce the hydraulic load on the downstream drainage network. The consultant's report in the draft plan suggests some guiding principles for ASR scheme siting, however

Government of South Australia

in the period since the consultant's report was written, there has been a move by DEWNR to investigate the impacts of pressure within the aquifer from ASR schemes. If an existing ASR scheme or T1/T2 bore user is within the pressure zone of a proposed ASR scheme, there may be difficulty in getting the required approvals from DEWNR to enable the construction of a new scheme;

- Section 5.7 includes discussion on the need to dredge wetlands to remove sediment accumulation. There is also discussion throughout the report regarding modifications to open concrete channels. In recent assessments of the open, vegetated drain at the downstream end of the HEP drainage system it was identified that this vegetated drain acted as a filter to reduce the volume of sediment reaching the wetland, and hence reducing the need to dredge the wetland while improving the water quality within the wetland and the quality of water overflowing to Barker Inlet and Port River. Furthermore, where there is ample room to widen the channel, the conversion of a concrete lined channel to a more natural, vegetated channel will enhance the aesthetics of the area and may encourage biodiversity;
- Where possible, it may be prudent to investigate the ability to install subsurface storage systems and associated street trees where this opportunity is present when modifications to the existing stormwater network are undertaken.

SA Water can provide further detail on the information presented above if required, and as stated above, SA Water is willing to provide guidance on the aspects that affect our operations or aspects where SA Water has experience in these activities.

Yours sincerely

John Ringham
CHIEF EXECUTIVE

RenewalSA
people partnerships progress

Urban Renewal Authority
trading as Renewal SA.
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North Terrace, Adelaide SA 5000
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Ref: 14-09-03-02-0001

Mr. Murali KG
Co-ordinator Water Projects
City of Charles Sturt
PO Box 1
WOODVILLE SA 5011

19/11/13

Torrens Road Draft Stormwater Management Plan

Dear Murali,

Thank you for the opportunity to comment on the *Draft Torrens Road Stormwater Management Plan.*

Renewal SA supports the comprehensive approach to managing stormwater in the catchment and congratulates the City of Charles Sturt and the City of Port Adelaide field on collaborating to prepare the Plan.

Renewal SA has strong interest in the catchment as a land owner at Gillman and St Clair.

Please find attached comments on the plan. The comments are mostly technical in nature and do not change the overall direction of the plan.

If you have any queries relating to the comments please contact Mr. Michael Nietschke on 8207 0140 or via email at michael.nietschke@sa.gov.au.

Yours sincerely

Debra Just
General Manager, Urban and Portfolio Planning

Government of South Australia

Renewal SA comments

General comments

- The report uses language which appears to suggest that development, particularly within Gillman is 'bad' and may 'encroach' on the preferred use of the land for stormwater management, noting Section 7.2.5. This appears to be brought about by the premise that stormwater management needs to be managed through a gravity-based system (rather than through pumping), noting that the report does not highlight reduced operating costs etc. (which is presumably one of the reasons why pumped systems might not be considered) as an explicit goal at Section 6.1.

Section 2 - Existing Catchment Features

- Reference is made to Renewal SA's land holdings being "known as the TRDA Ponding Basin". It is requested that the land is referred to as 'existing key industry land' as per the *30-year Plan for Greater Adelaide*.

- Figure 2.2: The former Dean Rifle Range is shown as "Reserve". Consistent with the above, this should be shown as a combination of Reserve/Vacant land. There are consequential amendments to Table 2.1.

Section 3 - Previous Investigations

- The Jensen Structure Plan and the subsequent master plan (which post-dates the current works) are considered to be relevant previous investigations noting the structure plan is included as Figure 5.2.

Section 4 – Development potential

- The introduction is silent on discussions held with Renewal SA in the context of Gillman (despite section 4.4).

- Figure 4.2 assumes that the existing runoff coefficient (over the area included in Figure 2.2 as "Reserve") is unchanged (i.e. no development is modelled). Renewal SA's expectation is that this is likely to under-estimate the level of development in the 10-year horizon.

- The document refers to the SAHT owning scattered pockets of housing throughout the catchment, including suburbs of Pennington, Woodville North, Athol Park, Woodville Gardens and Mansfield Park. It infers that in the longer term the majority of these sites will be redeveloped, thus increasing the runoff coefficients for such areas. This point may be over-played.

- Renewal SA suggests that the 2009 Jensen report (Development Potential of Sites within the Catchment) is perhaps more accurate. This report states that "there is a high proportion of Housing SA [actually SAHT] developed residential

areas in the catchment, although only a relatively small number of houses are still owned by Housing SA [actually SAHT]"

- Some areas such as within Pennington, where SAHT still has a concentration of housing stock, is situated in a Residential Character Zone which is unlikely to be redeveloped at higher densities.

