Greater Edinburgh Parks and St Kilda Catchment

Stormwater Management Plan

City of Playford and City of Salisbury

Client Ref No. 000554
27 June 2024
Ref: 20170712R002E

Building exceptional outcomes together

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft	MM/TAK	TAK	TAK	24 June 2019
B	Consultation issue	MM/TAK	TAK	TAK	22 May 2020
C	Consultation reissue	MM/TAK	TAK	TAK	24 June 2021
D	Final draft	MM/TAK	TAK	TAK	6 July 2022
E	Issued for use	MM/TAK	TAK	TAK	27 June 2024

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Client: City of Playford and City of Salisbury
Ref: 20170712R002E

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Glossary

ACHRD	Adams Creek and Helps Road Drain
ACWQIP	Adelaide coastal water quality improvement plan
ACWS	Adelaide coastal waters study
AEP	Annual exceedance probability
AMLR	Adelaide and Mount Lofty Ranges
ARI	Average recurrence interval
ARR	Australian Rainfall and Runoff
ASR	Aquifer storage and recovery
CEMP	Construction environmental management plan
CL	Continuing loss
EY	Exceedances per year
GEP	Greater Edinburgh Parks
GP/GPT	Gross pollutants / gross pollutant trap
IL	Initial loss
MAP	Epic Energy Moomba to Adelaide pipeline
MAR	Managed aquifer recharge
MHWS	Mean high water springs
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NAPLS	Northern Adelaide Plains Land System
NEPM	National Environment Protection Measure
NRM	Natural Resources Management
PFAS	Per- and poly-fluoroalkyl substances
RAM	Rapid appraisal method
SEDMP	Soil erosion and drainage management plan
SMA	Stormwater Management Authority
SMP	Stormwater management plan
SSWFE	Southern and South-Western Flatlands East
TN	Total nitrogen
TOC	Time of concentration
TP	Total phosphorus
TSS	Total suspended solids
WSUD	Water sensitive urban design

Report terminology

Typically, general practice has been to use the term Average Recurrence Interval (ARI) for design flood estimation. However, the new Australian Rainfall and Runoff (ARR) guidelines have adopted the term Annual Exceedance Probability (AEP) or Exceedance Year (EY) (depending on the event and use) to reduce ambiguity and confusion within the community.

Terminology in this report is used interchangeably between ARI and AEP depending on the context. Where this report refers to modelling or documents prepared prior to 2016 the use of ARI has been continued for consistency. For any new work or modelling the term AEP has been used, as recommended by ARR 2019.

There are some differences between ARI and AEP for events under the 5% AEP (20 year ARI). Where this report refers to these more frequent events, ARI is used for consistency with modelling previously carried out.

Executive summary

A Stormwater Management Plan has been prepared for the Greater Edinburgh Parks and St Kilda catchment, an area of approximately 24 km^2 that is split across two Council boundaries (City of Playford and City of Salisbury). The plan provides a framework for the holistic management of stormwater within the catchment area. It summarises the current state of the catchment, identifies problems and opportunities, defines objectives and develops a list of prioritised strategies which seek to achieve Councils' goals and meet the multi-objective requirements of the SMP planning process. The strategies are aimed at:

- Providing an acceptable level of protection from flooding to the community and public and private assets
- Improving water quality to meet the requirements for protection of the receiving environment
- Maximising the economic reuse of stormwater for beneficial purposes
- Managing stormwater assets in a sustainable manner
- Achieving desirable planning outcomes associated with new development, open space, recreation and amenity
- Managing stormwater runoff in a manner that protects and enhances biodiversity and the natural environment

A multi-criteria analysis framework was used to rate the stormwater management strategies against a wide range of benefits including reduction in flood risk, water reuse and water quality improvements. A key feature of the plan is the progressive development of a trunk drainage network to provide a drainage outfall for areas of the catchment which are expected to undergo significant development.

The Greater Edinburgh Parks and St Kilda Catchment covers an area of approximately 24 km^2. The area has been identified by State Government for economic growth and over the coming years a significant proportion of the catchment is expected to experience changes to the land use. The changes to the land use will result in the need for drainage infrastructure to manage increased stormwater runoff.

The SMP provides a framework for future stormwater initiatives. The SMP identifies a suite of capital stormwater works and stormwater management measures to be undertaken within the catchment area. These projects are conceptual only and require further planning, investigations, feasibility, design considerations and an approved funding pathway.

Due to the large quantum and value of drainage works, the implementation will likely need to be carried out over many years and with support and partnerships between Councils, private sector and state/federal governments. The timing and implementation of the works outlined in this SMP will be influenced by the Growth Framework and timing of various developments. Council will consult with the community on these projects as they are planned for delivery.

At the time of preparing the SMP, Strategic Growth Framework for the region had not been completed by the City of Salisbury or Playford. For this reason, there will be a need to ensure the SMP and framework are aligned. The growth frameworks provide high level infrastructure alignments and stage of rezoning to employment lands.

1 Introduction

This Stormwater Management Plan (SMP) provides a framework for a coordinated, multi-objective approach for the management of stormwater within the Greater Edinburgh Parks (GEP) and St Kilda catchment area. The process that has been undertaken during the development of the plan, and the contents of the plan itself comply with the requirements of the Stormwater Management Planning Guidelines (Stormwater Management Authority, 2007).

Consistent with the intent of the SMP Guidelines, this plan is founded on an integrated multi-objective approach to stormwater management on a whole of catchment basis. It provides an overview of the existing state of the catchment, including identification of problems and opportunities associated with the management of stormwater. It defines objectives for the management of stormwater and presents structural and non-structural strategies to address the objectives. The plan then defines the priorities, responsibilities and timeframes for the implementation of the works identified by the plan.

The plan has been prepared in consultation with staff from the City of Playford and the City of Salisbury and a dedicated Project Steering Committee including representatives from the Stormwater Management Authority (SMA), Natural Resources Adelaide and Mount Lofty Ranges, Department for Environment and Water.

The plan was written before creation of Green Adelaide and has been based on the natural resources management plan for what was the AMLR region.

2 Study area

2.1 Catchment description

The GEP and St Kilda catchment boundary covers an area of approximately 24 km^2, as shown in Figure 2.1. The catchment is located to the north of Adelaide CBD (an approximate distance of 20 km) and straddles the boundaries of the City of Playford and City of Salisbury. It is bound by the Northern Expressway to the east and the coastal zone to the west. The majority of the catchment area is currently sparsely developed.

In most areas, stormwater runoff is conveyed through the catchment via roadside swales. Due to the flat nature of the catchment and the presence of road embankments, there is the potential for large shallow areas of ponding following heavy rain. The land has very little formal stormwater drainage with flood flows traversing low lying areas and ponding in trapped low spots, where it dissipates through infiltration and evaporation.

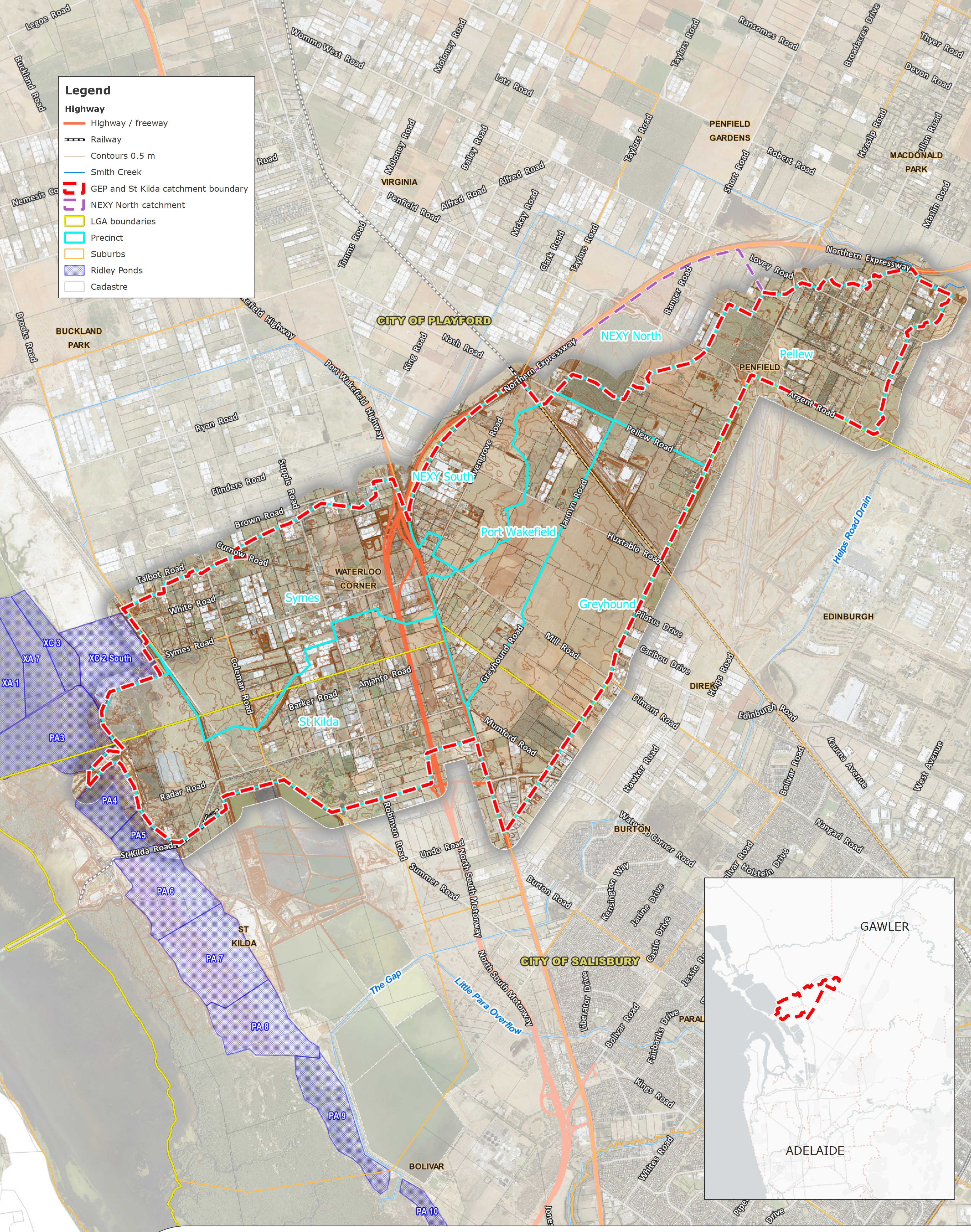
An extract of the floodplain mapping undertaken previously for the long term development scenario is included in Appendix A (Tonkin, 2018a). The map provides an indication of the existing drainage behaviour, and has been annotated to show current natural overland flood flow paths. Additionally, Tonkin (2020) has also undertaken modelling of both the ACHRD and GEP catchments for the existing development scenario, to represent the current level of flooding across the catchments. The results of this modelling are also shown in Appendix A.

There are two discharge locations to Gulf St Vincent within the GEP and St Kilda catchment area. The northern discharge location is between Ridley salt ponds PA3 and PA4. There is also the 'Gap' channel located between the Bolivar treatment lagoons which, although not within the GEP and St Kilda catchment, GEP surface flood flows currently spill towards, discharging to the Barker Inlet between Ponds PA9 and PA10. A portion of land that is located to the north-west of the main catchment boundary, currently drains towards the Northern Connector and passes under cross culverts that eventually feed into Smith Creek. While this area is outside of the strict GEP catchment boundary, from a development potential area, high level discussions of how stormwater management can occur in this area is provided within this document.

The 30-Year Plan for Greater Adelaide (DPTI, 2017) has identified that Greater Edinburgh Parks could meet the future demand for industrial land. The catchment is predominantly rural and is used for agriculture, horticulture, livestock and rural residential purposes. The catchment will ultimately be a mixed use of industrial, commercial, residential and high-density horticulture. This will transform the land from its current pervious form to a mostly impervious state.

Major drainage infrastructure, including a trunk drain that will convey flow towards an outfall, is needed to service this ultimate developed catchment. The trunk drain alignment proposed within this SMP has typically been configured to follow natural flow paths which will minimise required earthworks. The alignment has also been set to minimise disturbance to existing development and infrastructure. Development within this area is likely to require filling in order to direct runoff towards the trunk drain, thereby reduce flood risk through eliminating trapped low spots that cause significant ponding. Future development is likely to result in minimal change to the salt ponds, located near the outfall.

Based on the existing flow regime and outlet locations, the catchment area has been sub-divided into six separate precincts as summarised in Table 2.1 and shown in Figure 2.1. Due to its close proximity to the other precincts, the figure also shows the NEXY north precinct, which is part of the adjacent Smith Creek catchment.



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Job Number: 20170712
Filename: 20170712GQ001A
Revision: Rev B
Date: 2020-05-15
Drawn: MM

Data Acknowledgement:
Aerial imagery from MetroMap, 2017
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015

CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT
CATCHMENT BOUNDARY AND PRECINCT AREAS

Figure 2.1

Table 2.1 Main catchment area details

Precinct	Area (ha)	Future land use	Current outlet location
Pellew	395	Industrial	Discharges to Greyhound precinct
Greyhound	480	Industrial/Residential	Discharges to the Gap outlet
Port Wakefield	250	Industrial/Residential	Discharges to St Kilda precinct
St Kilda	570	Horticultural	Discharges via syphon to the Gap
NEXY South	175	Industrial/Residential	Discharges into existing NEXY retention pond
Symes	490	Horticultural	Between Saltfields Ponds PA3 and PA4

2.1.1 Land use

The existing land use types within the catchment are shown in Figure 2.2. Land within the catchment is predominantly used for agricultural/horticultural purposes, particularly in the Greyhound precinct to the east of Greyhound and Jarmyn Roads. The proportion of rural residential allotments within the catchment is also high, especially to the west of Port Wakefield Road.

2.1.2 Soils

The GEP and St Kilda catchment is situated within the Northern Adelaide Plains Land System (NAPLS). The NAPLS is a very gently inclined plain with a range of sand to sandy loam soils over clayey subsoils. As irrigated horticulture is the main land use in the System, differences in thickness of surface soil, and profile drainage are significant. Most soils are saline at depth, partly due to accumulated salt leaching under irrigation, and partly due to saline groundwater influence (Department of Water, Land and Biodiversity Conservation, 2007).

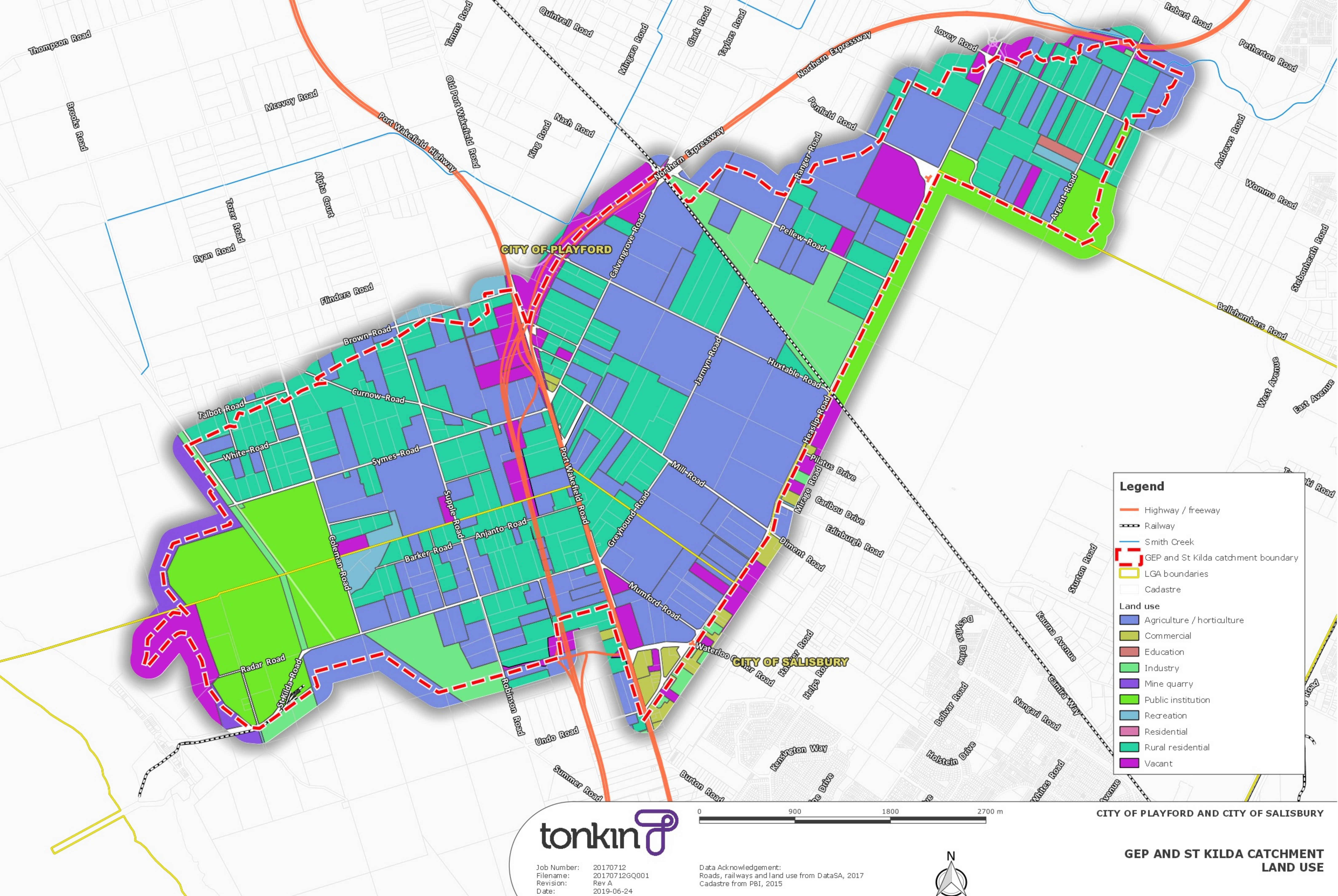
Data contained in the Data SA soils database were used to map the distribution of soils across the catchment area, as shown in Figure 2.3. Soil types for some portions of the catchment area (e.g. coastal and residential zones) were unavailable; these areas are shown in the figure as 'not available'.

The predominant soil type covering most of the catchment area is type D5 (hard loamy sand over red clay). This soil type is described as thick red gritty sand to sandy loam overlying a weakly structured red gritty sandy clay loam to sandy clay. It is a well-draining soil and is unlikely to remain wet for more than a few days. The sandy surface has low strength and is highly susceptible to erosion.