- Athol Park (and other areas of Westwood) have already been redeveloped with the large concentrations of SAHT stock dispersed considerably below levels previously seen for this area. This large scale redevelopment project considered stormwater management over the wider project area in conjunction with both the City of PAE & CCS.

- It is also noted that SAHT stock in Woodville Gardens and Mansfield Park (to a lesser degree) appear to fall outside the Torrens Road Catchment.

Section 5 - Hydrological Analysis

- Figure 5.1 includes reference to "TRDA Basin" which should be amended consistent with previous comments.

Section 6 – Stormwater Management Objectives

- Section 6.3.1: It is not understood why stormwater (from the defined TRDA Basin/Future industrial land) would be "unable to be discharged to sea" unless there was a presumption that only a gravity system was being considered.

- Objective 1.5: It is noted that the report contemplates a potential trade-off between the level of protection and the cost of providing that protection. Renewal SA would consider that an equivalent argument could be made in the context of "value generated" by development (providing that the party receiving the benefit and covering the risk are the same).

Section 7 - Stormwater Management Strategies

- The strategy mentioned as the most appropriate first response for managing development control is Strategy 3. Initial description in 7.2.1 (page 34) mentions that flows should be detained back to 5 year pre development rates.

- Under water re-use 7.5 (page 46) a key strategy is mentioned for management of redevelopment flows by retention of additional flows. Similarly under priorities and timeframes 9.1 (page 51) the highest priority mentions establishing changes to development controls to provide for retention of flows on site to ensure that peak flows and volume of discharge matches pre development flows.

- Renewal SA would prefer more clarity about what is being proposed as it appears that additional retention is what is being put forward but this is not clear.

- Section 7 has a primary focus on utilising Development Plan provisions at the development application stage for redevelopment sites to ensure the "provision of on-site measures to limit discharges from new development... to protect the standard of downstream drainage systems, and by managing flows volumes will also protect the standard of downstream ponding basins and wetlands". It goes on to state... "in order to meet this requirement, systems such as rainwater tanks plumbed into the house and used to supplement garden watering or infiltration devices will be required".

- This appears to be a shift away from Council's current practices of requiring detention systems (often requiring additional storage capacity) and controlling (limiting) discharge to the street water table. Clarity on this issue is required, that is whether the document is proposing detaining (and slow release) or retaining (for re-use on site) stormwater.

- The current practice with the City of West Torrens whereby developers can trade a portion of harvested detained stormwater for retention and re-use may serve as a more flexible model.

Section 4 – Development Potential

- Renewal SA land at Dry Creek / Gillman has been identified as being considered for a staged industrial land release/development over a 15-20 year horizon. It is stated that much of this land is presently used for stormwater and tidal management.

- The document states that "there is a need for the preparation of a co-ordinated plan for the area that addresses the proposed use of land, the proposed limits on development and the constraints necessary to ensure that the flood storage and stormwater management function currently provided by this area is not compromised as a result of this [future] development". It is noted that Renewal SA has commenced its master plan for the Gillman/Dry Creek Area.

Government of South Australia
Department of Planning, Transport and Infrastructure

In reply please quote 2009/14832
Enquiries to Martin Fidge
Telephone 8343 2292

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Mr Murali KG
Coordinator Water Projects
City of Charles Sturt
PO Box 1
WOODVILLE SA 5011

Dear Mr KG,

TORRENS ROAD CATCHMENT DRAFT STORMWATER MANAGEMENT PLAN

On 16 October 2013, Ms Jan Cornish, General Manager Asset Management Services, City of Charles Sturt and Mr Rob Tiggemann, A/Director, Technical Services, City of Port Adelaide Enfield wrote to Mr Andy Milazzo, Executive Director, Department of Planning, Transport and Infrastructure (DPTI), seeking comments on the draft Stormwater Management Plan (SMP) for the Torrens Road Catchment. I have been requested to respond on his behalf.

The draft SMP has recognised that the 30 year Plan for Greater Adelaide will result in significant increases in the volume of stormwater runoff. The plan identifies that further upgrades to the trunk drainage system are cost prohibitive and predominantly relies on development controls to mitigate increases in peak runoff rates. Increased runoff into the road network can result from the following three causes following redevelopment:-

1. The draft SMP indicates that the Cities of Charles Sturt and Port Adelaide Enfield already have planning controls for increased stormwater runoff in their development plans. The planning sections of other Metropolitan Adelaide Councils have consistently identified that they do not have the skills to assess on site stormwater management controls or resources to ensure compliance with them over time.

2. The draft SMP has set the drainage standard for main drains and outfall channels at 10 years. However the planning measures proposed only manage runoff up to the 5 year standard. With a lower planning standard, the standard of the main drains will continue to be eroded over time. This will impact on the service standard of the road network. Hence DPTI would prefer to have all events up to the 10 year standard managed on site as part of the development process.

3. The rational method is most commonly used to justify changes in runoff rates as a result of development on a site. Calibrated hydrology models for gauged urban catchments show that the rational method significantly overestimates runoff and peak flow from pervious surfaces particularly in the 5 and 10 year Average Recurrence Interval (ARI) events. Hence pre development flows determined using the rational method will be overestimated. As the development process results in the conversion of pervious surfaces into impervious surfaces, an overestimation of runoff from pre development pervious surfaces results in more uncontrolled runoff from impervious surfaces as redevelopment proceeds.

As a result of these three issues it is concerning to DPTI that the drainage standard identified for Torrens Road is now less than 5 year ARI in sections, and that the adjoining side roads have an even poorer standard. Surface flows entering from side roads are likely to further reduce the service standard of Torrens Road below the nominal drainage standard.

In order to better address these issues it is recommended that Council develop a table or spreadsheet guide of predevelopment flow rates and approved stormwater retention and detention mitigation measures to support their development controls. This could take the form of a web based interface.

The importance of the Gillman stormwater ponding basins at the coast will increase as sea level rises, as will the risk to any development allowed in the current stormwater ponds. A high priority project in the draft SMP is to prepare a Master Plan for the Gillman Ponding Basin area. The Coast Protection Board sea level rise recommendations are 1m higher by 2100. The latest International Panel on Climate Change report indicates a continuing increase in sea level post 2100. It is strongly recommended that time frames in excess of 2100 are considered in the Master Plan.

DPTI also manages the West Lakes inlet and outlet structures. West Lakes is essentially a large detention basin with a limited time period for outflows. As sea levels rise, the time for outflows decrease. This, coupled with increasing volumes of stormwater inflow from urban development, will potentially require more expensive outflow solutions in the future.

DPTI therefore request that on site water retention measures for redevelopment be applied and enforced across the whole of the City of Charles Sturt area. The DPTI Stormwater Group can advise further if required. Please contact Mr Martin Fidge on telephone number 8343 2292.

Yours sincerely,

Lou George
Director, Projects

20 November 2013

8134464

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EPA 05/13/2384

Mr Murali KG
Coordinator Water Projects, City of Charles Sturt
mkg@charlessturt.sa.gov.au

Dear Mr Murali KG

Thank you for the opportunity to provide comment on the *Torrens Road Draft Stormwater Management Plan* (the Plan). As this issue falls within my area of responsibility, Dr Gemmell has asked that I respond on his behalf.

The EPA has legislative responsibility under the *Environment Protection Act 1993* and the *Environment Protection (Water Quality) Policy 2003* to ensure water quality outcomes in the States waters, including stormwater. Accordingly, the below comments on the Plan are focused on water quality outcomes.

I note that the entire catchment run-off passes to either Magazine Creek wetland or Range wetland which provide water quality treatment of stormwater for the catchment before it passes to Barker Inlet. These wetlands are sized to treat ru-noff from the current development scenario, not future development. Strategy 7.7.3 in the Plan recommends that monitoring of the wetlands is undertaken to inform a comprehensive management strategy for the wetlands. The EPA supports this strategy and may be able to offer assistance in developing the monitoring regime for the wetlands. Baseline monitoring in the near future is also recommended as part of this strategy. Further, since the wetlands are critical to treatment of all stormwater from this catchment, it is recommended that responsibility for care and management of the wetlands is clearly articulated in the Plan.

With the exception of the Cheltenham/St Clair wetland under construction, water quality improvements within the catchment are limited and the EPA recommends inclusion of some further strategies to enhance those outlined in section 7.4 of the Plan:

1. That the proposed development controls for flood management are extended to include water quality outcomes and water sensitive urban design for all development.
2. That details of development controls are articulated in the plan.
3. That Councils explore all opportunities to install water quality improvement structures and water sensitive urban design in streetscapes as part of their respective infrastructure replacement programs.
4. That adequate controls are put in place and enforced during construction activities.

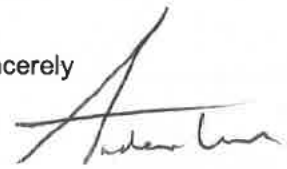
Strategy 7.2.5 of the Plan seeks to ensure that the Gilman ponding basins are not encroached by proposed future industrial land. Given this area is immediately adjacent the two stormwater treatment wetland systems, and there is potential for any development on this land to affect the functionality of the wetlands, the development of a stormwater master plan for this area is supported by the EPA. Note that a wetland management strategy and the proposed master plan may require a degree of interaction.

It is also noted that the *Development Potential Report* Jensen Planning, dated June 2009 which informs future development scenarios, predates the release of the *30 Year Plan for Greater Adelaide*. A review of *Development Potential Report* may be warranted to ensure all future development scenarios are incorporated.

Separately, section 9.3 appears to contain some works that have not appeared in earlier sections of the Plan and that do not appear to align with this catchment (for example low spots behind coastal dunes and GPTs on coastal outfalls). They appear to be erroneous and this section should reflect the works outlined in previous sections of the document.