The catchment area is also interspersed with small pockets of the following surface types:

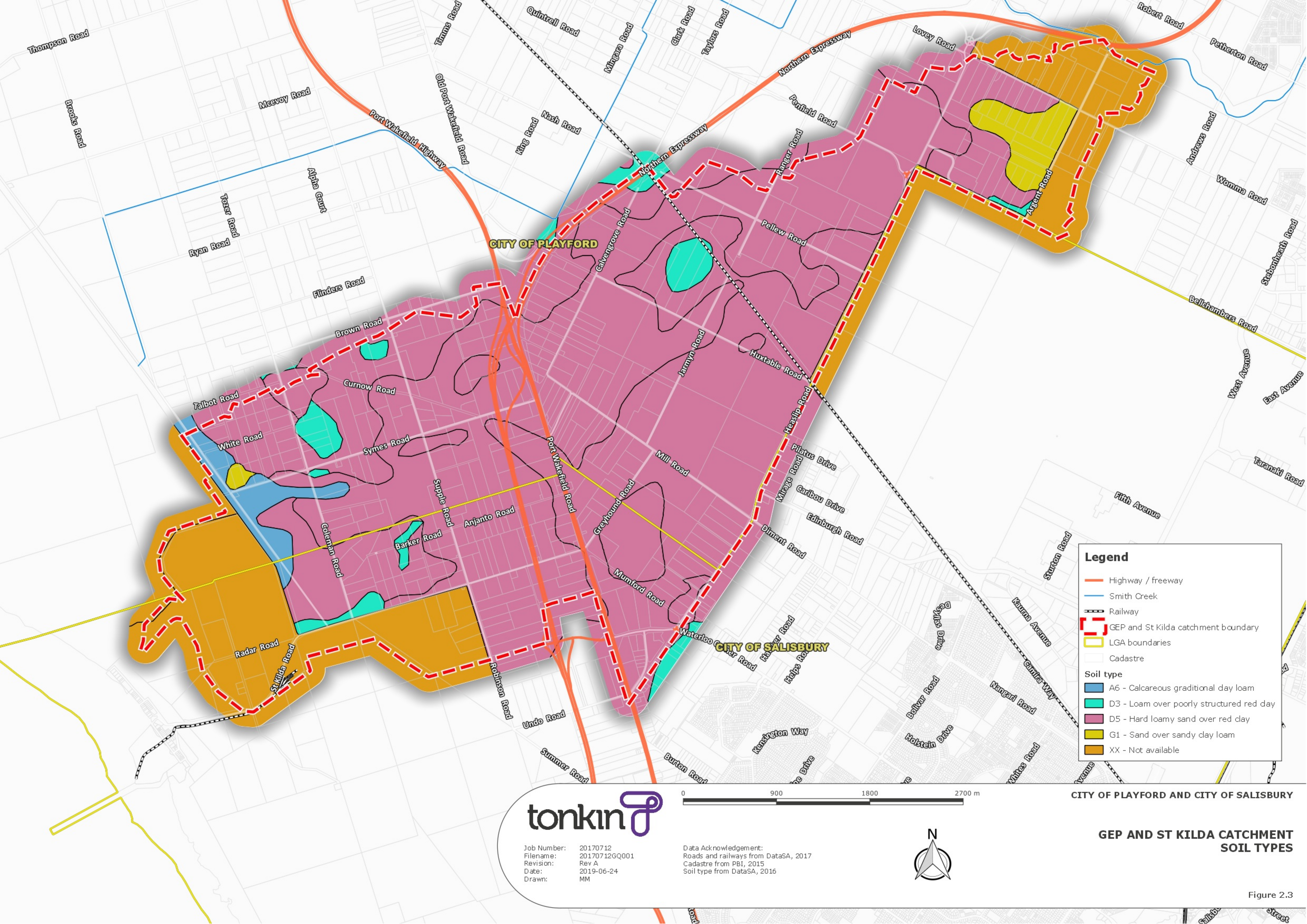
- A6 Calcareous graditional clay loam
- D3 Loam over poorly structured red clay
- G1 Sand over sandy clay loam

It is recommended that site specific geotechnical investigations be undertaken during the detailed design phase for any proposed works such as to determine bank stability or the suitability of excavated material for other purposes, such as site filling.



GEP AND ST KILDA CATCHMENT LAND USE

Figure 2.2



Job Number: 20170712
Filename: 20170712GQ001
Revision: Rev A
Date: 2019-06-24
Drawn: MM

Data Acknowledgement:
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015
Soil type from DataSA, 2016

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GEP AND ST KILDA CATCHMENT SOIL TYPES

Figure 2.3

2.1.3 Existing stormwater infrastructure

The GEP and St Kilda catchment is largely undeveloped and as such there is very little existing stormwater infrastructure in place.

Runoff is either stored in low lying areas or drains via shallow roadside swales and small culverts. Some infrastructure to note is provided below. The ownership of these assets is not typically known or recorded.

- Culverts under the railway line at the Penfield Intermodal site. These were installed whilst the intermodal site was being developed to allow for future drainage to connect into it.
- Retention basins at the Penfield Intermodal facility.
- Cross culverts under the Northern Connector, south of St Kilda Road, to allow for future drainage.
- Syphons under the Bolivar Outfall Channel.
- Coastal outlet channel between Ridley ponds PA3 and PA4.
- Channel and retention basins at the start of the Northern Expressway (intersection with Port Wakefield Road).

Figure 2.4 illustrates the location of the above-mentioned stormwater infrastructure.

2.2 Previous studies and investigations

A number of previous studies of relevance to this SMP have been undertaken in recent years. In some cases, the previous studies represent early developmental work on this SMP and have provided the basis for the modelling undertaken as part of this project. A brief description of the previous studies and their relevance to this SMP is provided below.

2.2.1 Greater Edinburgh Parks stormwater management strategy

With the GEP area expected to become a world class industrial precinct, a stormwater management strategy was essential to address flood risk, water quality, water reuse and environmental protection and enhancement.

In 2011, Tonkin completed the original Greater Edinburgh Parks stormwater management strategy (Tonkin 2011). Key stormwater objectives for the region were prepared and used to form the stormwater management strategies. The study identified the major stormwater related infrastructure required to service the future industrialised area.

This strategy was revised (Tonkin 2018a) to incorporate the following:

- Outcomes of the Smith Creek Floodplain Mapping Study.
- Helps Road drainage system review by the City of Salisbury.
- Planning of the Northern Connector.
- Constraints due to existing major services within the area.
- Potential closure/divestment of the Dry Creek Saltfields.

The project was further developed to assist with the partial rezoning of the DeRuvo development which requires interim stormwater management. The project also progressed to 30% design for the outfall from Port Wakefield Road to the outlet into the Barker Inlet.

The present report builds upon the outcomes of these previous strategies.

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Job Number: 20170712
Filename: 20170712GQ001A
Revision: Rev B
Date: 2020-04-02
Drawn: MM

Data Acknowledgement:
Aerial imagery from MetroMap, 2017
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015

CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT
EXISTING STORMWATER INFRASTRUCTURE

Figure 2.4

2.2.2 Little Para and Helps Road Drain catchments floodplain mapping and stormwater management strategy

This study (Tonkin 2018b) was completed by Tonkin for the City of Salisbury.

A significant portion of the northern suburbs of Adelaide drain to Gulf St Vincent via the Little Para River and the Helps Road drain. The two systems are interlinked via the Little Para overflow channel which directs water from the Little Para River into the Helps Road catchment outfall.

As part of this study, the two adjacent catchments were integrated into one model. The floodplain mapping undertaken provides essential information on the drainage capacity restrictions through the Helps Road Drain outfall (the Gap). The Gap is located between the Bolivar Treatment plant ponds and discharges via a gap between the Ridley salt ponds. The Helps Road Drain and the Little Para overflow converge just upstream of the Gap, which is a pinch point in the system.

The study identified areas of problem flooding at a number of locations. The flood damages assessment used the rapid appraisal method (RAM) developed for the Victorian Department of Natural Resources and Environment (DNRE, 2000). The annual average damage for the study area was assessed to be $5.04 million.

2.2.3 Adams Creek and Greater Edinburgh Parks areas flood mapping, flood hazard mapping and flood damages assessment

The Adams Creek and GEP floodplain and flood hazard mapping and damages assessment (Tonkin, 2016a) was carried out for the City of Playford and City of Salisbury. It covered all of the study area for the GEP and St Kilda SMP.

The purpose of the study was to generate inflow hydrographs and define the extent of inundation and to categorise the potential hazard resulting from a series of design storm events.

2.2.4 Smith Creek catchment floodplain and flood hazard study

The Smith Creek floodplain and flood hazard study (Water Technology & Australian Water Environments, 2015) shows that the Smith Creek floodplain extends into the GEP catchment area on the western side of Port Wakefield Road from Talbot Road to Anjanto Road.

Tonkin (2011) originally proposed an outfall from the GEP catchment to the north of Ryan Road. Given the flooding extents shown on the Smith Creek floodplain map, this outlet is no longer considered viable.

2.2.5 Northern urban catchments: stormwater yield review

This report (Aqueon, 2016) models the mean annual discharge to sea and identifies the mean annual flow available for harvest from catchments within the City of Salisbury, City of Playford and City of Tea Tree Gully. It provides options for the expansion of the current managed aquifer recharge (MAR) systems and potential for future new MAR systems.

2.2.6 Edinburgh Parks trunk drainage outfall

The Edinburgh Parks trunk drainage outfall investigation (Tonkin 2016b) presented an alignment of the main outfall channel discharging along the eastern side of Pond PA6. This drainage alignment has been superseded by the alignment proposed in the present study.

2.2.7 Berno Road drain concept design

Tonkin was engaged by the City of Playford to develop a concept design for a trunk drain to be constructed at the downstream end of the GEP and St Kilda catchment to serve as a discharge point for development in the area (Tonkin, 2019a). The upstream end of the drain will run along the western side of Coleman Road, extending from Berno Road to the intersection with Symes Road, before connecting into a drain that runs in a westerly direction along Symes Road. The channel will then head north along Brooks Road to discharge to the existing syphon under the Bolivar outfall channel. The total length of the channel that was designed was roughly 1,400 m.

An additional outlet for a drainage system passing along Symes Road is to construct a new drain along Brooks Road. This would required closing off Brooks Road and converting the full road reserve into a open channel. The new drain, which would be approximately 3km in length would be able to outlet at the existing outlet of Smith Creek. Given the very flat longitudinal grades the drain would have an estimated capacity of approximately 2-3m^3/s. There is likely to some flow attenuation along the channel given the large amount of storage within it. It would also provide some water quality improvements through vegetative filtering and passive infiltration along its length.

2.2.8 Nearshore marine habitats of the AMLR NRM region

This report (Bryars, 2013) provides information to assist in prioritising land-based impacts to protect coastal fisheries habitat within the Adelaide and Mount Lofty Ranges (AMLR) Natural Resources Management (NRM) region. Evaluation of existing information has identified that a diverse range of seagrass, reef and sand habitats exist within the AMLR NRM region and these nearshore marine habitats have considerable value.

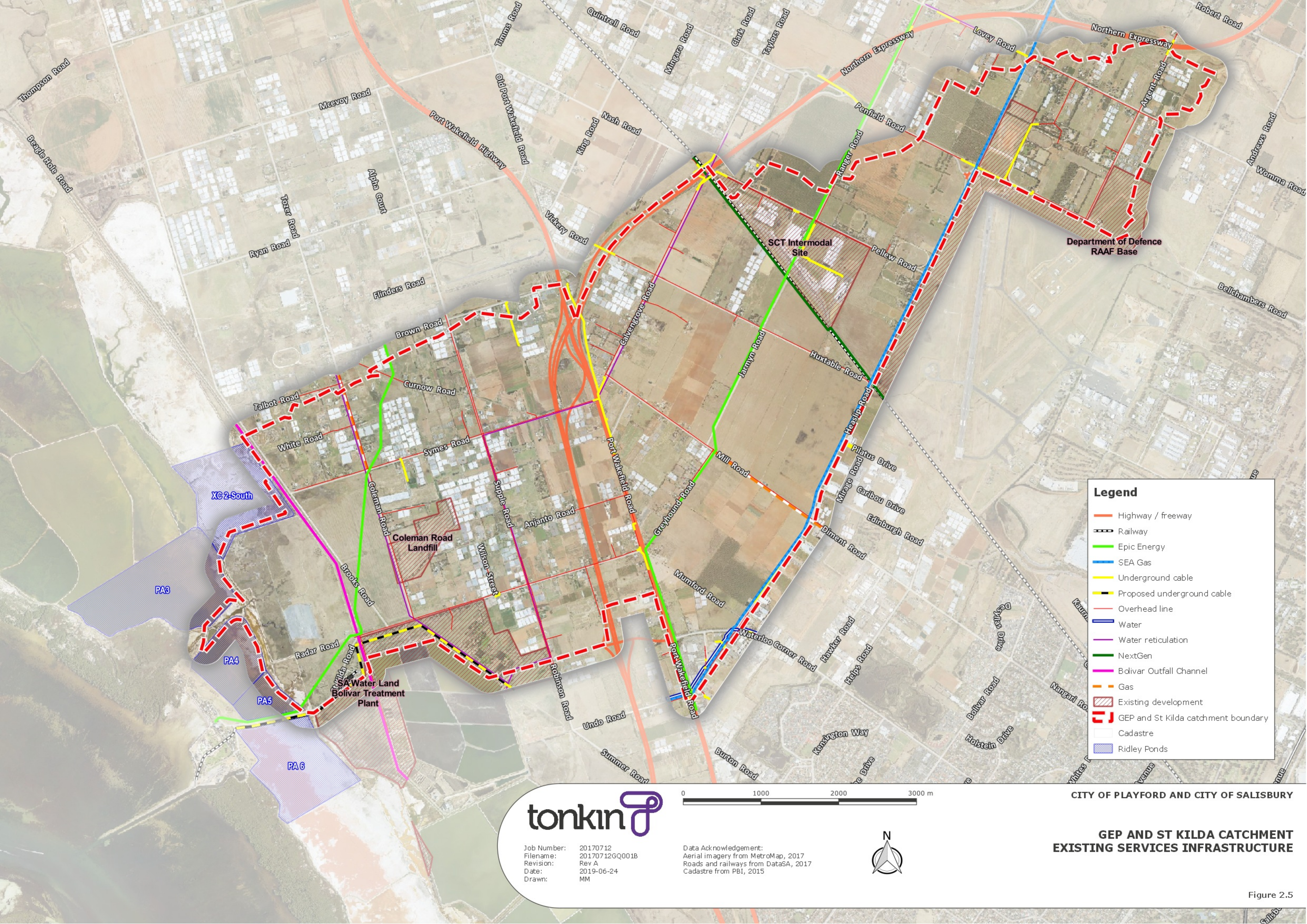
Stormwater and poor-quality runoff from catchments were recognised as threats to most of the coastal habitats within the AMLR NRM region. This report has identified a number of local and regional actions to address and mitigate threats to these valuable habitats.

2.3 Strategy constraints and opportunities

Detailed investigations of potential constraints and opportunities within the GEP area have been undertaken previously (refer Greater Edinburgh Parks Stormwater Management Strategy, Tonkin 2018a). This included consideration of major service infrastructure and government operations. Constraints and opportunities in addition to those identified previously are summarised in the following sections.

2.3.1 General constraints

- The study area is flat, which presents difficulty in constructing channels with a grade sufficient to drain water.
- The proposed drainage alignment includes many long sections of channel. For example, the length of the drain along Symes Road exceeds 3 km making it very expensive to construct.
- Large channel widths are required to ensure sufficient capacity is provided. This will require land acquisition to allow the infrastructure to be built as many of the drains cannot fit within existing road reserves.
- Drain alignments are constrained by the locations of existing services infrastructure within the area, particularly SEA Gas and Epic Energy. A plan of the existing key services infrastructure is shown in Figure 2.5.
- The RAAF base has strict requirements in relation to how surface water is managed in proximity to their base to minimise the risk of there being a bird strike.
- The depth to groundwater is very shallow in the western portion of the catchment which is likely to limit excavation depths for stormwater infrastructure.
- Large amounts of private property are required for the construction of the proposed open channels and detention basins. The acquisition of private property is a critical risk to the successful implementation of the proposed stormwater management strategy. A property acquisition plan, in addition to negotiation with state government and land owners, will be required. Until negotiations are finalised there is no guarantee that a trunk drainage system can be constructed or that adequate land is available to provide enough detention storage.



CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT
EXISTING SERVICES INFRASTRUCTURE

Job Number: 20170712
Filename: 20170712GQ001B
Revision: Rev A
Date: 2019-06-24
Drawn: MM

Data Acknowledgement:
Aerial imagery from MetroMap, 2017
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015

Figure 2.5

- Increased stormwater discharge to Gulf St Vincent may threaten water quality, placing stress on important aquatic ecosystems, and hence careful management of water quality is required.

2.3.2 Groundwater

The catchment is underlain by shallow, saline groundwater that ranges in depth typically between 4-7 m below ground level in the eastern portion of the catchment (Northern Adelaide Plains), to less than 1 m below ground level in the western portion of the catchment (Coastal Zone). The expected regional groundwater flow direction is west, towards the Dry Creek Saltfields and the Barker Inlet.

Near surface aquifers of the Northern Adelaide Plains are typically found within interbedded silt, sand and gravel layers of the Pooraka Formation sediments (upper Quaternary aquifers). The Pooraka Formation is overlain by coastal sediments of the St Kilda Formation in the lower lying areas to the west of the SA Water Outfall Channel.

Shallow aquifers within the St Kilda Formation are generally more saline than the Pooraka Formation aquifers and are connected to saline to hypersaline surface water bodies (i.e. salt evaporation ponds or coastal sabkha/clay pans).

The salinity of groundwater within the Pooraka Formation aquifers, east of the SA Water outfall channel, are expected to range from 1,000 mg/L to greater than 15,000 mg/L. Differences in salinity and water table elevations are likely to be governed by local variations in surface recharge due to topography, soil texture, irrigation and vegetation type/density. Seasonal water table fluctuations of up to 1 m may occur due to winter recharge and summer evapotranspiration and proximity to existing drains, ponds or irrigated horticulture. Groundwater salinity will also vary seasonally in response to recharge and discharge characteristics of the shallow aquifers.

Groundwater extraction and use may occur from the upper Quaternary aquifer, in the eastern portion of the study area where groundwater salinities are typically 3,000-6,000 mg/L and yields are higher. The vast majority of groundwater extraction wells (for domestic and or irrigation purposes) within the area are installed in the lower Quaternary (Q4) and Tertiary (T1 and T2) aquifers, which are separated from the surficial Quaternary aquifers by up to 10 m of Hindmarsh Clay.

In local areas, fresher (potable to brackish) groundwater may be perched above saline groundwater, particularly in the eastern portions of the study area where aquifers may be associated with sandy and gravelly lenses representing paleo-drainage channels within the Pooraka Formation.

The depth of groundwater may present a constraint on the effective depth of detention basins or drains that may be constructed within the study area due to inflows of shallow saline groundwater. In areas where the shallow aquifer is confined, the removal of overburden during construction of drains or basins may locally reduce confining pressures, leading to vertical movement of groundwater. The rate of lateral or vertical seepage to the constructed drains or basins would be dependent on the permeability (vertical and horizontal permeability) of the local geology/overburden. Where the groundwater potentiometric surface is intersected by the drain or basins, seepage rates will influence the risk of saline inflows, surface water levels (pooling) and constructability (additional control measures may be required during construction to manage soil moisture and groundwater). Excavation during summer months would reduce the impact of groundwater inflows during construction.

Given the anticipated depths of the proposed drains and basins recommended as part of this SMP, groundwater seepage rates (on average) are likely to be very low (in the order of 0.3 to 0.6 m/year) due to the low groundwater hydraulic gradient (approximately 0.095%) and low transmissivity of the upper Quaternary aquifers, however local variations will occur.