If you would like any further information on this matter, please contact Ruth Ward on 8204 2065 or ruth.ward@epa.sa.gov.au.

Yours sincerely



Andrew Wood

EXECUTIVE DIRECTOR OPERATIONS

ENVIRONMENT PROTECTION AUTHORITY

Date: 12/11/13

NRM Notes on Torrens Road draft SMP

Need to add:

1. A summary/list of flood prone properties.
2. Costs to maintain/replace, clean the existing GPTs at Magazine and Range wetlands.
3. Stress the need for a Monitoring program for water quantity and quality. All references report the good performance of the Magazine and Range wetlands in improving water quality, please include supporting evidence for this (if any is available).
4. It is likely that the presence of European Carp and lack of filtering vegetation on Magazine and Range wetlands is reducing the effectiveness for water treatment. Plan to include modifications to improve in performance of Magazine and Range wetlands. Improvements may be possible at modest cost with assistance from NRM (as for North Arm East).
5. A series of GPTs has been proposed and costed for mid-catchment downstream of Cheltenham, in support of Objective 2.1 Is there any indication that Council is willing to implement these?
6. The Department of Water no longer exists, it is part of DEWNR.
7. Could the Plan please include a 3-page Summary, including the basics that the senior managers need to read, which sets out the things that are important for the Torrens Road catchment, what needs to be done, the costs, and the likely risks if we don't carry out the necessary works.

The thinking behind this plan is that stormwater volumes are too large for there to be any opportunity to minimise the risk of flood damage by discharging directly to the marine environment. This is because the main drainage network, built in an earlier time, with less development in the catchment, is now unable to cope with increases in flow as a consequence of increases in impervious areas. It is not feasible to increase the size or depth of main drains, therefore the community has either to provide flood storage in the catchment or to accept a greater risk of flood damage. The SMP explores ways of using open areas, such as sports ovals and the Cheltenham wetlands to provide flood storage and thereby mitigating flood risk. It also identifies a need to introduce development controls so that as far as possible, rainwater is retained on individual sites, and that the overall risk of flooding is not allowed to increase. Effective introduction of stormwater retention measures will allow significant savings in public works (at least $12M). An underlying potential problem for stormwater systems in this catchment is the effect of Acid Sulphate Soils on civil structures, particularly concrete. A monitoring program to detect and remedy any of these effects is advised.

The following are Key points in the SMP, they will be referred to in the NRM report to the Stormwater Management Authority (ie: they are points of emphasis, and do not imply any need to change the SMP)

Pg 17 and Figure 5.1 show how the standard of flood capacity in the main drains will be reduced in time if stormwater volumes and peak flows are not addressed.

Pg 25 importance of developing a "Treatment Train" to minimise the movement of sediment and pollution down the catchment. This will involve careful control of effluent from development sites.

Similarly, regulatory controls on the volumes and peak flows from all development sites, will be effective in minimising any increase in flood risk, and therefore cost to the community.

Pg 27 indicates that the 100-year flood event cannot be contained within the stormwater system, and therefore flooding will occur. It can be mitigated to some extent by restricting stormwater

flows from individual sites, and by some improvements in the stormwater system. All new dwellings and structure need to be built above the 100-year flood level. The use of roadways to carry flood waters from time to time is regarded as acceptable.

Pg 41 - suggested lowering of the surface level of sports ovals to provide flood storage (typically 1.5 to 2.0 metres) will relieve peak flood flows in the main drain. Management issues include drainage, and post flood recovery/cleanup. Frequency of inundation is +/- 10 years.

The construction of a wall (levee) along the sides of the main drain in the Ottoway area will reduce the risk of flood overflows but has unsatisfactory side effects.

Pg 42 need to ensure that the capacity of the outfall ponding basins is not reduced. This is because sea level rise will restrict the time available to release stored stormwater during low tides. **A master plan is required to ensure flood storage is not compromised**.

Pg 44 anticipated that at some time in the future, the Ottoway lagoons will need a pumping system to discharge flood water into the Barker Inlet, possibly as a consequence of sea-level rise.

Pg 45 Uses the opportunity to pump water from the R Torrens to increase MAR at Cheltenham.

S 7.4 Monitoring of Water quality in Magazine Creek? Please provide background to current performance.

Water quality improvement is achieved as a result of Cheltenham Retention/Wetland. Small scale water quality treatment at individual developments is recommended, S 5.7

The current performance of Magazine and Range wetlands in water quality improvement is due mainly to sedimentation during 10-day detention.

Pg 47. A Monitoring program of water quantity and quality will enable effective management of stormwater into the future.

Pg 48 Important to note that the proposed Torrens Road Relief d

Drain reduces flood risk, but construction cost ($12M) can be avoided if WSUD principles are applied to all development so that increases in quantity and peak flow rates are avoided. Note that if Torrens Road Relief Drain is constructed, it will be necessary to provide additional flood storage at Cheltenham (see Pg 39)

Pg 50 S 8.2.2 NRM agreement currently offers 50% of design and construction costs of GPTs.

Council

THE CHELTENHAM PARK RESIDENTS ASSOCIATION Inc.

PO BOX 5154 ALBERTON SA 5014

CPRA SUBMISSION TO THE CITY OF CHARLES STURT.

REVIEW OF A DRAFT STORMWATER MANAGEMENT PLAN FOR THE TORRENS ROAD CATCHMENT.

HISTORY OF THE REVIEWED DOCUMENT.

DRAFT	JAN. 2012
FINAL DRAFT	OCT. 2012
AMENDED FINAL DRAFT	APR. 2013
AMENDED FOLLOWING COUNCIL WORKSHOP	JULY 2013

Trevor White

CPRA Chairman. 18/01/2014.

DEPUTATION 00012014

Trevor White
18/01/14

INTRODUCTION

Charles Sturt Council is required to prepare a Stormwater Management (SWM) Plan for the Torrens Road Catchment that must include action plans to ensure proper management of stormwater and flood mitigation.

CPRA has maintained a strong interest in the subject including :-

2007 CPRA Submission to the Australian Government National Water Initiative

Appeal to the Supreme Court of South Australia [2008] SCSA 1680

2011 CPRA Deputation to the City of Charles Sturt

CPRA members have an interest in that part of the Catchment north of Grand Junction Road, however this region is within the Port Adelaide Enfield Local Government Area and information within the management plan is noted but not included in this review.

CATCHMENT DRAIN LOCATION AND LAND FORM.

The Catchment has its southern boundary along the Port Adelaide railway line extending from South Road with Torrens Road essentially the northern boundary until in the vicinity of Hanson Road, the catchment area extends northwards until connecting with Grand Junction Road that provides the boundary between Port Adelaide Enfield Council and Charles Sturt Council.

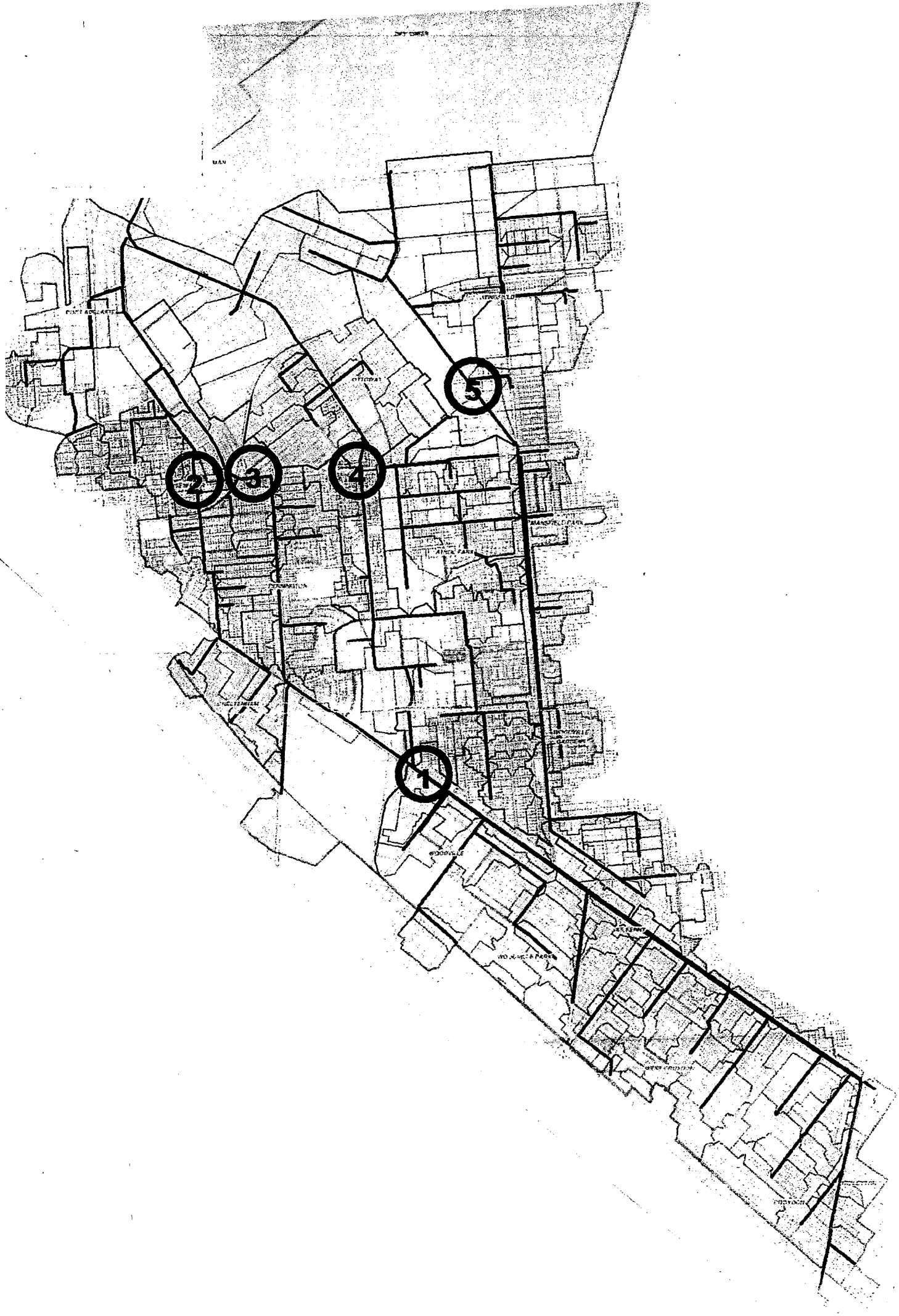
The catchment has five major drains that service sub-catchments associated with major road systems.