Walbridge Gilbert Aztec (WGA) were engaged by Tonkin to carry out an assessment of the groundwater, aquifer and soil conditions in the area. WGA (2018) identified where local shallow groundwater may limit the depth of stormwater infrastructure such as basins and channels and also considered deep groundwater hydrogeology to identify opportunities for potential MAR schemes. An extract of the WGA report showing the extent of shallow groundwater is included in Appendix B.

It was determined that the deeper Port Willunga Formation (T2 aquifer) is the most suitable target aquifer for MAR in the catchment for the following reasons:

- Multiple active MAR systems currently target the T2 aquifer across the Northern Adelaide Plains and have been operating successfully for several years.
- The shallow Quaternary aquifers are not considered viable for recharge due to the relatively thin nature of the aquifer, shallow depth to water, high salinity and limited lateral extent.
- The overlying Tertiary (T1) aquifers have proved more difficult to target in the past, particularly in areas where there are low recharge rates.
- There is little known about the deeper T3 and T4 aquifers, but groundwater through these has been reported as highly saline, which may lower the recovery efficiency.

The report identified that there is the potential for a significant volume of water (~1,100 ML/a) to be harvested by a MAR scheme located towards the downstream end of the catchment, once it becomes developed. There is therefore a potential future opportunity so supplement SA Water's treated water supply with harvested stormwater.

Evaluation of currently available data suggests that across some parts of the NAP, water levels in the perched aquifer and uppermost Quaternary (Q1) aquifer are rising at rates of up to 0.16 m/a. Water levels in the shallow Q1 aquifer are particularly high (less than 2 m below ground level) at areas west of Port Wakefield Road. Infrastructure installed in the area between the coast and approximately 6 km inland will need to consider impacts from shallow saline groundwater that may occur due to the rising groundwater table in the Q1 aquifer.

WGA (2018) estimated that if the rising trend in groundwater levels continues, within the next six years groundwater levels in the area extending 2 km to the east of Port Wakefield Road could be up to 1 m higher than the 2017 recorded groundwater levels. Consequently, any wetland, detention basin or biofiltration option will need to consider that the maximum excavation depth may only be 1 m to account for the potential rising groundwater levels. The footprint required to accommodate any below ground stormwater infrastructure is therefore likely to be large, as the depth available for construction will be limited by the shallow water table. Aquifer storage and recovery (ASR) may generate additional hydraulic loading on the shallow aquifer, exacerbating water logging risks. Additionally, wetlands or basins will need to be lined to prevent ingress of saline groundwater and prevent mounding beneath the wetland.

It has been identified that there is contamination associated with per- and poly-fluoroalkyl substances (PFAS) in stormwater runoff leaving the RAAF Edinburgh Airforce Base. The proposed locations for MAR systems are downstream of the contaminant source site. In order to meet water quality criteria for PFAS limits (set by the Environmental Protection Agency (EPA)) there are options to introduce treatment at a MAR system, including the potential use of activated carbon.

2.3.3 Development potential

The Greater Edinburgh Parks region has been 'earmarked' to meet industry land demand as directed by the 30-Year Plan for Greater Adelaide (DPTI, 2017).

The region to the east of Port Wakefield Road has been designated for employment lands including industrial, intermodal and mixed use, as well as some areas of residential development. The final development 'mix' for this region is still uncertain. The area of land between the Northern Connector and Port Wakefield Road is likely to be zoned for industry land with the eastern portion of the road being used for stormwater management. The land to the west of the Northern Connector will continue as horticulture, however will potentially be improved with modern hothouses.

URPS was engaged by Tonkin to review the percentage impervious areas applied to the GEP Stormwater Strategy DRAINS model (Tonkin, 2018a) for the future scenario (2050) development.

URPS carried out a desktop assessment of current land use and development conditions, a desktop assessment of emerging policy directions outlined in State and Local Government Planning documents, and targeted conversations with planning officers at local Councils.

The recommendations from URPS (2018) are summarised in Table 2.2. As these recommendations are for the 2050 scenario, estimates of the imperviousness of the catchment for the ultimate state of development are also provided.

Table 2.2 Future catchment impervious proportions (%)

Land use	URPS impervious recommendation (2050)	Adopted impervious value for ultimate development
High density industrial	60	80
High density commercial	80	80
SCT intermodal extension (privately owned, refer Figure 2.6)	60	80
DeRuvo industry/employment (privately owned, refer Figure 2.6)	60	80

The DRAINS model has adopted the impervious proportions corresponding to the ultimate development scenario. This approach is considered conservative. The future land uses and adopted impervious areas are illustrated in Figure 2.6.

The City of Salisbury has identified that a number of non-residential developments are currently occurring in areas identified as 'high density residential'. Given the high impervious percentages across the catchment (which may not be as high in reality), changes to the land use type are unlikely to have a significant impact on the strategies identified within this SMP.

Additionally, it is understood that a new naval development is proposed for the St Kilda precinct (identified as having no impervious area). Given the lack of drainage infrastructure in the precinct, this development would need to incorporate on-site stormwater management methods.

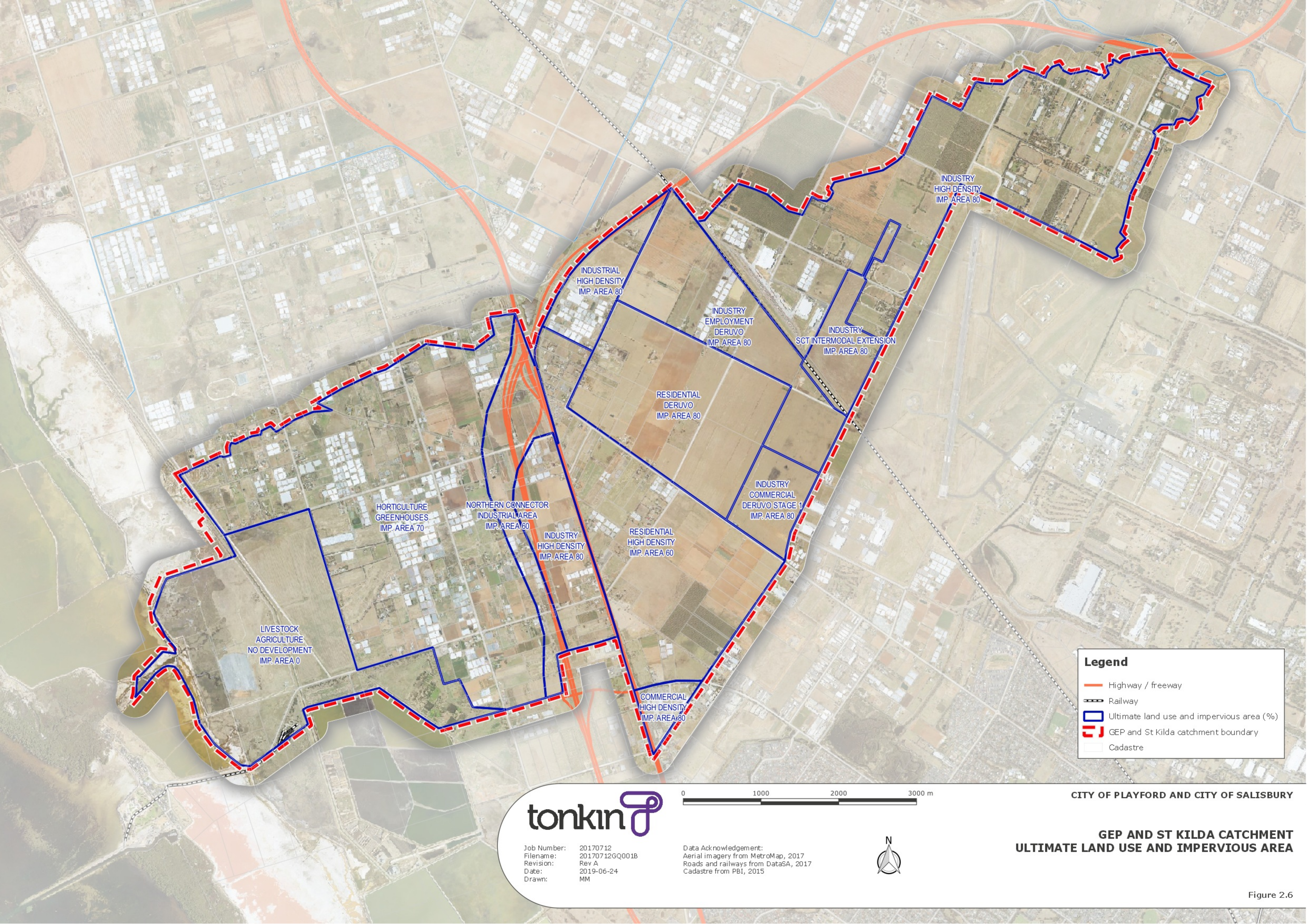
2.3.4 Climate change assessment

The latest available science indicates that the climate is changing. CSIRO and the Bureau of Meteorology preface the latest regional climate change summaries with the following statement:

"*Australia's changing climate represents a significant challenge to individuals, communities, governments, businesses, industry and the environment. Australia has already experienced increases in average temperatures over the past 60 years, with more frequent hot weather, fewer cold days, shifting rainfall patterns, and rising sea levels*."

Australian Rainfall and Runoff (ARR, 2016) states "*human-induced climate change has the potential to alter the prevalence and severity of rainfall extremes, storm surge and floods*".

Despite global efforts to mitigate greenhouse gas emissions, the momentum of the climate system means that the observed climatic changes will continue with increasing magnitude, for many decades to come.



CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT
ULTIMATE LAND USE AND IMPERVIOUS AREA

Figure 2.6

Climate Change in Australia (CSIRO and BoM) provides regional summaries of projected climate change for Australia. The study area is within the Southern and South-Western Flatlands East (SSWFE) cluster. The key climate change projections relevant to the design of stormwater systems for the SSWFE cluster are as follows:

- A continuation of the trend of decreasing winter rainfall is projected with high confidence. Spring rainfall decreases are also projected with high confidence.
- Increased intensity of extreme rainfall events is projected, with high confidence.
- Mean sea level will continue to rise and the height of extreme sea-level events will also increase (very high confidence).

With respect to the management of stormwater within the study area, the projected changes in climate represent the following risks:

- A reduced level of service (greater frequency of flooding) due to the higher intensity rainfall events resulting in higher peak flows.
- Higher downstream water levels as a result of rising sea levels.
- Rising groundwater levels as a result of rising sea levels.
- Lower volumes of water able to be harvested.

A methodology for modelling climate change has been developed with reference to the project brief, the latest climate change science and in collaboration with the Project Steering Committee. A full description of the methodology can be found in the climate change modelling memorandum dated 12 December 2017 (Tonkin ref. 20170712M003).

The climate variables that are considered directly relevant to the SMP modelling are average annual rainfall, rainfall intensity, evaporation and sea level rise. Two climate change scenarios were selected for modelling in DRAINS. The scenarios are summarised in Table 2.3. The change in rainfall is relative to the current annual average rainfall for the region of 430 mm.

Table 2.3 Climate change scenarios

Year	RCP	Rainfall intensity increase	Sea level rise	Change in annual average rainfall
2050	8.5	9%	0.4 m	-30 mm (-7%)
2090	8.5	17%	1.0 m	-39 mm (-9%)

Risk-based approach to climate adaptation

Recognition of the risks associated with climate change is required for better planning for new infrastructure and mitigating the potential damage to existing infrastructure (ARR, 2016). Despite advances in climate science there are still significant uncertainties associated with the projections of future climate, not least of which is patterns of global development and greenhouse gas emissions. A risk-based approach to climate change adaptation is therefore recommended.

Factors to be considered when developing an adaptation approach include:

- The design life of the asset – the impacts of climate change will be greater for assets with a long design life.
- The consequences of failure – if failure is catastrophic then design should be based on the worst-case climate change projection for the end of the asset life. If not catastrophic, design may be based on climate change projections for the middle of the design life of the asset with acceptance of increased risk of failure towards the end of the asset life.
- Impacts of the projections on system performance – a sensitivity analysis should be undertaken to provide an understanding of what the projected changes mean for system performance.

- Cost of the adaptation measures – no cost or low-cost options should be sought, particularly where the consequence of failure is not severe.

2.3.5 Environmental considerations

Management of numerous direct and indirect environmental risks during the construction and operation of drains and storage basins has been discussed in the previous GEP Stormwater Management Strategy report (Tonkin, 2018a). Consideration was given to land zoning, Aboriginal heritage sites, threatened or rare species (flora and fauna) listed under the *Environment Protection and Biodiversity Conservation Act 1999*, management of soil and contaminated land, and management of water. The discussion of these environmental features is included in Appendix C. Additional environmental considerations are described below.

Receiving waters

The existing coastal outlet between Ridley ponds PA3 and PA4 is a tidal influenced natural watercourse with significant environmental value for the coast. Upstream of this outlet, there are no natural watercourses or other natural water bodies of significance within the catchment, and most drainage lines have been formed as a result of (or created as part of) development in the catchment.

Stormwater generated by the catchment discharges into Gulf St Vincent and therefore water quality guidelines to protect these downstream aquatic ecosystems are considered important. Water harvesting is also a key goal for the area and improvement in water quality is required prior to the injection of water into the aquifers.

Stormwater discharging to Gulf St Vincent has been identified as a significant factor in the dieback of seagrasses and is causing an increase in the nutrient levels and turbidity of the marine environment. The increased future stormwater flows resulting from development of the GEP and St Kilda catchment have the potential to modify salinity gradients and increase pollutant loads. If unmanaged, the increased discharges may threaten water quality in Gulf St Vincent and stress coastal ecosystems such as the intertidal mudflats, seagrass meadows, mangroves and tidal creeks. For these reasons, SMPs are required by legislation (refer Table 2.4) to consider stormwater quality and identify the environmental values of receiving waters to mitigate against harming the environment or human health (Myers et al., 2015).

Table 2.4 Relevant water quality legislation and guidelines

Legislation	Relevance to the Project
Planning, Development and Infrastructure Act 2016	The construction of a drainage and outfall channel will generally be part of a larger development requiring development approval under the *Planning, Development and Infrastructure Act 2016*. The Act ensures that a site is suitable for its intended use and does not pose an unacceptable risk to human health or the environment, taking into account the proposed use of the site.
Landscape South Australia Act 2019 (SA)	The *Landscape South Australia Act 2019* is the legislative foundation for the sustainable management of water in South Australia. The study area is contained within the Green Adelaide region. Environmental outcomes and strategies of the SMP will need to consider the regional landscape plan. Permits may be required for certain SMP activities.
Section 25 of the *Environment Protection Act 1993* (SA)	Any development, including the construction of drainage, outfall channel or sedimentation basin, has the potential for environmental impact, which can result from vegetation removal, stormwater management and construction processes. The Act requires a 'duty of care' in relation to activities that have potential to cause serious or material environmental harm or an environmental nuisance by polluting the environment and failing to inform the SA EPA of an incident that has

Legislation	Relevance to the Project
	caused, or threatens to cause, serious or material environmental harm as soon as reasonably practicable. The Act is the overarching legislative tool used to evoke protection of the environment and is administered and enforced by the SA EPA.
Environment Protection (Water Quality) Policy 2015	Water quality in South Australia is protected using the *Environment Protection Act 1993* and the associated *Environment Protection (Water Quality) Policy 2015*. The principal aim of the Water Quality Policy is to achieve the sustainable management of waters by protecting or enhancing water quality while allowing economic and social development. In particular, the policy seeks to ensure that pollution from both diffuse and point sources does not reduce water quality and promotes best practice environmental management.
Stormwater Management Authority (SMA)	The Stormwater Management Authority (SMA) was established on 1 July 2007 as a consequence of the *Local Government (Stormwater Management) Amendment Act 2007*. The SMA operates as the planning, prioritising and funding body in accordance with the Stormwater Management Agreement between the State of South Australia and the Local Government Association. A key element is the development of stormwater management plans for catchments or specified areas. The purpose of these plans is to ensure that stormwater management is addressed on a total catchment basis. The relevant Landscape Board, various local government authorities and state government agencies responsible for the catchment work together to develop, implement and fund a coordinated and multi-objective approach to management of stormwater for the area. The state released a Stormwater Strategy in 2011 (Government of South Australia, 2011), as a road map for achieving the stormwater-related actions in Water for Good.
Stormwater Pollution Prevention Code of Practice for Local, State and Commonwealth Government (EPA 1998)	This Code of Practice is intended to inform government agencies and their contractors of their 'general environmental duty' with respect to stormwater under the *Environment Protection Act 1993*. The code provides for the preparation of a soil erosion and drainage management plan (SEDMP) where there is a risk of significant sediment pollution to adjoining lands or receiving waters.
Water for Good (Government of South Australia 2009)	Underpinning the state's legislative requirements, the government's water security plan to 2050, Water for Good, outlines 94 actions to ensure the future availability of water. Released in 2009, the plan was developed during a time of severe drought. While having a focus on water quantity, it also addresses water quality and supports other state initiatives; these include the recommendations of the Adelaide Coastal Waters Study for improving the quality of water discharged into Gulf St Vincent from Adelaide's urban and peri-urban areas.
National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999	This Measure provides a national approach to site contamination assessment and forms an Environment Protection Policy under the *Environment Protection Act 1993*. Assessment of site contamination requires comparison to NEPM guidelines to determine the contamination status of a site.
Native Vegetation Act 1991	The Act controls the clearance of native vegetation and provides incentives and assistance to land owners for the enhancement and preservation of native vegetation. Clearance of native vegetation will require a management plan, endorsed by the Native Vegetation Council, that demonstrates the Project will result in a significant environmental benefit. Some potentially impacted areas of native vegetation are located in the St Kilda precinct of the catchment.

Legislation	Relevance to the Project
Aboriginal Heritage Act 1988	The *Aboriginal Heritage Act 1988* provides for the protection and preservation of the Aboriginal heritage.
Heritage Places Act 1993	The Act makes provision for the identification, recording and conservation of places and objects of non-Aboriginal heritage significance and establishes the South Australian Heritage Council.
Adelaide Coastal Water Quality Improvement Plan (ACWQIP) (EPA, 2013)	The ACWQIP, developed by the SA EPA, provides a long-term strategy to achieve and sustain water quality improvement for Adelaide's coastal waters and create conditions to see the return of seagrass along the Adelaide coastline.
Other legislation potentially relevant to the Project may include:	- *Mining Act 1971* and *Mining Regulations 2011* - *Environment Protection and Biodiversity Conservation Act 1999* - *Fisheries Management Act 2007* - *Adelaide Dolphin Sanctuary Act 2005* - *Coast Protection Act 1972* - *Occupational Health Safety and Welfare Act 1986* - *National Parks and Wildlife Act 1972*

Potential pollutants

Historically, stormwater has been managed as a drainage issue, essentially to minimise nuisance inundation across developed areas. However, the quality of stormwater runoff has implications for receiving waters due to pollutants such as nutrients, fertilisers, herbicides and pesticides. In addition, groundwater seepage to drains, or runoff from drain batters, has potential to further impact the quality of stormwater discharges.

A list of potential stormwater pollutants is provided in Table 2.5.