The drains servicing the eastern and western regions of the catchment are independent of the Torrens Road Drain.

The Torrens Road Drain is down gradient from South Road to where a splitter box directs low flows into the Audley Street drain that travels north to Eastern Parade. The remaining stormwater passes the former Cheltenham Park racecourse then turning north at Addison Road. This drain eventually connects with the Jenkins Street drain located in the Port Adelaide Enfield region.

The eastern end of the catchment is serviced by the Hanson Road drain that connects with North Arm Road in the Port Adelaide Enfield region.

The western area is serviced by drains rising in Brougham Place and Stroud Street then running north by connecting with the Pennington Terrace and Eastbourne Terrace drains. This drain continues into the Port Adelaide Enfield region and eventually connects with the Jenkins Street drain.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2
3
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1

The four northerly directing drains are identified by the numbers in the attached diagram. All lead to receiving open channels that direct the stormwater to the northern wetlands that empty in to the Barker Inlet of the Port River.

① Torrens Road.

② Eastbourne Terrace. Directed into Jenkins Street Channel then into Magazine Creek wetland.

③ Jenkins Street. Empties into Jenkins Street Channel then into Magazine Creek wetland.

④ Eastern Parade. Empties into Magazine Creek wetlands.

⑤ North Arm Road. Empties into Range wetland.

All destinations above Grand Junction Road are in the Port Adelaide Enfield Council area.

CATCHMENT PERFORMANCE UNDER EXISTING 5 year ARI RAIN EVENTS.

The computer prepared 5 year ARI flood plain predictions show all the existing drains essentially meeting the expected Standard but by performance, a small number of localities, including commercial properties, are seen to be regularly liable to nuisance road and property flooding.

However the Standards (estimated by ARI) of some of the local area drains are marginal and under predicted long term development, their ability to provide flood protection is suggested to further reduce:-

①	②	③	④	⑤	
Torrens Road	Easbourne Tce.	Jenkins St.	Eastern Parade	North Arm Rd.	
5 year ARI	1 year ARI	2 year ARI	> 10 year ARI	10 Year ARI	Standard
1 – 2 year ARI	< 1 year ARI	< 1 year ARI	> 10 year ARI	5 – 10 year ARI	Long Term

The prediction of the extreme flooded areas is shown in the provided flood plain maps arising from 5 year and 100 year ARI storm events.

REMEDIAL PLANS FOR EXISTING FLOOD PRONE AREAS.

Region ② Eastbourne Terrace Drain System.

The 5 year Flood plain mapping indicates the potential for flooding in the Cheltenham Parade /Torrens Road locality and the Pennington Terrace to Grand Junction Road area

at Rosewater. Major flooding for both areas is predicted by the 100 year flood plain maps.

In the latter area, some 65 residences are predicted to experience inundation and a number of other premises will experience flooding.

The remedy suggested for this Rosewater area is a major duplication of the existing drain from this area to connect to the Jenkins Street drain at Bedford Street. This proposed duplication of drain at an estimated cost of $4.5 million would occur essentially in the Port Adelaide Enfield area.

The serious flooding from overland flows in the Cheltenham Parade, Stroud Street, Torrens Road triangle is not addressed in the SWM Plan. The development on the previous open space Cheltenham Racecourse land to the runoff generated by sealed surfaces and directed stormwater drainage will exacerbate the flood inundation in this Cheltenham area.

Region ⑤ North Arm Road Drain System.

The localized Woodville North flooding from York Street up to Hamilton Street adjoining Hanson Road from overland flows is predicted to be more serious by the 100 year ARI flood plain map predictions. Some 17 residences are claimed as being at risk of inundation.

This area is at the head of and serviced by the O Eastern Parade drainage system. In that area the existing lateral drains recorded "pipe standard (ARI)" is less than 2 year.

Construction of a detention basin in Sparrow Reserve is not being considered further.

Two SWM Plan proposals include excavation of Fawk Reserve to provide a flood mitigation detention basin. The suggested redevelopment pond would be adjacent to Adele Street.

Redevelopment Pond	Long Term Detention Basin
Depth [say]400mm	Depth 1.5m to 2m
Volume 3,700 m^3	Volume of stormwater 22 ML

A 400mm pond depth could accommodate overland drainage from some 7 Ha of sealed surface in a 100 year flood event.

The indicated $ 0.6 million Capital Cost proposal acknowledges the need to structure the function of the drainage such that flows "only spill into the area during significant rainfall events to maintain the useability of the area for recreation". Meaning at other times. The estimate of Capital Cost also includes "Upstream Pipework". The situation existing for drains in Owen Street will be considered in the next section.

Regions ① Torrens Road and Extensions viz. ③ Jenkins Street and ④ Eastern Parade Drains.

Region ①, is essentially bounded between the Port Adelaide railway line and Torrens Road from South Road down to Audley Street , Woodville North.

The main existing Torrens Road trunk drain has a 5 year ARI Pipe Standard. The SWM Plan claims the Standard to drop to a long term development standard of 1-2yr ARI. This claim must be challenged as essentially the whole area is Historic Zone residences with limited open space and industrial areas likely for urban consolidation.

All lateral drains in the area, mostly of less than 2 year ARI Pipe Standard, run towards Torrens Road. Six of the lateral drains feeding the Torrens Road trunk drain are claimed to have "enlarged stubs" indicating that when constructed, the need to upgrade these laterals over time was contemplated at the design stage.

Two areas of nuisance flooding shown in the 5 year flood plain mapping occur in the South Road area to the Torrens Road Corner and also an area at West Croydon.

The 100 year flood plain mapping shows substantial more flooding along the drain roadways and significant property inundation nearer the Torrens Road area. This can be interpreted as evidence that the general upgrade of the laterals is due and that additional flows to the upper end of the main trunk drain should be avoided.

An alternate Charles Sturt promoted option is the Torrens Road Relief Drain. This will be considered later in this review.

Region ④, the Eastern Parade drain system.

This drain branches from the Torrens Road drain through a splitter box allowing only low flows directed into the Audley Street drain at Woodville North and extending northwards to Pennington and Athol Park bordering Grand Junction Road. This drain collects along the way stormwater from the area dealt with in respect to Fawk Reserve.

Considerable lengths of this drain system are less than 2 year ARI Pipe Standard but the overall drain capacity is rated as greater than 10 year ARI Pipe Standard.

The region serviced by this drain has areas of open space and large areas of commercial and industrial establishments.

The SWM Plan includes the large areas of 100 year ARI flood inundation for the Burleigh Avenue / Ninth Avenue locality but no remediation plan is included.

Region ③ Jenkins Street drain system.

This drain system is an extension along Addison Road of the Torrens Road drain passing the former Cheltenham racecourse and the Cheltenham Parade drain. The latter drain has been mentioned with the ② Eastbourne Terrace drain.

This drain with laterals servicing only the eastern side of Addison Road has a current 2 year ARI Pipe Standard. In the 100 year ARI flood prediction maps, inundation is

predicted along most of Addison Road. No remediation proposals for this area are mentioned in the SWM Plan.

PROPOSED SWM PLANS FOR FLOOD MITIGATION UTILISING THE FORMER CHELTENHAM PARK RACECOURSE LAND.

Preamble

From its earliest days CPRA has voiced that before all else, the Cheltenham Park racecourse land needs to be considered for stormwater flood mitigation. Planning staff from both Charles Sturt Council and Port Adelaide Enfield Council have made similar public statements.

The requirement for the SAJC to yield 40% of the racecourse land as public open space advanced by Premier Mike Rann, subsequently reduced to 35% when the Charles Sturt Council refused to provide $5 million towards the development of the open space, was intended to include a wetland with ASR capability. (Charles Sturt Council eventually made the payment).

Over time the SA Government increased its funding and required the area of the wetland be extended to 6 Ha and that stormwater be sourced from the Torrens Road drain and the River Torrens.

The SAJC and the Developer have agreed with the SA Government to enter into a Commitment Deed for the future development of the land. The SA Government (through its agency) has entered into a Development Deed with the Developer and the City of Charles Sturt for (in part) the agreement to establish wetlands for the purpose of aquifer storage and recovery of treated stormwater.

No plans for the wetlands are included in the SWM Plan however the area currently being excavated appears to exceed 6 Ha and has the form of a 9.7 Ha plan previously exhibited by the Developer.

Development Control

The SWM Plan includes Charles Sturt Council's Development Plan requirement that the 100 year stormwater peak flow leaving a site must be detained to pre-development rates for a 5 year ARI event.

The SWM Plan also proposes that further investigation be made into limiting the 5 year post development flow be detained back to the 5 year pre-development rates to protect "the standard of the underground drainage system".