Table 2.5 Potential stormwater pollutants

Potential stormwater pollutants	Potential exposure routes	Key receptors
Salinity	Leaching of salts from soil, surface water and groundwater seepage to drains	Aquatic ecosystems (fresh) and freshwater aquifer(s)
Acidity	Disturbed acid sulfate soils - widespread at depth within the Coastal Zone sediments	Aquatic ecosystems (fresh and marine) and aquifer(s) Excavation / maintenance workers
Nutrients and metals	Runoff from urban catchment, soils and groundwater in the vicinity of the wastewater lagoons or service easements, horticultural irrigation (reclaimed water or direct application) and outfall channel The number of commercial vehicles and the general nature of industrial areas are likely to generate a large quantity of heavy metals	Aquatic ecosystems (fresh and marine) and aquifer(s)
Suspended solid / soil erosion	Runoff from urban catchment, sodic / erodible soils within the drain (distribution unknown) During construction there is potential for large amounts of sediment to be washed into the drainage system	Aquatic ecosystems (fresh and marine) and aquifer(s)

Potential stormwater pollutants	Potential exposure routes	Key receptors
Discrete site contamination (e.g. PAHs, petroleum hydrocarbons and PFAS)	Roads, runoff or groundwater seepage from potentially contaminating sites, including the Edinburgh RAAF site	Aquatic ecosystems (fresh and marine) and aquifer(s) Excavation / maintenance workers

Additionally, stagnant water (for example shallow pools of water along the channel) may become a breeding ground for mosquitos, causing nuisance to humans and terrestrial and marine ecosystems.

Environmental receptors

Environmental values in this region include both those that relate to beneficial use as well as those independent of human need. In broad terms environmental values for the Gulf include the commercial, cultural and aesthetic uses of the area but also extend to the preservation or conservation of biodiversity and ecosystem function. Waters that are classified as having an ecosystem protection value should have ambient water quality that meets or exceeds the requirements of Schedule 2 of the *Environment Protection (Water Quality) Policy 2015* or the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) Tables 3.3.8 and 3.4.1.

The level of risk to the receiving marine environment will depend on the likelihood of an incident occurring and the consequence of that incident.

The greatest risks presented by stormwater quality within northern Adelaide catchments are considered to be turbidity generated from urban runoff and nutrients from wastewater leakages. Hydrocarbons and trace metals from roads, marinas and boat ramps are considered a lesser risk to maintaining water quality for all environmental values. Increased freshwater inflows also has potential to impact marine organisms. When salinity changes to above or below an optimum range, an organism may become stressed and can succumb to predation, competition, disease or parasitism (ANZECC 2000). The magnitude and duration of salinity changes will be somewhat dependent on the drainage catchment and outfall design.

Adelaide's coastal waters are part of the waters of Gulf St Vincent and include areas of seagrass and subtidal reef environments supporting important feeding grounds and nurseries for fish, crustaceans, molluscs and marine mammals. Maintaining good water quality is essential for the maintenance of these marine habitats and important for industry and the recreational uses of Adelaide's coastal waters and metropolitan beaches.

Historically, Adelaide's coastal waters have been impacted by poor water quality due to discharges from industry, wastewater and stormwater. The Adelaide Coastal Water Study (EPA SA, 2007) found that the discharges are high in nutrients and suspended solids and are causing loss of seagrass along the Adelaide coastline.

Discharges of high levels of suspended solids into the Adelaide coastal waters increase turbidity levels contributing to challenges for re-establishing seagrass, poor recreational water quality and may result in beach closures at times after rain events.

Loss of seagrass has implications in terms of sediment instability for the management of Adelaide's beaches and loss of seagrass results in more carbon released into the atmosphere.

Stressors to seagrass are listed below in order of impact rating (highest to lowest):

- Nutrient loads leading to eutrophication – caused by increased nitrogen and phosphorous concentrations in effluent and/or stormwater discharges
  - Eutrophication is the most widely reported cause of seagrass loss
  - High nutrient loads have a direct toxic effect on seagrasses
  - Nutrient inputs encourage growth of epiphytes which can create barriers to light absorption, gas exchange and nutrient absorption

- Nitrogen/phosphorus (N:P) ratios – important in determining the dominant plant community
- Turbidity – decreased light availability average resulting in decreased productivity – measurable impacts over longer term
- Turbidity – plume events reducing light – minimal impacts for events lasting less than 6 weeks
- Salinity increases or decreases – under marine influences the salinity is relatively stable and never gets diluted enough to impact mature plants (<1 ppm), seedlings or seeds (<10 ppm)
- Temperature – temperature extremes impacts (outside optimums).

2.3.6 System outlet

There are limited opportunities for discharging stormwater runoff to the Barker Inlet/Gulf St Vincent. These opportunities include:

- The existing coastal outfall downstream of the Gap outfall channel (that forms the outfall for the adjacent Adams Creek and Helps Road Drain (ACHRD) catchment).
- Creation of a new coastal outlet.
- The existing coastal outlet between Ridley ponds PA3 and PA4.

The Gap outfall channel servicing the ACHRD catchment is currently over capacity with large amounts of flooding observed to the east of the Bolivar site (Tonkin, 2018b). Increasing the capacity of the outlet all the way to the coast would be challenging. As such, directing additional flows into it from the GEP and St Kilda catchment is not recommended.

A new coastal outflow would introduce fresh water into a portion of the coastal environment which has the potential to cause detrimental impacts. It would also require having to pass through the Ridley salt ponds which would be very difficult to negotiate. Both of these constraints are significant and as such a new coastal outfall has been precluded.

The final coastal outfall location is the outlet between Ridley ponds PA3 and PA4. This existing outfall is shown in Figure 2.4. The capacity of this outfall is unlikely to be large enough to pass the predicted peak flow rates from the developed catchment and hence would require enlarging (Tonkin, 2017).

2.3.7 Water sensitive urban design

Given the largely undeveloped nature of the study area and lack of existing infrastructure, there is an opportunity to enhance water quality within the catchment through water sensitive urban design (WSUD). The incorporation of new WSUD measures can potentially treat a significant portion of the site. A 'master plan' approach for the entire catchment area should be adopted. The incorporation of WSUD into the areas of new development should be consistent with WSUD best practice, aiming to achieve the desired water quality targets (refer Section 3.2.2).

3 Stormwater management objectives

The Stormwater Management Planning Guidelines published by the SMA includes the following in relation to stormwater management objectives:

Catchment specific objectives for the management of stormwater within the area are to be set and are to be based on the problems and opportunities identified. The objectives should provide measurable goals for the management of stormwater in the catchment.

The stormwater management guidelines (SMA, 2007) stipulate that:

"As a minimum, the objectives are to set goals for:

- *an acceptable level of protection of the community and both private and public assets from flooding;*
- *management of the quality of runoff and effect on the receiving waters, both terrestrial and marine where relevant;*
- *extent of beneficial use of stormwater runoff;*
- *desirable end-state values for watercourse and riparian ecosystems;*
- *desirable planning outcomes associated with new development, open space, recreation and amenity;*
- *sustainable management of stormwater infrastructure, including maintenance and resilience against climate change*".

3.1 Stormwater management service attributes

The key issues to be addressed in the development of the SMP for the management of stormwater runoff from an urban catchment are:

- Flooding
- Water quality and reuse
- Amenity, recreation and environmental protection and enhancement
- Asset management.

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

Service attribute 1: Flood management

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

Service attribute 2: Water quality improvement and reuse

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

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

Service attribute 3: Amenity, recreation and environmental enhancement

Where possible, develop land used for stormwater management purposes to facilitate recreation use, amenity and environmental enhancement.

Service attribute 4: Asset management

Ensure the condition of existing stormwater infrastructure is suitable for its intended purpose. Ensure that proposed stormwater infrastructure is sustainable.

The development of a SMP for the GEP and St Kilda catchment requires these broad objectives to be further refined to identify catchment specific management objectives. These specific objectives have enabled targeted management strategies to be identified and assessed.

3.2 Catchment specific objectives

The following catchment specific objectives and levels of service have been developed by the City of Playford and the City of Salisbury in collaboration with the project steering committee.

3.2.1 Service attribute 1: flood management

Currently accepted design standards

ARR (2019) 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 1% annual exceedance probability (AEP) 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 1% AEP event. A design standard of 0.5 exceedances per year (EY) to 5% AEP is generally adopted for the minor system. This is consistent with the Playford Council Development Plan and Salisbury Council Development Plan which state that new developments are to be protected from the 100 year ARI event.

Proposed drainage system design standard

Main drains and outfall

The GEP and St Kilda catchment is largely undeveloped and currently has little stormwater infrastructure. This provides an opportunity to ensure that all new trunk drains and channels are constructed to a 1% AEP standard assuming a fully developed catchment with allowances for climate change.

A lower drainage standard of 5% AEP for the St Kilda horticultural area could be adopted due to the likely flood damages being at a lower magnitude than a residential, commercial or industrial area.

Lateral drains

In accordance with generally accepted practice, the historical use of a 5 year ARI (0.2 EY) design standard for new underground lateral drainage systems in the catchment should be continued.

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 1% AEP) is appropriate. However, in some instances it may not be economically viable to provide a 1% AEP level of protection if the cost of the works would greatly exceed the likely magnitude of the flood damages.

Flood management levels of service

Based on the above, the following catchment specific objectives for management of flooding within the GEP and St Kilda catchment have been set.

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

Level of service 1.1

Protect all habitable buildings from inundation in a 1% AEP event, where it is economically practicable.

- Customer performance measure:

- 1% AEP modelled protection for habitable floor levels with 300 mm freeboard.
  Target: 99% of habitable floors within catchment by 2040.

- Technical performance measure:
  - Annual capital value modelled flood losses.
    Target: less than 0.1% of property capital value by 2040.

Level of service 1.2

Protect primary production land from inundation.

- Customer performance measure:
  - 5% AEP protection for primary production land with zero freeboard.
    Target: 75% of land area within catchment by 2040.
- Technical performance measure:
  - Annual average modelled produce/stock losses to floods (indexed 2020).
    Target: less than $4 m per annum.

Level of service 1.3

Flood hazard to the community.

- Customer performance measure:
  - Proportion of residential properties subject to no more than low flood hazard during a 1% AEP flood.
    Target: 95%.
  - Proportion of road reserves that have flood hazard less than high during a 1% AEP flood.
    Target: 98% by 2040.
  - Proportion of residential habitable floors that remain dry or have safe[1] exit routes for all floods.
    Target: 99.99% by 2040.
- Technical performance measure:
  - Proportion of minor[2] drainage network that has capacity of at least 20% AEP flow.
    Target: 80% by 2030.
  - New development does not increase flood hazard to other properties for all events up to a 1% AEP.
    Target: 100% of developments.
  - Proportion of infrastructure designed after 2020 to take account of RCP 8.5 climate change scenario, including sea level rise predictions.
    Target: 95%
  - Engage with critical engineering 'lifelines' infrastructure providers and complete flood hazard vulnerability assessment.
    Target: initial 'Lifelines Project' completed by 2025.

3.2.2 Service attribute 2: water quality improvement and reuse

Existing water quality

Stormwater from the GEP and St Kilda catchment ultimately discharges into Gulf St Vincent. Currently, there is minimal outflow with most of the runoff being stored within the catchment. However, as the catchment develops, an increase in stormwater volume, suspended solids, heavy metals and nutrient loads will occur.

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[1] 'Safe' means not subject to FIS class hazard and has a rising egress route, of maximum H2 hazard, to dry ground beyond the PMF (Ref. Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, AIDR 2017).

[2] As defined in ARR 2016, Book 9, Section 3.4.

Currently accepted design standards

To ensure that this stormwater management plan aligns with other strategies and guidelines, stormwater quality targets from other documents have been reviewed. These include the recommendations made in:

- Adelaide Coastal Waters Study (ACWS) (EPA SA, 2007) and Adelaide Coastal Water Quality Improvement Plan (ACWQIP) (EPA SA, 2013).
- Australian Runoff Quality: A Guide to Water Sensitive Urban Design (Engineers Australia, 2006).
- Water Sensitive Urban Design – Creating more liveable and water sensitive cities in South Australia (DEWNR, 2013).

It must be acknowledged that, given current pollutant loadings discharging from the catchment are virtually zero, targets are relative to a developed catchment without any treatment measures. Unless full on-site retention is proposed there will be an increase in pollutant loads.

ACWS and ACWQIP

Based on the outcomes of the ACWS, the EPA has developed strategies to assist with achieving their target of reducing nitrogen loads by approximately 75% from 2003 levels to halt seagrass loss and create conditions that support seagrass restoration. The strategies that apply to stormwater management include reducing nutrient, sediment and organic matter discharges through the uptake and implementation of water sensitive urban design (WSUD) and promote integrated reuse of wastewater and stormwater (EPA SA, 2013). The strategies include:

- The total load of nitrogen discharged to the marine environment should be reduced to around 600 tonnes/year (representing a 75% reduction from the 2003 value of 2,400 tonnes). The ACWQIP target for the stormwater contribution is 50 tonnes/year by 2028 including population growth.
- Commensurate with efforts to reduce the nitrogen load, steps should be taken to progressively reduce the load of particulate matter discharged to the marine environment. A 50% load reduction (from 2003 levels) would be sufficient to maintain adequate light levels above seagrass beds for most of the time. The reduced sediment load will also contribute to improved water quality and aesthetics.
- The ACWQIP target for the stormwater contribution of suspended solids is 730 tonnes/year by 2028 for discharges into the Barker Inlet. One means of reaching this target is to reduce the volume of stormwater discharging to the Barker Inlet.
- To assist in the improvement of the optical qualities of Adelaide's coastal waters, steps should be taken to reduce the amount of coloured dissolved organic matter in waters discharged by rivers, creeks and stormwater drains.

Australian runoff quality

Guidelines on the reduction of pollutant loads for new developments are set out for Victoria and New South Wales in the Australian Runoff Quality Guidelines (Engineers Australia, 2006). Stormwater treatment objectives are as follows:

- Total suspended solids (TSS) – 80% reduction of the developed catchment average annual load
- Total phosphorus (TP) – 45% reduction of the developed catchment average annual load
- Total nitrogen (TN) – 45% reduction of the developed catchment average annual load
- Litter – Retention of litter greater than 50 mm for flows up to the 3 month ARI peak flow
- Coarse sediment – Retention of sediment coarser than 0.125 mm for flows up to the 3 month ARI peak flow
- Oil and grease – No visible oils for flows up to the 3 month ARI peak flow.

WSUD – creating more liveable and water sensitive cities in South Australia

This document (DEWNR, 2013) provides a comprehensive and consistent approach to WSUD for State and Local Governments, the private sector and the community. It stems from both the Water for Good and Planning Strategy which recognises WSUD as an important element in creating more liveable urban environments. The state-wide performance target for runoff quality are as follows:

- Total suspended solids (TSS) – 80% reduction of the developed catchment average annual load.
- Total phosphorus (TP) – 60% reduction of the developed catchment average annual load.
- Total nitrogen (TN) – 45% reduction of the developed catchment average annual load.
- Litter/gross pollutants (GP) – 90% reduction of the developed catchment average annual load.

Water reuse

The NRM Board's target for reuse of stormwater is 75%. This is an ambitious target that will be difficult to achieve in the study area because of shallow ground water levels and limited suitable locations for harvesting schemes. Notwithstanding this, opportunities exist for capture and beneficial reuse of runoff.

It should be noted that there are synergies between objectives for reuse and water quality. For example, streetscape WSUD devices for water quality improvements will also provide a source of water for street tree and streetscape improvement. Also, reducing discharge volumes reduces pollutant loadings on the receiving environment.

Water quality improvement and reuse levels of service

With the catchment set to become an industrial precinct, it is imperative that pollution loadings are not increased to a level that would be harmful to the receiving environments. The following catchment specific objectives have been set to ensure that water quality and reuse targets are met.

Level of service 2.1

Water sensitive urban design (WSUD).

- Customer performance measure:
  - Relevant new developments feature at least 6 different key WSUD measures that reduce pollution and/or make beneficial use of stormwater[3].
    Target: by July 2021.
  - Percentage of all urban streets retrofitted with WSUD devices.
    Target: 10% by 2040.
- Technical performance measure:
  - Pollution reduction from new developments after July 2021.
    Target:
    - TSS 80%
    - TP 60%
    - TN 45%
    - GP 90%

Level of service 2.2

Quality of stormwater outflows at the coast.

- Customer performance measure:
  - Coastal discharges do not exceed National Water Quality Management Strategy 'slightly disturbed' ecosystem default trigger levels.
    Target: 95% of time by July 2034.
- Technical performance measure:
  - By July 2034, released water is of concentration equal to or better than the following targets 95% of the time:

[3] Refer Table 1.1, Chapter 1, Department of Planning and Local Government, 2010, *Water Sensitive Urban Design Technical Manual for the Greater Adelaide Region*, Government of South Australia, Adelaide.

- TP = 0.1 mg/L
- TN = 1 mg/L
- turbidity = 50 NTU
- faecal coliforms = 1000 faecal coliform organisms / 100 mL

- For system effectiveness monitoring purposes only, main channel flow water quality is measured mid catchment against the same parameters as for outflows at the coast.
  Target: by July 2025.

Level of service 2.3

Water reuse.

- Customer performance measure:
  - Cost effective household stormwater reuse options are promoted and available.
    Target: for at least 20% of average daily demand by 2034.
- Technical performance measure:
  - Proportion of overall stormwater runoff volume that is reused.
    Target: 75% by July 2034.

3.2.3 Service attribute 3: amenity, recreation and environmental enhancement

The drainage infrastructure is still to be built within the GEP and St Kilda catchment which allows plenty of opportunity to integrate stormwater management with environment and social enhancement.

Amenity, recreation and environmental enhancement levels of service

Level of service 3.1

Beneficial use of drainage reserves.

- Customer performance measure:
  - Proportion of total stormwater management reserve area that provides community amenity or recreation opportunities.
    Target: 90% by 2029.

Level of service 3.2

Environmental enhancement of drainage reserves and watercourses.

- Technical performance measure:
  - Ten year change in weighted average Bushland Assessment Method Total Biodiversity Score for all drainage reserves.
    Target: 2% improvement per annum.

3.2.4 Service attribute 4: asset management

Most of the GEP stormwater infrastructure is still to be built. An Asset Management Plan will be required to ensure that the future infrastructure is sustainable and operates effectively throughout its design life.

Asset management levels of service

Level of service 4.1

Total service.

- Customer performance measure:
  - Proportion of all levels of service targets being met.
    Target: 80% by 2024.
- Technical performance measure:

- Asset Management Maturity Index Score for Stormwater at City of Playford.
  Target: average score 3.5 by June 2023.

Level of service 4.2

Renewing assets at the rate required.

- Customer performance measure:
  - Number of asset structural failures that affect level of service
    Target: no more than 5 per annum after 2023.
- Technical performance measure:

Variance of renewal expenditure to AMP forecast.
Target: maximum +/- 30% each year after 2023.

4 Modelling of the catchment

This section describes the assumptions that form the basis of the hydrological/hydraulic and water quality modelling of the catchment area.