In the event of the wetland exceeding a level above 4.3m AHD, by design wetland water will discharge into the Cheltenham Parade drain at a flow rate of 1.26 m^3 per second (AECOM).

This rate for a nominal 5 year recurrence intensity (21mm per hour) would require collection from 16Ha of impervious surface as well as the collection by the 6Ha wetland itself. This amount of indicated impervious surface is far in excess of that existing at the former racecourse site.

The 5 year ARI flood plain mapping indicates inundation of that area of Cheltenham Parade with overland flow commencing towards Cheltenham residences. Also for a system failure, the overflow from the wetland is to be discharged by a spillway into Torrens Road near the Cheltenham Parade intersection. Both of these processes have the potential to exacerbate the flood risk at Cheltenham during storm events.

Utilizing Cheltenham Park Wetland For Stormwater Detention.

In February 2009, the State Government announced the $20 million project for an expanded stormwater harvesting scheme for Cheltenham Park viz. " to treat, store, recover and reuse 1.2GL per year of stormwater".

The harvesting will occur from the Audley Street junction with the Torrens Road major drain. The SWM Plan does not refer to the diversion of stormwater into Cheltenham Park wetlands from the two areas of development on the former Sheridan/ ACTIL industrial site. This diversion influences the capacity of the wetland to provide flood mitigation during extreme storm events.

The possible option of the utilization of the Cheltenham Park wetlands for the future long term development of the Torrens Road relief drain and its influence again for the wetland to provide flood mitigation during extreme storm events will be considered in a following section.

The SWM Plan intends to pump stormwater from the Audley Street drain to the wetland at 500 L per second. To attain the harvest of 1.3GL per year of stormwater will require 722 hours of pumping. Without knowledge of the diversion rate of the Audley Street splitter box ,no further analysis can be undertaken on harvesting except note that the pump requires stormwater delivery to the pump well at the pump rate for 722 hours to achieve the harvest quantity. This harvest quantity represents approximately 62% of the annual rainfall for the Torrens Road sub-catchment.

Cheltenham Park Wetlands and Flood Mitigation.

The wetlands of 6Ha area with permanent operating level of 3.9m AHD and allowed to rise 400m for extended retention provides an opportunity for flood mitigation in extreme storm events.

The extended retention would accommodate 24ML of stormwater.

A 100 year one hour duration rainfall event (47.2 mm) for the 420Ha catchment, would produce at 81% yield a volume of 160 ML of stormwater. This volume would clear the Torrens Road drain at Audley Street in approximately one hour.

The Audley Street pump takeoff in one hour would be 1.8ML delivered to the wetlands reducing to some extent the stormwater flow to Eastern Parade.

The above takes no account of the inflow to the wetlands from the 26Ha of development on Cheltenham Park or the stormwater diverted from the development on the previous Sheridan/Actil industrial site.

Torrens Road Relief Drain.

As an alternative to upgrading lateral drains in the upper part of the Torrens Road catchment region, a proposal to construct a central major collection drain intercepting the existing laterals in the centre of this sub-catchment region is included in the SWM Plan. The estimated capital cost for this proposal is $10-12 million and requires another $4 million for the construction of a 4Ha retention basin by a 200mm excavation of the Brocas playing field surface.

It is suggested that this project may be required as a 30 year development upgrade.

From the previous section a 100 year one hour storm event for the 210 Ha (half) area would generate [say] 80 ML of stormwater. The Brocas Avenue retention pond of 8ML volume would soon overspill into the wetlands that at the best of times could receive 24ML before stormwater would be discharged to the Cheltenham Parade drain and the Torrens Road carriageway.

This proposal needs reconsideration.

SUMMARY

The Consultant has provided valuable source material for developing a SWM Plan for the Torrens Road Catchment.

This review has considered the provided information for each sub-catchment area attempting to identify the drainage problems and examine the remediation plans if presented.

The remediation plans in the Charles Sturt Council local government area are limited. One being the remediation of local area flooding such as the $0.6 million Fawk Reserve proposal.

The Cheltenham Diversion and Flood Storage proposal at a Capital Cost of $1 million to protect four flood prone residences and protection of other properties in the Pennington area has not been identified. A basin is proposed to mitigate the additional flows resulting from the construction of the Torrens Road Relief Drain.

Evidence has been presented in this review that diverting stormwater in flood events from half the Torrens Road sub-catchment area through the Brocas playing fields into the Cheltenham Park wetlands will exacerbate the overland stormwater flows both at Pennington and Cheltenham.

The Torrens Road Relief Drain $10-12 million and the Brocas playing field retention basin $4 million are described as "May be required in the 30yr timeframe".

CONCLUSION.

Over all, the information presented in this Consultants report will provide little comfort to the many Charles Sturt property owners that already suffer the inconvenience of local flooding and the many ratepayers that received flood plain mapping risk advice about their properties many years ago.