4.1 Hydrologic/hydraulic modelling

The quantity of runoff generated by the GEP and St Kilda catchment was evaluated using the hydrological/hydraulic modelling software DRAINS. The open channels, culverts and detention basins recommended within this SMP have typically been sized to accommodate the 100 year ARI flows indicated by the modelling. The modelling is based on the final alignment and management strategies described in Section 5. As outlined in Table 2.3, two climate change scenarios (2050 and 2090) have been modelled in DRAINS.

4.1.1 Hydrology

Catchments

The study region as shown in Figure 2.1 has a total catchment area of approximately 24 km^2. The study region has been divided into 6 main precincts, which were selected based on the location of the outlet and proposed detention basins. The catchment boundary has been amended since the previous study (Tonkin, 2018a) to exclude runoff which will ultimately discharge to the Smith Creek or Helps Road Drain catchments.

Future land use

The region will change from mostly pervious ground to high density industrial, residential, commercial and horticultural catchments. The ultimate development land use impervious areas were selected and agreed with Council as shown in Figure 2.6. These were used for the directly connected impervious areas in the DRAINS model. In general, an additional 2% was applied for the indirectly connected area.

Pervious area losses

The initial loss (IL) continuing loss (CL) hydrological model was used for modelling runoff from pervious areas. The values applied are:

- IL 45 mm
- CL 3 mm/hr

Time of concentration

The time of concentration (TOC) was calculated for fully developed catchments based on the following assumptions:

- 10 minutes from roof to street.
- 5 minutes from street to first side entry pit.
- 2 m/s for the remaining length (1,200 mm pipe on a 0.2% grade).
- Additional 15 minutes for pervious areas.

The TOC for most catchments is approximately:

- 20 minutes for impervious areas.
- 35 minutes for pervious areas within allotments.
- 5 minutes for supplementary areas.

4.1.2 Hydraulics

Open channel drainage network

All channels have been modelled with similar characteristics as follows:

Depth	2 m such that they are deep enough to serve a regional drainage function
Side slope	1 in 5 for ease of maintenance
Channel base width	ranging from 1 – 20 m but typically 5 – 10 m, depending on capacity requirements
Manning's n	0.03 to allow for a maintained trapezoidal grass lined channel with some weeds
Longitudinal slope	typically 0.15%

The natural topography of the region is so flat that the trunk channel needs to be deep enough to receive connecting lateral drains from future developments. These drains could be underground pipes in the order of 1,200 mm diameter with a 600 mm minimum cover requirement, leading to the selection of a 2 m minimum depth.

Road crossings

Culverts were modelled at each road crossing. Detailed modelling of culvert hydraulics was not undertaken except along the proposed SA Water channel (St Kilda and Waterloo Corner) where the hydraulic constraints could influence the feasibility of the alignment.

Most crossings were modelled as either a single 1,050 mm diameter pipe or 900 mm high box culvert to allow for suitable cover. Generally, where more than one pipe was required, box culverts were used instead.

Downstream control

The proposed outlet location (between Ridley ponds PA3 and PA4) is influenced by tidal fluctuations. The duration of a 100 year ARI event is expected to be around 24 hours with the hydrograph having an extended peak of around 7 hours due to the upstream detention basins. Therefore, the peak tide is likely to coincide with the 100 year outlet hydrograph.

The adopted sea level boundary condition has been derived from the summation of the mean high water springs (MHWS) tide height and predicted sea level rise (Port Adelaide Seawater Stormwater Flooding Study, Tonkin, 2005).

- Outer Harbor MHWS level 0.95 mAHD
- Sea level rise 300 mm by 2030
- Sea level rise 1,000 mm by 2100

Consistent with the climate change modelling methodology described in Section 2.3.4, a level of 1.35 mAHD was adopted for the 2050 model, with 1.95 mAHD adopted for the 2090 model to allow for sea level rise.

4.2 Water quality modelling

The quality of runoff from the study area was modelled using the eWater Model for Urban Stormwater Improvement Conceptualisation (MUSIC). Details of the development of the MUSIC model are provided in Appendix D (Tonkin, 2019b).

5 Stormwater management strategies

The following stormwater management strategies have been selected to address the service attributes identified in Section 3.

5.1 Flood management

The selection of the drainage alignment and culvert and basin locations was an iterative process balancing the opportunities, constraints, natural flood flow paths and hydraulic modelling. Sizing of stormwater infrastructure elements was based on the results of the climate change modelling for the 2050 scenario. The drainage strategy considers two scenarios, as listed in Table 5.1.

Table 5.1 Drainage scenarios

Scenario	Region	Standard of protection
A	Greater Edinburgh Parks	100 year ARI
	Horticultural area (St Kilda and Symes precinct)	100 year ARI
B	Greater Edinburgh Parks	100 year ARI
	Horticultural area (St Kilda and Symes precinct)	20 year ARI

Figure 5.1 and Figure 5.2 (Scenario A) and Figure 5.3 (Scenario B), include peak flow rates, indicative channel widths and basin volumes. The basis for the strategy has been provided in the following sections.

5.1.1 General principles

The drainage alignment has been selected with consideration of the following:

- Natural low-lying areas
- Northern Connector alignment
- Major services
- Existing development sites
- Potential outfall locations
- Road crossings
- RAAF base
- Northern Expressway
- Basin locations – groundwater, existing infrastructure restrictions (1,650 mm diameter pipe under railway), RAAF requirements
- Bolivar outfall channel.

Open channels

Given the high-value developed nature anticipated for the area, the majority of open channels have been sized to accommodate runoff from a 100 year ARI event. In some areas, such as the Symes Precinct, the channels are sized to prevent overloading the capacity of the coastal outfall. A lower standard (20% AEP) is also proposed for the lateral drains within the St Kilda precinct where flood damages will be lower due to the horticultural zoning of the area.

Lateral drains

This strategy has identified the main drainage alignment and does not allow for lateral drainage which could still be significant in size. Lateral pipe diameters could reach up to 1,200 mm diameter and therefore the open channels need to be deep enough to accept the lateral drains. The open channel drainage system is generally no less than 2 m deep except in locations of small catchment areas.

A 5 or 10 year ARI drainage standard would be appropriate for any lateral drainage systems, with additional capacity available within the road network.

Detention basin locations

Detention basins have been strategically located based on the constraints and opportunities of the project including groundwater levels and existing infrastructure restrictions. The main regional constraints that influenced the basin locations are:

- The existing triple 1,650 mm diameter pipes under the freight rail line approximately 500m west of Heaslip Road
- Existing services and traffic restrictions at Port Wakefield Road.
- Shallow groundwater levels on the western side of Port Wakefield Road.
- The system outlet location.
- Proximity to the RAAF base due to the potential for increased risk of bird strike.

The previous stormwater strategy (Tonkin, 2018a) identified the location of 11 proposed regional scale basins. Following review of the catchment boundaries, there are now four basins within the GEP catchment, with the remaining basins discharging to the Smith Creek or Helps Road Drain catchments.

Three of the basins are located along the alignment of the proposed trunk drain. The basins have been sized to achieve a suitable balance between the required footprint, the reduction in outflow and the hydrograph timing of downstream catchments. The fourth basin has been sized based on existing downstream capacity restrictions.

Drainage philosophy

Details of the drainage philosophy for each precinct are provided in the following sections.

5.1.2 Pellew

The Pellew precinct naturally drains in a south westerly direction. However, it is also undulating with pockets of low lying areas that provide natural storage within the precinct. The characteristics that have influenced the drainage alignment and basin locations are:

- The natural gradient of the land and ponding areas, which are evident from the floodplain mapping undertaken previously (refer Appendix A).
- The RAAF base and the proposed future extension of the runway.
- Roadways.
- Proposed SCT development.

The channel alignment has been located strategically to allow ponded areas to drain. The channel is located to the north of the RAAF base and future runway, along Heaslip Road and Penfield Road towards Pellew Road. The channel will be located within the 30 m easement on the northern boundary of the RAAF base.

RAAF

While it would be preferable to have a channel along Penfield Road, from Argent Road to Heaslip Road, to drain more of the precinct, this was found to be impracticable due to the extension of the RAAF runway. An easement would be needed within the RAAF base with a culvert under the runway. This option is not preferred by RAAF. As the eastern portion of the precinct (east of Heaslip Road) is bounded by the RAAF base and cannot naturally drain to the proposed stormwater channel, the alternatives are:

- Restrict development in this area.
- Substantial filling (about 3.5 m at the lowest point) to allow drainage back to the proposed stormwater trunk channel.
- Pump system.
- Negotiations with RAAF to discharge to their drainage swales. There may be an opportunity for RAAF to have their drainage systems and existing flooding issues improved should they accept Council's stormwater.

Allowing runoff to drain via gravity towards the proposed stormwater trunk channel is the preferred option, however it is acknowledged that 3.5 m of fill at the southern boundary is excessive, and may limit the viability of this option. A combination of the alternatives shown above may be necessary; for example, the northern portion of the site may be filled, with a pump system discharging flows from the remaining area.

SEA Gas/RAAF

It was originally proposed that a basin be located at the Heaslip Road crossing to minimise culvert sizes and hence avoid clashes with the SEA Gas service. RAAF advised that this would create unacceptable risk due to standing water directly in the flight path of RAAF aircraft. It was also advised that bird netting over the basin may be reflective and therefore could impact visibility for pilots.

As the channel is very flat in this area, it is likely that water would still pond in the channel invert, even without the basin. There are also constraints with the SEA Gas pipe along Heaslip Road. It is proposed that a bridge over the stormwater channel is constructed instead of culverts to avoid the SEA Gas pipe with the added benefit that blockage/standing water will be minimised within the flight path of the RAAF aircraft. The SEA Gas pipe will require protection during the construction of the bridge.

Detention basin

Downstream of Heaslip Road the proposed channel continues along the rear of properties between Heaslip and Ranger Roads to Pellew Road. The lateral channel, draining flows along Ranger Road, connects at Pellew Road. The Pellew basin has been located at the corner of Heaslip and Pellew Roads such that the flows can be throttled back to the capacity of the existing triple 1,650 mm diameter pipes under the railway line. The basin was not located directly upstream of these culverts as there are currently plans to expand the intermodal facility by SCT. Refer to Table 5.3 for the Pellew basin properties. All discharge from the precinct is into the Greyhound precinct.

5.1.3 Greyhound

The Jarmyn Road channel (previously referred to as the Short Road channel) continues from the Pellew Road detention basin, under the railway line and along the eastern side of Jarmyn Road to Port Wakefield Road. A detention basin is proposed on the corner of Mumford and Greyhound Roads; this is a potential site for a wetland/water harvesting scheme.

The characteristics that have influenced the location of the stormwater channel and detention basin are the:

- Existing triple 1,650 mm diameter pipes under the railway line.
- Natural flood flow path along Jarmyn Road.
- Epic Energy pipeline along Jarmyn and Greyhound Roads which limits opportunities to cross the roads to the eastern side.
- Existing significant ponding behind Port Wakefield Road, from Taylors to Heaslip Roads.

There is a congestion of major services at the intersection of Mill Road and Greyhound Road. The drain will need to cross either the Epic Energy Moomba to Adelaide Pipeline (MAP) or the APA high pressure transmission main. The preferred alignment is to cross the APA gas main to keep the channel on the eastern side of Jarmyn and Greyhound Roads. The APA gas main was depthed at approximately 1.3 m deep (8.67 mAHD) and therefore the drain should be able to go underneath by using multiple 600 mm deep box culverts. There will be minimal clearance between the two services and therefore the APA gas main will require protection.

The Greyhound Road detention basin takes advantage of the natural low area adjacent Port Wakefield Road. The basin will restrict outflows such that outflows do not exceed the capacity of the culverts that have recently been constructed under the Northern Connector (~15m^3/s capacity), located within the St Kilda precinct.

Shallow groundwater is a potential restriction to the depth of the Greyhound basin. It is recommended that site specific groundwater testing is undertaken to work out how deep the basin can be without intercepting groundwater.

The outlet to the detention basin will be the only crossing of the Epic MAP on Greyhound Road. The crossing will need to be carefully designed as the pipeline will be difficult and expensive to alter. It is anticipated that multiple shallow box culverts will allow the drainage to pass under the Epic service. Some protection to the Epic service will be required due to the minimal clearance to the culverts.

The land bounded by Mumford, Port Wakefield and Waterloo Corner Roads naturally falls to the south west. However, the bank of 14 Telstra conduits and the Epic pipeline would make crossing Port Wakefield Road challenging at this location. Alternatively, filling by 0.5 – 1.0 m could allow stormwater to drain in a north westerly direction to the Greyhound Road basin. This option:

- Avoids major works across Port Wakefield Road.
- Lessens the chance of conflicting with major services.
- Reduces stormwater flows heading in the direction of the Gap.
- Provides flood flow attenuation in the Greyhound Road Basin.

Depthing of services will be required to determine the most economic and viable solution for this parcel of land. The modelling has assumed that this portion of the precinct will be site filled such that it drains into the Greyhound Road basin.

5.1.4 Port Wakefield

The Port Wakefield precinct naturally drains to Jarmyn Road on the western side. Due to the Epic service it was not feasible to have multiple crossings into the Jarmyn Road drain. Therefore, a parallel trunk drain has been located along the western side of Jarmyn Road to Port Wakefield Road.

It is likely that the Nextgen service along the railway line will need to be altered. Nextgen have advised that this is achievable and that it has already been done once for a stormwater drain constructed to the north.

The Port Wakefield detention basin takes advantage of the natural low area. Basin outflows are discharged to downstream of the Greyhound Road basin to prevent the basins acting in series.

The catchments downstream of Port Wakefield Road generate an approximate peak flow rate of 10 m^3/s during a short duration event. The upstream catchment generates a peak flow rate into the basins of about 40 m^3/s, also for a short duration event. However, the downstream catchment peak flows will precede the arrival of the peak flow under Port Wakefield Road due to the GEP hydrograph attenuation within the basins. Therefore, intuitively, the two detention basins have been designed aiming for a combined outflow in the order of 10-15 m^3/s but also keeping a balance between the outlet culvert size and the detention basin footprint. The final basin properties are provided in Table 5.3.

5.1.5 St Kilda

There are a number of potential alignments for the main trunk drain after the crossing of Port Wakefield Road. The options that were identified in a workshop with stakeholders are:

- Aligning with the natural topography of the land to the south and discharging at the Gap Outfall.
- An outfall running along the eastern side of the Northern Connector towards the Little Para River.
- A direct path, along the back of St Kilda Road properties, to a new syphon under the Bolivar Outfall Channel and into Ridley Pond PA 6 or PA 5.
- An alignment along the western side of the Northern Connector and then through SA Water land back to a new syphon under the Bolivar Outfall Channel and via the existing coastal outlet between Ridley Ponds PA3 and PA4.

The first two points were considered to be the least feasible due to the limited capacity of the Gap Outfall and the undulating ground levels towards the Little Para River.

The St Kilda Road option was seemingly the most appropriate due to the direct path towards a new outlet. However, to take advantage of the construction of the Northern Connector and to limit the number of property acquisitions, a detailed investigation was commissioned for the feasibility of the last option above. The outcomes of the report were generally in favour of this option, however a number of risks were identified. Full details are provided in the Edinburgh Parks Trunk Drainage Outfall Feasibility Assessment (Tonkin, 2016b).

The trunk drain will also require a secondary lateral drain that will allow for properties north of St Kilda Road to drain into. The final alignment will predominantly be within private property. To be consistent with the approach in the Symes Road catchment (refer Section 5.1.7) it is recommended that developments in the horticultural portion of the precinct provide a significant amount of on-site detention to reduce the size of the trunk drainage system that is required.

5.1.6 NEXY South

The NEXY South precinct currently outfalls to a retention basin at the intersection of Port Wakefield Road and the NEXY via a cross culvert. Industrialisation of the area will increase peak flows and peak volumes that will exceed the storage capacity of the retention basin.

The options for managing increased flood flows in this area are:

- Provide an outlet to the existing retention basin such that flood flows continue to the proposed GEP Brown Road channel.
- Detain flood flows within a new basin such that both the peak flow rate and volume are limited to existing conditions.
- Detain flows within a new basin and pump flood flows back to the GEP trunk drain within the adjacent Port Wakefield precinct.

The management of stormwater in the precinct will vary greatly depending on which option is selected.

Initially it may be viable to manage runoff from the precinct within a new retention basin to the east of the NEXY, within the footprint of what will eventually become a detention basin. However, after a set amount of development, the retention storage would not be adequate to prevent there being an increase in downstream flood risk.

Discharge via gravity

Once development reaches a certain threshold the basin will need to be provided with an outlet. The first option is to have a gravity output with the basin connected into the proposed outfall channel adjacent to Brown Road (in the Symes precinct). This would require the following works:

- A detention basin upstream of the cross culvert to throttle the flood flows to approximately 1 m^3/s to prevent overloading the capacity of the outlet of the Symes Road precinct (refer Section 5.1.7).

- A culvert crossing at Port Wakefield Road.
- A channel from Port Wakefield Road to the start of the proposed GEP Brown Road channel.
- The full length of the Brown Road channel to the outlet near the Ridley Salt works (~3.5 km of drain).

A gravity option would require a significant amount of downstream infrastructure to be in place and would require property acquisition from numerous owners.

Discharge via pump

The second option would be to pump the water back into the Port Wakefield precinct. A flow rate of approximately 150 L/s would be adequate to ensure that the basin would not reach capacity during a period of extended heavy rainfall. The rising main could be entirely within road reserves and therefore would not require land acquisition (beyond what is required for the basin). The lower discharge rate would mean a larger basin than a gravity discharge option (170 ML compared to 110 ML). This would partially offset the lower cost of providing a pump station, compared to a full gravity outlet option.

If development occurs in the NEXY South precinct before there is a need to provide drainage infrastructure along the northern portion of the Symes precinct, it is likely that the pumped outfall option would be the most viable, despite the additional maintenance costs of a pump station compared to a gravity outfall.

Both the gravity and pump discharge options have been modelled, and the basin characteristics of each have been provided in Table 5.3.

Wetland

Incorporation of a wetland should be considered for the proposed NEXY South basin to improve the quality of water that discharges from the basin.

5.1.7 Symes

The Symes precinct encompasses the horticultural area within the north west region of the catchment. There is currently no drainage infrastructure in the area other than shallow roadside swales. This means that virtually all runoff that is generated by the site is retained within the precinct which creates nuisance flooding issues during the wetter part of the year or following any significant rainfall event. Existing overland flood flows generally follow along Symes Road towards the Bolivar Outfall Channel.

Trunk drain alignments have been located along Symes Road and along the northern boundary of the study region to provide a trunk drainage outfall for the precinct. The two outfalls will converge at the existing syphon that passes under the Bolivar outfall channel adjacent to Ridley Pond XC 2-South. From here the flow passes via a channel along the eastern side of Pond XC 2-South and PA3 before reaching the coastal outlet. The syphon and the downstream channel system have been assessed to have a capacity in the order of 3 m^3/s (Tonkin, 2019). Upgrading the capacity of the system would require significant capital expenditure including a new larger syphon under the Bolivar channel and significant widening of almost 2.0 km of open channel through the salt fields. As such it has been assumed that this is a constraint to the capacity of the catchment. An additional 2 m^3/s capacity could be accommodated by transforming the Brooks Road road reserve north of Symes Road into a drainage channel and discharging into the outlet of Smith Creek, approximately 3 kms to the north.

Given the horticultural nature of the area (lower flood potential than industrial or residential areas), the significant downstream capacity restrictions and the flatness of the area, a lower drainage design standard is proposed for the precinct. A 20 year ARI level of protection is recommended for this area; this will provide a balance between capital costs and flood reduction benefit.

In order to meet the outlet capacity restrictions of the catchment, large Council-owned detention basins could be constructed near the outlet of the catchment. These would be limited by very shallow groundwater levels and hence would require a substantial amount of land.

Alternatively, the requirement for new development to provide on-site detention storage, such that the discharge rates from each site do not overload the capacity of the proposed trunk drainage system, could be implemented. The Symes precinct is close to 500 ha in size. Based on DRAINS modelling of the catchment each hectare of development would need to provide in the vicinity of 200 kL of detention storage in order to sufficiently detain flows (in the 20 year ARI rainfall event). Based on an average basin depth of 1.0 m, the basin footprint is likely to occupy in the order of 2% of each property (200 kL per hectare). Localised underground drainage systems would then be required to connect the outlets from the basins into the main outfall drains.

The Symes Road channel has been located along the road frontage to the west of Coleman Road which is owned by the Department of Defence. Further to the east a new channel would likely require substantial alteration of property supply services. While there isn't a logical rear of property alignment, due to irregular allotment layouts, the final location of the channel is flexible and would depend on land holder preferences for easement location. Due to the limited capacity of the downstream system a viable alternative is to install an underground drainage system with the Symes Road road reserve. Subject to getting clearance over the gas services in the area, twin 900 mm pipes would be adequate to provide a design flow rate comparable to the outlet capacity of the catchment.

The Symes Road and northern channel (White Road) alignments will cross Tozer Road and hence the APA high pressure gas main. According to DBYD plans, the APA gas main is likely to be 900 mm deep at a distance of 6.7 m off the boundary at each location. A comparison of service levels with drainage design levels is provided in Table 5.2 with levels to be refined as a part of further design development. It may be that a clash is unavoidable and that the service would require alteration.

The channels will also cross the Epic pipeline (MAP) at three locations. These have been depthed and a comparison of levels is also provided in Table 5.2.

Table 5.2 Symes precinct service crossing levels

Location	Service	Approx. top level (mAHD)	Proposed drain invert level (mAHD)
Tozer/White Road	APA	4.7	3.62
Tozer/Symes Road	APA	4.5	4.4
Curnow Road	Epic	3.63	4.1
Symes Road	Epic	4.2	4.4
Berno Road	Epic	3.42	4.05

The open channel at Symes Road would potentially clash with the Epic pipeline. To avoid conflict with the Epic pipeline the drainage system is likely to have to pass over the top of the service which will limit both the invert and the size of the drains east of Tozer Road.

It is likely that the proposed open channels can be designed such that they clear the Epic service at Curnow Road and Berno Road, although the Epic main will need protection due to reduced cover.

5.1.8 NEXY North

The NEXY north area all drains towards the Northern Expressway. As a part of the original GEP stormwater management strategy (Tonkin 2018a), the proposed drainage strategy for this precinct was to detain the water and pump it back into the trunk drain in the adjacent Pellew precinct. However, this would rely on infrastructure downstream of the Pellew precinct being in place.

An alternative arrangement has been investigated for this project which essentially retains the existing outfall for the precinct, but detains flows, such that the capacity of the existing cross drains under the

Northern Connector are not exceeded. The flows would then pass along the western drainage channel along the Northern Connector before discharging into Smith Creek (as it does currently), approximately 600m south east of the King Road, Pratt Road intersection.

Two detention basins are proposed, which are adjacent to the two existing cross drains adjacent to the NEXY north precinct. They are at the Pellew Road cross drain (triple 900mm diameter pipes) and the Penfield cross drain (triple 750mm diameter pipes). They detention basins have been sized based on the following parameters for the contributing catchment:

- 75% impervious area
- 30 minute time of concentration
- A 1.5 m average basin height
- 375 mm low flow outlet pipes with a high level spillway

The work ensured that the outflows from the basins do not exceed the existing peak flows that pass under the cross drain which are 1.7 m^3/s for the Pellew cross drain and 1.9 m^3/s for the Penfield cross drain. The required basin sizes are shown in Table 5.3.

It has been noted that the DRAINS model used to size infrastructure for the NEXY used the "basic" model which did not allow for the natural attenuation due to storage of water within the drainage elements. It is therefore likely to have oversized the size of cross drains, as it would have over predicted peak design flow rates.

5.1.9 Basin size summary

Details of the storage volumes required to sufficiently detain flows within each precinct are provided in Table 5.3. Sizing of the basin elements has been undertaken to detain flows for the 2050 climate change scenario. The storage volumes also include an allowance of at least 300 mm of freeboard.

Table 5.3 Detention basin characteristics

Basin Name	Existing 100 yr ARI Flow (m^3/s)	Ultimate 100 yr ARI Inflow (m^3/s)	Basin Volume (ML)	Outlet Size (mm)	Basin Outflow (m^3/s)
Pellew	N/A	26	225	2x2100x900	11
NEXY South (gravity discharge option)	3.2	13	80	1200x600 (existing)	1
NEXY South (pump discharge option)	3.2	13	120	Pump	0.15
Greyhound	N/A	25	337	4x2100x600	15
Port Wakefield	N/A	25	124	2x900	3
NEXY North Penfield	1.9	13	38	375 mm and spillway	1.8
NEXY North Pellew	1.7	15	50	375 mm and spillway	1.6
Symes and St Kilda (portion only)	N/A	Varies	0.2 per hectare of development	Varies	0.1 per ha of development

Detention basin design

The proposed detention basins described in the previous sections will be connected to the trunk drain, and hence will receive inflows during a range of rainfall events (both frequent and infrequent). As part of the design of the basins it is recommended that consideration be given to heavily detaining the outflows from the basins during frequent, small flow events. This will provide a number of benefits, including:

- Increased infiltration, thereby reducing the volume of runoff discharged from the catchment
- Increased water reuse, where possible.

5.1.10 Common management strategies

A number of management strategies are common to all precincts within the study area. These are discussed in the following sections.

Development controls

Development controls will be required to ensure development is protected from flooding during the 100-year ARI event. This would include requiring development to be set above adjacent road levels such that the roads are able to convey flood flows when the capacity of the underground drainage network is exceeded.

The new State Government Planning and Design Code governs controls for new development. There may be limitations to the code that are not in the best interests for Council in relation to stormwater management, particularly in a non-residential setting (such as hot houses). A recommended action is to undertake a detailed interrogation of the new code to check that it can still lead to satisfactory outcomes to Council in relation to stormwater management, such as increases in runoff and water quality management. A further action may involve liaising with the Stage Government to amend the code.

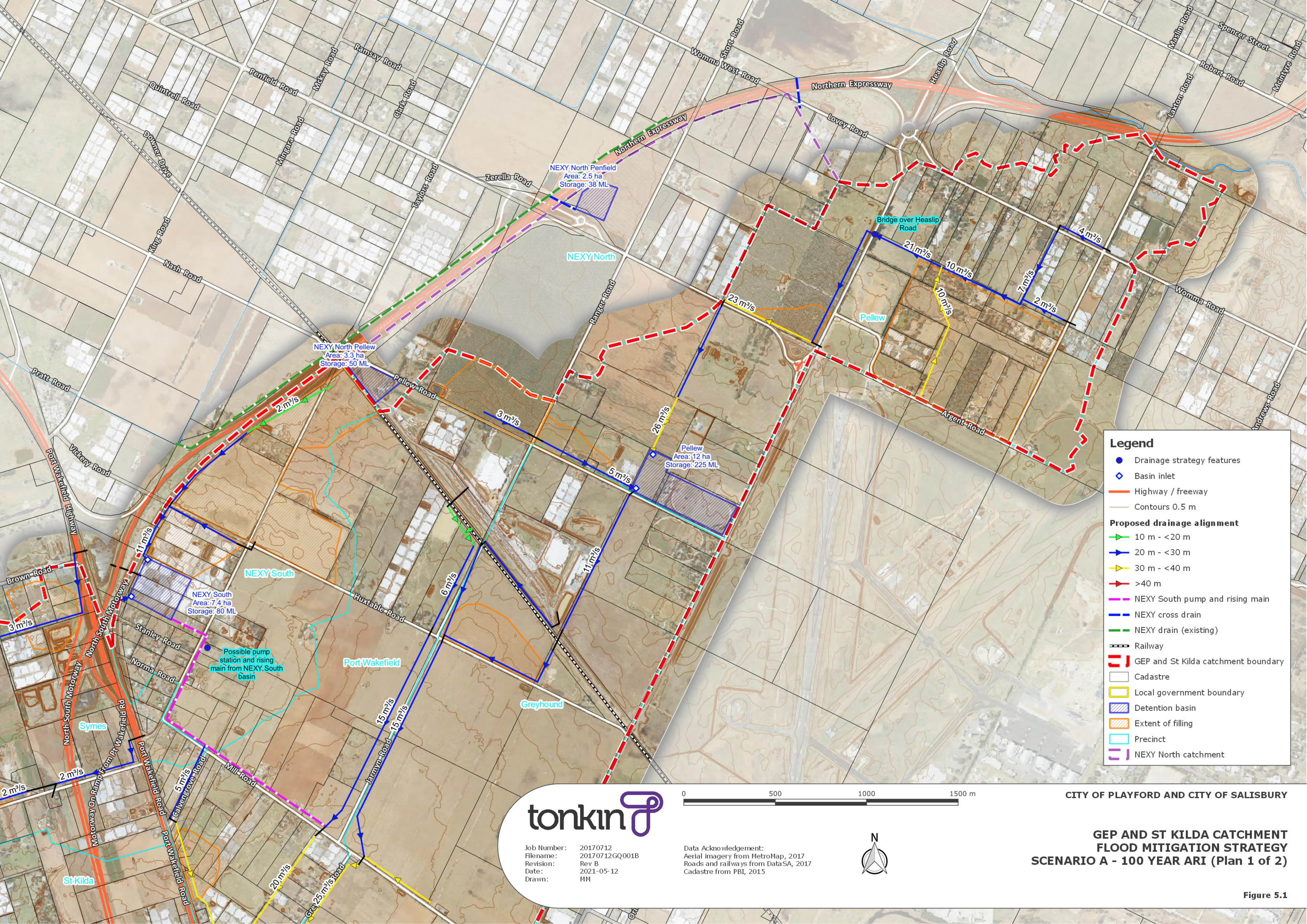
Road design

In some areas roads would need to be aligned to act as a secondary overland flood flow path once the capacity of the underground drainage system is exceeded. They will need to have a continuous grade to the trunk outfall drains.

Education and awareness

Flood mapping of the catchment in its current undeveloped state is available (Tonkin 2016a). This information should be made widely available to the community so that it is understood where flooding is likely to occur. Awareness of flood risk can allow the community to better manage their risk and reduce flood damages. This awareness could be achieved via letter and brochures, circulating flood maps publicly (e.g. accessible via the internet) and having information available at public places such as Council offices. Business and residents can be encouraged to develop flood action plans to reduce damages during a flood, for example by changing the manner in which valuable items are stored.

As development proceeds within the catchment, areas are filled and the trunk drainage system is constructed, the flood maps will no longer be current and would potentially become misleading. Periodic updating of the flood maps could be undertaken with updates provided to the community.



tonkin

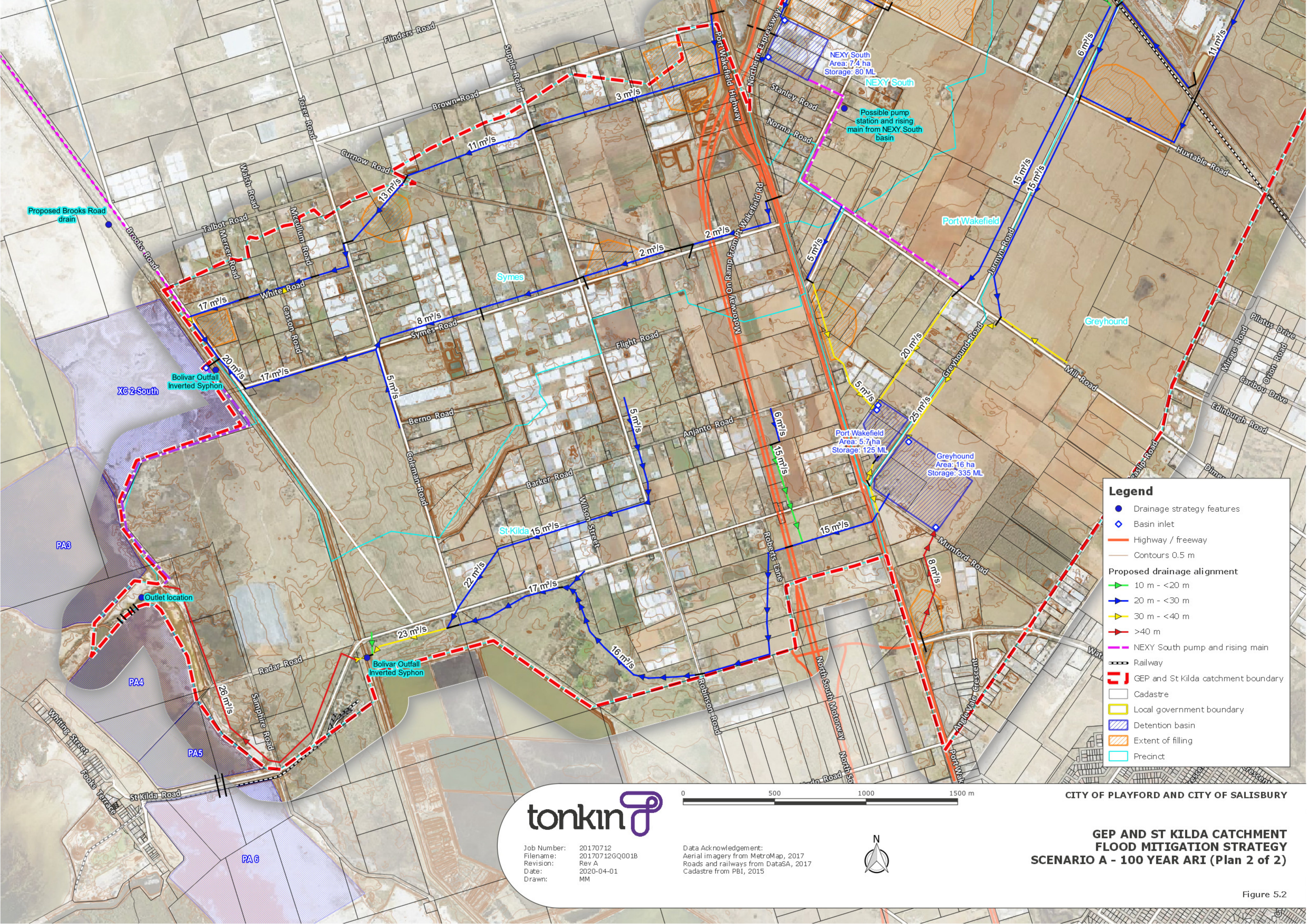
Job Number: 20170712
Filename: 20170712GQ001B
Revision: Rev B
Date: 2021-05-12
Drawn: MM

Data Acknowledgement:
Aerial imagery from MetroMap, 2017
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015

CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT FLOOD MITIGATION STRATEGY
SCENARIO A - 100 YEAR ARI (Plan 1 of 2)

Figure 5.1



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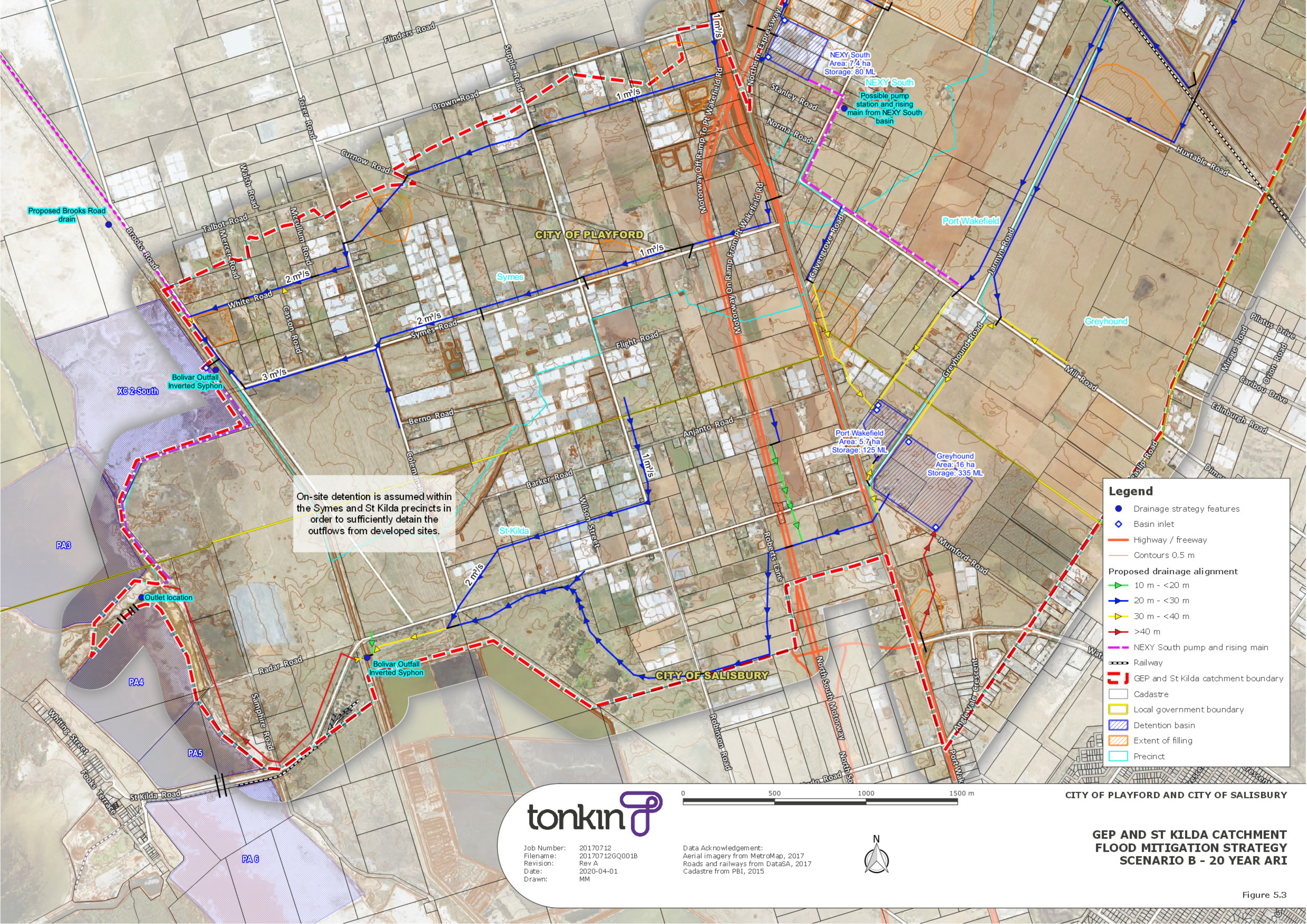
Job Number: 20170712
Filename: 20170712GQ001B
Revision: Rev A
Date: 2020-04-01
Drawn: MM

Data Acknowledgement:
Aerial imagery from MetroMap, 2017
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015

CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT FLOOD MITIGATION STRATEGY SCENARIO A - 100 YEAR ARI (Plan 2 of 2)

Figure 5.2



tonkin

Job Number: 20170712
Filename: 20170712GQ001B
Revision: Rev A
Date: 2020-04-01
Drawn: MM

Data Acknowledgement:
Aerial imagery from MetroMap, 2017
Roads and railways from DataSA, 2017
Cadastre from PBI, 2015

CITY OF PLAYFORD AND CITY OF SALISBURY

GEP AND ST KILDA CATCHMENT FLOOD MITIGATION STRATEGY SCENARIO B - 20 YEAR ARI

Figure 5.3

Flood warning and flood forecasting

If the community is forewarned of the potential for flooding, the magnitude of the social and economic damages could be reduced significantly. Warning of flooding provides the community and emergency services time to enact response measures such as placing sand bags around flood prone areas or moving valuable portable property out of flood areas. The potential reduction in flood damages when more than 12 hours of warning is provided, as opposed to less than two hours, can range from 20% to 50% depending on the relative experience of the community in dealing with flooding (DNRE, 2000).

5.1.11 Hot house development

The hot house intensification within the GEP and St Kilda catchment will predominantly occur within the Symes and St Kilda precincts. This area of the catchment is very flat with large amounts of water ponding during the wetter months. The key drainage strategy is to provide a trunk drainage system throughout the precincts, into which local drainage systems can discharge. Presently there is no outfall for properties to discharge to, and hence large storage basins would be required to retain all runoff on site. Providing the trunk outfall reduces the size of stormwater infrastructure that is required on each property.

However, given the flat grades, shallowness to groundwater and potential for high levels of imperviousness associated with hot house development, the size of the trunk drainage infrastructure would be significant. There are also limitations to the capacity of the downstream drainage systems, particularly for the Symes precinct. To mitigate this, it is proposed to require development to provide on-site detention to a rate that means that the peak flows discharged from developments in these areas can be accommodated either via pipes within the road reserve, or via moderate sized open channels. Given the horticultural nature of these precincts, it is proposed that a lesser standard (i.e. 20 year ARI) is adopted for these trunk drains in this area.

5.2 Water quality

5.2.1 Introduction

The following sections detail the proposed strategies for improving the water quality of the runoff from the developed areas of the catchment. Consistent with the stormwater management planning guidelines, the status of existing stormwater quality, along with opportunities for water quality improvement, have been considered in the development of the GEP and St Kilda SMP.

The stated water quality objectives for the study area reflect South Australia's state-wide performance targets for stormwater runoff quality (Department of Environment, Water and Natural Resources, 2013), as follows:

- 80% reduction in average annual total suspended solids (TSS)
- 60% reduction in average annual total phosphorous (TP)
- 45% reduction in average annual total nitrogen (TN), and
- 90% reduction in litter/gross pollutants (GP).

Given the largely undeveloped nature of the study area, there are opportunities for new measures that can treat a significant portion of the site. The incorporation of water sensitive urban design (WSUD) into the areas of new development will be consistent with WSUD best practice and should aim to achieve the stated water quality targets.

It must be acknowledged that, given current pollutant loadings discharging from the catchment are virtually zero, targets are relative to a developed catchment without any treatment measures. Unless full on-site retention of stormwater is proposed there will be an increase in pollutant loads.

5.2.2 Water quality improvement strategies

Open channels

The trunk drainage system will typically be in the form of earth-lined open channels with a flat longitudinal grade (typically 0.2%). As a part of construction they will be vegetated and it is likely that vegetation will become well established within the channels, similarly to other open channels in the area, once the contributing catchments become developed and frequently produce runoff. The flat base of the channels (typically 5m across) will facilitate vegetative filtering of low stormwater flows and encourage infiltration. It is likely that during smaller rainfall events that all water will infiltrate into the base of the channels which will help to mimic the existing hydrological regime.

Basins

The large basins required for detention purposes will act as sedimentation basins due to the slow flow velocities through them. The upstream portions of the basins should be configured to capture coarse sediments and have access tracks into them to allow for the periodical removal of sediment.

Wetlands

Incorporation of wetlands into the base of the basins (subject to groundwater ingress issues) has the potential to further improve water quality through physical (such as sedimentation), biological (such as biofilm creation on emergent plants) and pollutant transformation (such as denitrification) processes. To be effective the wetlands need to be sized proportionally to the size of the upstream catchment. Due to the proximity to the RAAF base, incorporation of wetlands into the Pellew basin would not be recommended unless costly bird netting was used (increased risk of bird strikes). However, wetlands could be incorporated into the large detention basins within the Greyhound and NEXY South precincts. A wetland in the Greyhound basin would have the added value of reducing the amount of cleansing that would be required before water could be harvested from the basin.

A potential constraint to the construction of a wetland within the Greyhound basin is shallow groundwater levels. It may preclude excavation below the level that is required for the main detention basin (assumed to be in the vicinity of 2.0m deep). Additional groundwater testing would be required to further quantify this risk.

Biofiltration

An alternative to wetlands would be to incorporate biofiltration within the basins, where space exists. This will provide stormwater quality improvement (nutrient removal) via infiltration through a porous media and uptake through vegetation.

5.2.3 Modelled water quality improvement

The MUSIC model was constructed with a focus on two primary water quality improvement features: the grass-lined channels constituting the trunk drainage network, and the large detention basins within the Pellew, Greyhound, NEXY south and Port Wakefield precincts.

The model was run to understand the patterns of flow and pollutant generation based on the developed catchment using 'industrial' source nodes. The channel and basin dimensions used in the model are consistent with those identified as part of the 2050 climate change analysis. The pollutants converge at the downstream receiving node, located at the outlet between ponds PA3 and PA4. The source loads represent total flows and pollutants generated within the study area. The residual load reflects the flows and pollutants arriving at the receiving node following treatment. The results of the modelling are summarised in Table 5.4. It is acknowledged that the MUSIC modelling undertaken as part of the SMP is high-level.

Table 5.4 Modelled annual pollutant loads at the downstream receiving node

Pollutant	Sources	Residual Load	% Reduction	Daily mean (95th percentile)
TSS (kg/yr)	633,000	49,400	92.2	16.0 mg/L
TP (kg/yr)	1,700	400	76.8	0.13 mg/L
TN (kg/yr)	11,600	4,500	59.7	1.7 mg/L
GP (kg/yr)	224,000	0	100	0 kg/day

The reduction in pollutant loads shown in Table 5.4 meets the targets recommended by the Department for Environment and Water (DEW), however given that the site in its current state is unlikely to discharge any pollutants, it is prudent to investigate additional methods to further reduce the residual loads. The concentration targets identified in Level of Service 2.2 for total phosphorus (0.1 mg/L) and total nitrogen (1.0 mg/L) have not been met.

It is proposed to incorporate a wetland in the base of the detention basin located at Greyhound Road within the Greyhound precinct. A reuse demand of 3,500 kL/day was assumed in the modelling, representing the potential for water harvesting. This provides a reduction in the total flows, and hence total pollutants, discharged from the catchment. Additionally, a wetland within the NEXY South basin is also proposed (with no allowance for water harvesting). The modelled water quality improvements at the receiving node following the inclusion of these wetlands is shown in Table 5.5. Additionally, a breakdown of the pollutant load reductions for each precinct is provided in Appendix E.

Table 5.5 Modelled annual pollutant loads following inclusion of wetlands

Pollutant	Sources	Residual Load	% Reduction	Daily mean (95th percentile)
TSS (kg/yr)	633,000	42,100	94	16.5 mg/L
TP (kg/yr)	1,700	300	82.5	0.13 mg/L
TN (kg/yr)	11,600	3,900	69.6	1.7 mg/L
GP (kg/yr)	224,000	0	100	0 kg/day

Despite the additional water quality treatment provided by the wetlands, the TN and TP concentration targets are still not met. Distributing various infiltration mechanisms throughout the catchment is therefore recommended. Further detailed investigations, such as confirmation of soil type and associated infiltration rate, would be required. Additional discussion surrounding infiltration systems is provided in Section 5.2.4.

The MUSIC model also provides an understanding of the reduction in annual average flows discharged from the site. The 2050 and 2090 seasonal scaling factors were applied to the model to compare the impacts of climate change on the water balance outcomes. This is summarised in Table 5.6 for all climate scenarios, with and without water harvesting.

Table 5.6 Modelled annual flows (ML/yr) at the downstream receiving node

Scenario	Sources	Residual Load	% Reduction
Current climate scenario with no water harvesting	4,910	2,620	46.6

Scenario	Sources	Residual Load	% Reduction
Current climate scenario with water harvesting in wetland	4,910	2,270	53.8
Projected 2050 climate scenario with no water harvesting	4,300	2,130	50.4
Projected 2050 climate scenario with water harvesting in wetland	4,300	1,820	57.7
Projected 2090 climate scenario with no water harvesting	3,940	1,860	52.7
Projected 2090 climate scenario with water harvesting in wetland	3,940	1,570	60.1

As expected, the annual runoff from the catchment decreases both in a drier climate, and when a water harvesting scheme utilising the wetland is adopted. Comparing the water harvesting option to the scenario with no water harvesting shows a reduction in flows discharged from the catchment of approximately 7% for all climate scenarios.

5.2.4 Additional water quality considerations

On-site measures

It is anticipated that individual developments will need to undertake site specific water quality control measures, such as installing oil and grit separators prior to discharge of water from their site, particularly from high pollutant sources, such as car parking areas. Runoff from hard stand areas should also be directed to adjacent landscape areas for passive irrigation.

Collection and reuse of roof water would also help to minimise the dilution of 'dirty' surface water with cleaner roof runoff. However, as outlined in 5.3.3, the estimated demand on tanks within the industrial areas is likely to be less than the amount of runoff generated, and as such the tanks will often be at capacity and overtop.

Where it is determined that on site detention is required to detain runoff from a new development, there is potential to incorporate biofiltration (refer Section 5.2.2). This would result in improvements to stormwater quality (but would not improve the frequency of a basin overtopping).

Gross pollutant traps

For all modelled water quality scenarios, the residual load of gross pollutants discharged from the catchment was 0 kg/year. This is because MUSIC assumes that gross pollutants entering all treatment nodes are 100% captured (eWater, 2011). Given that the proposed swales are the predominant water quality improvement feature within the study area, this assumption suggests that gross pollutants will remain within the swales until they are manually removed.

The installation of GPTs at locations upstream of the main outfall channel (e.g. within industrial developments or along smaller lateral drains) should therefore be considered in order to alleviate the burden of the swales in capturing gross pollutants. Final locations of GPTs cannot be quantified at this stage, as they are dependent on the future development within the catchment. However, the GPT configuration would need to consider issues such as access for maintenance.

The maximum removal of gross pollutants will be dependent on the selected GPT and maximum treatable flow rate.

While the primary purpose of GPTs is to remove gross pollutants and coarse sediments, an in-ground GPT (as opposed to a trash rack) may also provide a reduction in TSS, TP and TN. Specifications provided by manufacturers suggest that GPTs may remove up to 80% of TSS and 30% of TP and TN. Independent field trials of GPTs suggest that the actual treatment efficiencies is heavily influenced by operations and maintenance practices. If organic matter is allowed to accumulate in the wet sump of a GPT, anaerobic decomposition can occur resulting in the release of highly bio-available forms of nutrients into downstream waterways (DPLG, 2010).

Raingardens

Raingardens are typically shallow, planted depressions that can provide water quality improvement benefits via biofiltration mechanisms. Raingardens may be implemented at a range of scales from individual residential blocks up to the treatment of whole of catchment flows. Raingardens can reduce the quantity of sediment and nutrients exported to receiving waters.

As a part of new development streetscape raingardens may be considered within the GEP and St Kilda catchment area in order to provide improved stormwater quality. Typically constructed within verges or roads, streetscape raingardens receive gutter flows via gaps in the kerbing. Flows are then allowed to pond and infiltrate. A high level overflow/outlet may be provided to discharge flows exceeding the storage capacity of the raingarden into the underground drainage network.

Design Flow (2016) determined that the required area of a raingarden to achieve the State Government’s stormwater treatment targets can be approximated as 0.7% of the impervious area of the contributing catchment. Raingardens of a smaller size will still provide some water quality treatment. A typical layout for a streetscape raingarden is illustrated in Figure 5.4.

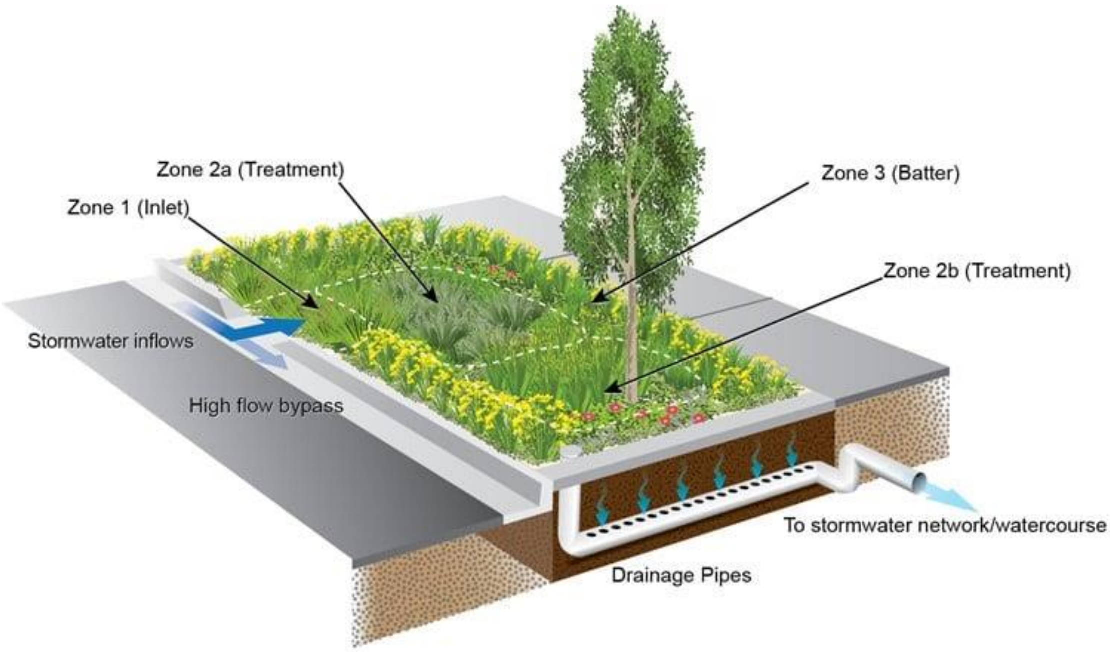


Figure 5.4 Typical layout of a raingarden (Water Sensitive SA, 2016)

Given the flat terrain, raingardens are well suited to construction within the catchment. However, there are currently very few roads with kerbs in the catchment. The majority of road runoff therefore drains along the roadside verges. There is also little directly connected catchment to the roads.

As development proceeds it is likely that new kerbed roads will be installed to service the new industrial areas. As a part of these works raingardens should be incorporated into the road designs.

Other small-scale potential water quality improvement measures

In addition to the raingardens described above, there are a number of other small-scale water sensitive urban design measures which could be considered for implementation within the catchment. The measures could be implemented as stand-alone projects or incorporated into other capital works projects.

Modifications to existing basins

There are a number of existing detention and retention basins within the study area. There may be an opportunity to provide stormwater quality improvement within these basins by constructing vegetated low flow channels and/or lowering the invert of the basins to provide a wetland within the detention basins. Other small-scale opportunities that may be considered where space exists include the construction of bioretention swales and basins (refer Section 5.2.2).

Permeable paving

Permeable paving, also known as porous paving, is a load bearing pavement structure which can be used on trafficable surfaces including roads and driveways with low traffic volumes, carparks and pedestrian areas. It is best suited to areas that are relatively flat (DPLG, 2010).

Permeable paving typically comprises a permeable surface layer overlying an aggregate storage layer and provides many runoff management benefits including:

- Reduction in peak discharges and volumes.
- Increased groundwater recharge.
- Water quality improvement as a result of infiltration.

It is recommended that permeable paving is included within the relevant development plans as a requirement for new developments. For new industrial developments, permeable paving could be included in areas of the site where heavy vehicle loadings do not occur. Additionally, Council should consider permeable paving in lieu of other footpath pavement options across the catchment.

Tree pits

Tree pits typically involve the construction of an opening in the kerb to divert low gutter flows into infiltration pits behind the kerb. The primary objective of the pits is to provide passive irrigation for street trees, with associated amenity and cooling benefits. However, the pits also provide a reduction in stormwater volumes and pollutant loads discharged to receiving environments. As with raingardens, tree pits should be incorporated into road designs for new kerbed roads.

WSUD in the backyard

'WSUD in the backyard' may be encouraged by each Council both for existing residences and new developments. Examples of measures could include rainwater tanks (with effective reuse), permeable paving and small-scale raingardens. Potential benefits that could be achieved by a WSUD in the backyard approach include reduced peak flows and runoff volumes and improved water quality.

Implementation of WSUD in the backyard will require community buy-in, in addition to a community awareness and education campaign.

Monitoring of the downstream environment

Given the additional nutrient loads discharging to Gulf St Vincent associated with development of the catchment, it is recommended that the existing downstream estuarine environment be investigated, and ongoing monitoring be undertaken to identify any deleterious impacts that may require mitigation.

Additionally, high concentrations of pollutants, such as nutrients associated with greenhouse activities, originate within the St Kilda precinct. Formalising the trunk drainage within this region will likely mobilise the pollutants, and could result in greater delivery of pollutants to the coastal outlet. This is a risk to the receiving environment, and may require monitoring to quantify impacts. The works could potentially be stages with an monitoring done initially at a small scale. If the monitoring identifies a significant issue, it may be that the mobilisation of pollutants is considered too large an impact and that water in the horticultural areas will need to be retained on site.

5.3 Stormwater harvesting and reuse

Each Council is currently licenced to inject harvested stormwater into the aquifer, and extract it for reuse. The injection limit is set by the EPA while the extraction limit is set by DEW. The GEP and St Kilda catchment area is located within the Northern Adelaide Plains prescribed wells area. Discharging water into a well is subject to the conditions specified in the water allocation plan. The water quality improvement features described in Section 5.2 will ensure that harvested stormwater will be of a suitable quality for injection into the aquifer, even at the downstream catchments.

5.3.1 GEP managed aquifer recharge system

The large central area within the GEP and St Kilda catchment (consisting of the Pellew, Greyhound and Port Wakefield precincts) is approximately 1,100 ha in size. Two large basins are proposed upstream of Port Wakefield Road to reduce the size of infrastructure needed under Port Wakefield Road and under the Northern Connector. The size of the basins in combination with the large upstream contributing catchment mean that this site has the best potential to be a viable water harvesting site. Work undertaken by Australian Groundwater Technologies, as part of the previous GEP Stormwater Management Strategy (Tonkin, 2011), indicated that aquifers in the area are suitable for recharge and that they have adequate capacity for the likely volumes of water that could potentially be harvested from the catchment.

Wallbridge Gilbert Aztec was engaged to determine the present and potential future reliable supply of stormwater that may be sourced annually within the City of Salisbury and the City of Playford, and to identify additional harvesting opportunities. Their report (Wallbridge Gilbert Aztec, 2018) indicates that the proposed Greater Edinburgh Parks managed aquifer recharge system has an estimated reliable supply of 1,090 ML/a. Based on the costs indicated in the report and a 50 year time horizon, the system could potentially harvest water at a cost of $2.20/kL (4.5% discount rate) to return a benefit cost ratio of 1.0. This cost is below the cost of mains water. Treated water from the Bolivar wastewater treatment plant currently services areas within the catchment, including the irrigation of market gardens at Virginia as part of the Virginia Pipeline Scheme. Depending on the desired end use of any additional harvested stormwater, competition between these water supply options may arise.

The proposed concept for the GEP MAR system includes up to 20 ASR bores to achieve a treatment rate of 360 L/s. Development in the region is expected to be slow and during the development there are likely to be potential water quality issues such as turbidity. For this reason, the staging and timing of the MAR construction, establishment, commissioning and operation should be timed accordingly, as the full potential of the scheme will not be achieved until the area is fully developed; the harvestable volumes of water will increase as development increases. Given the proximity of the site to the RAAF base, it should be noted that PFAS may be encountered in the stormwater, which will need to be suitably controlled.

The large basins will also require excavation in an area of relatively shallow groundwater. Over-excavation that would be required to accommodate a wetland in the base may therefore be limited. While a well-constructed and maintained lined wetland is unlikely to be subject to groundwater ingress, the concern is related to the excavation and construction phase, when dewatering would be difficult.

Given the current undeveloped nature of the catchment, there is presently a very limited potential for water harvesting. This strategy can only be implemented once development has started to occur; the harvestable volumes of water will increase as development increases.

5.3.2 Diversion to existing schemes

An alternative to constructing a new ASR scheme would be to divert flows to existing ASR schemes in the adjacent ACHRD catchment. The diversion system would require pumps to divert the flows to a point where they could then gravity feed into schemes further downstream. While it is unlikely that the diversion of flows will impact on the flood risk of the adjacent drainage networks (given the likely relatively small pump discharge rates compared to the capacity of a typical trunk drainage system) the large increase in volume of flow could potentially overload the capacity of the existing scheme (operated by the City of Salisbury). Further analysis would be required to assess this potential impact.

There may also be the opportunity to transfer water internally with the catchment to harvesting schemes that get constructed. The main opportunity for this would be to transfer water from the NEXY South precinct into the Port Wakefield precinct such that it could be harvested by the proposed scheme within the Greyhound basin (refer Section 5.3.1).

5.3.3 Rainwater tank site harvesting

Rainwater tanks also provide alternative means to harvest and reuse stormwater runoff. Rainwater tanks are designed to capture and store rainwater from gutters or downpipes on a building. The large roof areas that are likely to be fairly common within the future industrial areas of the precinct can be harvested by rainwater tanks for on-site reuse. This has the potential to reduce mains water demand.

The MUSIC model outlined in Section 4.2 of this report was amended to incorporate rainwater tanks for a sample site of lumped sub-catchments within the Pellew precinct, as shown in Figure 5.5.

The on-site reuse of water from tanks has been estimated based on the following assumptions:

- Supply will be to toilets and small landscaped areas with demand at 50 L/person/day or 18 kL/person/year.
- Occupancy rates are assumed to be 12 people per hectare (based on projected employment growth) resulting in a demand of 0.6 kL/ha/day.
- Assumed roof area directed to tank is 30% of catchment size.
- Tanks have been sized to be equivalent to 30 kL per hectare of catchment area.

Results of the water balance modelling are shown in Table 5.7.

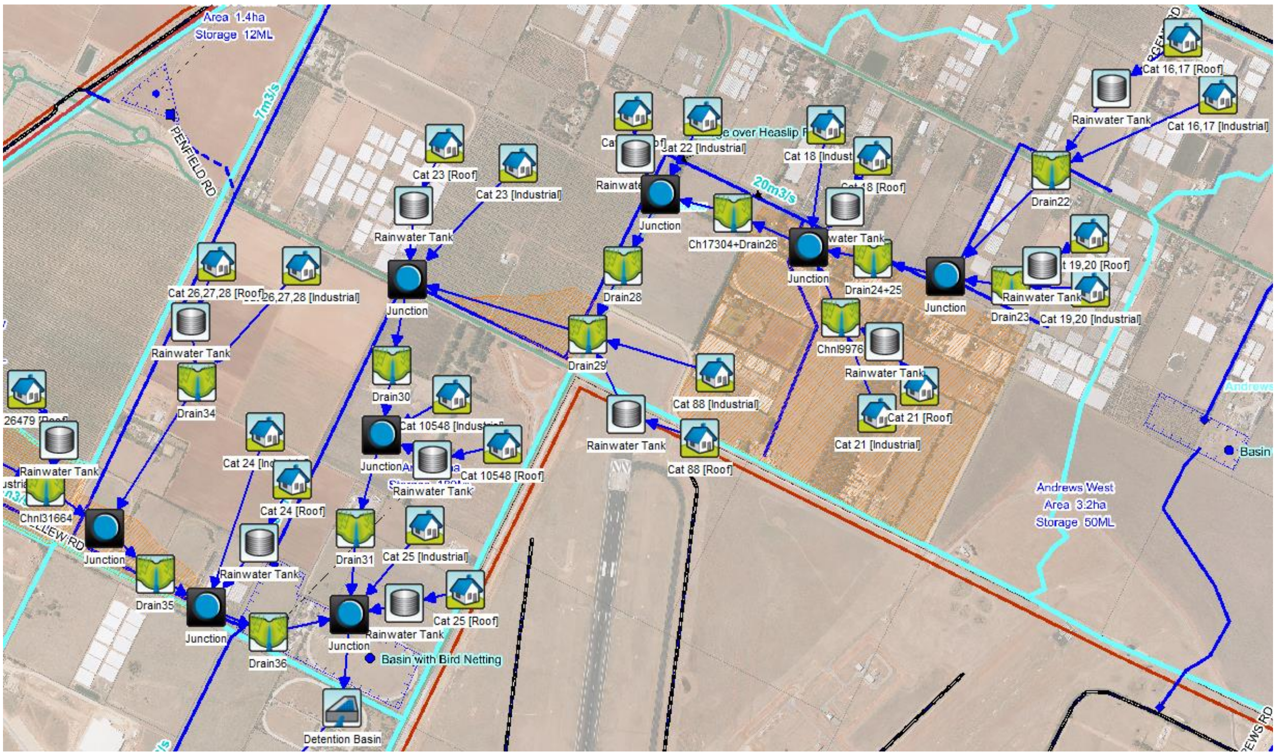


Figure 5.5 MUSIC modelling of Pellew precinct using rainwater tanks for water harvesting

Table 5.7 Modelling results showing the effectiveness of water reuse within the Pellew precinct

Scenario	Current climate			2050			2090		
	Sources	Residual load	Reduction (%)	Sources	Residual load	Reduction (%)	Sources	Residual load	Reduction (%)
Flow (ML/yr) with no water reuse	1230	952	22.6	1090	827	24.1	1000	747	25.3
Flow (ML/yr) with water reuse by rainwater tanks	1230	927	24.6	1090	803	26.3	1000	724	27.6
Difference (%)			2.0			2.2			2.3

The losses for the 'no water reuse' scenario can be attributed to evaporation and infiltration occurring within the channels. The introduction of rainwater tanks on a scale suitable to meet the water demands required for 12 people per hectare resulted in the total runoff discharged from the Pellew precinct decreasing by approximately 2% for each climate scenario.

It is therefore concluded that the yield from the catchment greatly exceeds the expected demand, and hence the uptake of rainwater tanks across the study area will do little to reduce the annual flows leaving the site. This does not discount the importance of rainwater tanks in providing an alternative supply to mains water.

The reuse estimate could be amended if additional reuse opportunities were identified. For example, the use of stormwater as a water supply for evaporative air conditioning would increase the demand across the catchment.

5.3.4 Passive water reuse

Given that only a small fraction of on-site runoff can be captured and reused, the importance of passive water reuse as a mechanism for reducing the total volume of runoff discharged from the catchment is increased. A number of the water quality measures described in Section 5.2.4 will provide passive infiltration close to the location where the runoff is first generated. These measures include:

- Raingardens
- Permeable paving
- Tree pits.

5.4 Environmental enhancement and protection

The recommended strategies for achieving the SMP objectives relating to environmental protection and enhancement are summarised in the following sections.

5.4.1 Utilisation of open space

The establishment of wetlands, swales or detention systems provides an opportunity to increase biodiversity, improved amenity, education and recreation facilities as well as provision of habitat for fauna and water quality treatment. These opportunities for providing enhancements to areas of open space must be considered when implementing the wetlands, swales and basins identified within this SMP.

The strategic use of open space for stormwater management has the potential to secure the long-term use of an area as useable open space. The key opportunity for this strategy is in association with the wetland proposed for the Greyhound Road basin, which could be an opportunity to connect with the local community. The wetland is likely to be a high-profile site due to its proximity to a major transport route.

Green corridors

Additionally, given the long, linear lengths of the proposed drainage system, there is potential to establish green corridors/linear parks along the drainage route. Green corridors contribute to the conservation of urban wildlife and can provide positive effects for human health and climate change adaptation. They could be used for the purposes of transport (walking, cycling) and be landscaped and vegetated with local plant species.

5.4.2 Construction environmental management plan

During design and before construction begins, a construction environmental management plan (CEMP) will be required for new major pieces of drainage infrastructure. The CEMP would need to include mitigation measures for soils (erosion/sediment, contamination, acid sulfate soils), groundwater, pests, vegetation and heritage impacts, including traffic, noise and vibration. A number of specific management plans may be required to address residual risks and key issues. To ensure that appropriate measures to manage potential impacts are implemented, further environmental and heritage assessments will be required. Management measures will need to be developed through a stakeholder engagement process to support the planning, construction and operation stages of the project.

Operational management will include rehabilitation/re-vegetation following construction and any related environmental validation, monitoring and management work, such as routine maintenance to remove weeds and sediment build-up in channels or at discharge points into natural waterways that affect the hydraulic efficiency of the drainage system.

Given the construction works expected to occur as part of the development of the study area, there is an increased risk of sediment loads being transported off-site and deposited into Gulf St Vincent. Soil erosion and drainage management plans (SEDMP) will be required for each site, and these will need to be strictly enforced.

5.4.3 Development control

The swales, wetlands and detention systems outlined within this SMP are critical to the attainment of the water quality improvement targets and amenity and recreation targets. The Council or authority that develops the drainage network and associated infrastructure must consider the requirements for meeting these targets. In order to ensure efforts are made to achieve these targets, development controls, as regulated by the *Development Act 1993*, shall be imposed. The development controls must also detail the obligation of the developers to manage water quality on site.

5.4.4 Protection of coastal assets

Given the proposed coastal outfall associated with construction of the major trunk drain, it is important that consideration is given to the impacts of the increased flow rate on the environment near the outlet. Priority should be given to protection of the coast by limiting the flow rates of runoff generated within the catchment from frequent rainfall events; this will reduce velocities and limit the occurrence of pollutant flows reaching the coast.

A future study should be undertaken to consider in more detail the likelihood of pollutants entering and causing damage to the coastal environment. The study should include a risk assessment with identification of mitigation measures.

5.5 Asset management

A number of recommendations of this SMP include infrastructure that will require regular maintenance to ensure that it will continue to function as intended. It is recommended that the City of Playford and City of Salisbury develop maintenance plans to cover the long-term management of their drainage assets, particularly the assets that have a high maintenance frequency. These plans would be expected to align with each Council’s existing asset management plans, and would need to include the following key areas:

- The location and description of the asset.
- The likely frequency (or event trigger such as a heavy rainfall event) that maintenance will be required.
- The type of maintenance that will be required (e.g. removal of silt, weeding, etc.).
- Each Council will also need to allow for adequate resourcing and budgets to maintain the additional infrastructure that may be constructed as part of the implementation of the recommendations of this SMP.

Given that the assets will be new, there is an opportunity for the management of stormwater infrastructure to be underpinned with a focus on sustainable practices. For example, the detailed design of all assets should consider the impacts of a changing climate; assets with a long design life are more likely to be impacted by climate change.

The inspection/maintenance requirements recommended by the Department of Planning and Local Government (2010) for a number of measures are outlined below.

Gross pollutant traps

The main environmental issues with GPTs are associated with:

- Long-term storage of pollutants that may be remobilised or cause odour.
- Limitations on the disposal of the trapped material.

Maintenance of an in-ground GPT involves lifting an access lid and removing collected pollutants manually or with a vacuum system. For GPTs treating large catchment areas (as would be required for the GEP and St Kilda catchment), eWater (2011) price guidelines indicate that maintenance costs in the order of $6,000/year per GPT would be expected.

Removal of pollutants from a trash rack or net system is often undertaken manually, but collection can also be undertaken using large excavators or a crane.

Disposal of waste should be undertaken in accordance with the requirements of the *Environment Protection Act 1993*. The maintenance program should allow for the costs of collection, transport and delivery of captured gross pollutants to an appropriate waste disposal facility. The nature of collected pollutants can determine their suitability for disposal.

Open vegetated channels

Regular inspections and maintenance are required during the establishment period of channels. Typical maintenance will involve:

- Routine inspection of the channel profile to identify any areas of obvious increased sediment deposition, or scouring of the swale invert from a storm.
- Routine inspection of the channel profile to identify any damage from vehicles.
- Routine inspection of channel batters to identify any rill erosion caused by lateral inflows.
- Routine inspection to identify any areas of scour, litter build up or blockages.
- Removal of sediment where it is impeding the conveyance of the channel and/or smothering the channel vegetation and, if necessary, reprofiling of the channel and revegetating to original design specification.
- Mowing of turf or slashing of vegetation to preserve the vegetation design height.
- Removal of blockages (including woody weeds).

Annual channel maintenance costs are estimated to be in the order of $0.023/m^2 (following recommendations within the MUSIC manual (eWater, 2011)) on the assumption that the only maintenance will be to mow / slash the channels once per year ($25,000/yr). Significant additional expenditure could occur if there is more extensive maintenance such as periodic inspections, grass maintenance, litter removal and revegetation.

Sedimentation basins

Typical maintenance of sedimentation basins will involve:

- Routine inspection of the sedimentation basin to identify depth of sediment accumulation, damage to vegetation, scouring, or litter and debris build up (after the first three significant storm events and then at least every three months).
- Routine inspection of inlet and outlet points to identify any areas of scour, litter build up and blockages.
- Removal of litter and debris.
- Removal and management of invasive weeds (both terrestrial and aquatic).
- Periodic (usually every five years) draining and desilting, which will require excavation and dewatering of removed sediment (and disposal to an approved location).
- Regular watering of littoral vegetation during plant establishment.
- Replacement of plants that have died (from any cause) with plants of equivalent size and species.
- Inspections are also recommended following large storm events to check for scour and damage.

Landscaped areas

For landscaped areas, the following items should be inspected:

- Signs of plant moisture stress.
- Dead or damaged vegetation.
- Weed infestation.
- Signs of surface erosion and scouring.

The following maintenance activities should be undertaken:

- Repair/replace any damaged vegetation.
- Reapply or apply mulch litter.
- Watering.
- Repair surface erosion and scouring.

Rainwater tanks

For rainwater tanks, the following items should be inspected:

- Clogging and blockage of the first flush device.
- Clogging and blockage of the tank inlet leaf/litter screen.
- Depth of sediment within the tank.

The following maintenance activities should be undertaken:

- First flush device to be cleaned out.
- Leaves and debris to be removed from the inlet leaf/litter screen.
- Leaves and debris removed from roof gutters.
- Sediment and debris removed from rainwater tank floor.

Annual maintenance costs incurred for a domestic-sized rainwater tank are estimated to be $70/year.

Urban water harvesting and reuse

Appropriate maintenance of urban water harvesting and reuse schemes is important to ensure that the scheme continues to meet its design objectives in the long-term and does not present public health or environmental risks.

Protection from contamination is a necessary part of designing an urban water harvesting and reuse system. This includes constructing treatment systems away from flood prone land, taking care with or avoiding the use of herbicides and pesticides within the surrounding catchment, planting non-deciduous vegetation, and preventing mosquitoes and other pests breeding in storage ponds.

Contingency plans should be developed to cater for the possibility of contaminated water being inadvertently utilised. These plans should focus on:

- Determining the duration of recovery pumping required (to extract contaminated water).
- Sampling intervals required.
- Managing recovered water.

Regular inspections of a scheme are needed to identify any defects or additional maintenance required. The inspections may need to include:

- Storages for the presence of cyanobacteria (i.e. algae), particularly during warmer months.
- Spillways and creeks downstream of any on-line storage after a major storm for any erosion.
- Water treatment systems.
- Distributions systems for faults (e.g. broken pipes).
- Irrigation areas for signs of erosion, under watering, waterlogging or surface runoff.

5.6 Safety in design

Safety in design best practice involves identifying any hazards that could be eliminated or reduced through changes in design.

A safety in design register associated with the design and construction of the stormwater management strategies detailed in this report is included in Appendix F.

6 Climate change impact assessment

The existing GEP DRAINS model was updated for both the 2050 and 2090 climate change scenarios, using projected increases in rainfall intensity of 9% and 17%, respectively. The infrastructure required to accommodate runoff from each of these scenarios, compared to the existing scenario with no increased rainfall intensity, is summarised in the following sections.

6.1.1 Basin sizes

Basin sizes were identified by iteratively increasing the capacity until the peak water levels in each basin closely matched those of the base model. This ensures that the same freeboard allowances (at least 300 mm) are provided for each scenario. The area (i.e. basin footprint), and hence volume was adjusted for each basin, however the basin slopes and depth remained unchanged. The updated basin sizes are included in Table 6.1. Given that the peak outlet rates are fixed, the volumes increase quite significantly.

Table 6.1 Increases in basin area and volume for the 2050 and 2090 climate change scenarios

	Base		2050			2090		
Basin	**Surface area (m^2)**	**Volume (m^3)**	**% increase from base**	**Surface area (m^2)**	**Volume (m^3)**	**% increase from base**	**Surface area (m^2)**	**Volume (m^3)**
Pellew	96,000	180,000	25	120,000	225,000	45	139,000	261,000
NEXY South*	86,000	100,000	10	95,000	110,000	30	124,000	143,000
Greyhound	145,000	306,000	10	160,000	337,000	30	189,000	398,000
Port Wakefield	44,000	96,000	30	57,000	125,000	64	72,000	156,000
Total	352,000	653,000		411,000	761,000		487,000	903,000

*Assumes the gravity discharge option with a basin outflow of 1 m^3/s.

6.1.2 Culverts

As with the basin sizing, the determination of additional culvert requirements was undertaken using an iterative procedure. The adopted approach focused on increasing the number of identical parallel culverts, rather than altering the dimensions of the culverts which have already been sized.

For the 2050 scenario, it was found that the culvert capacity was insufficient at eight locations. For each of these instances, increasing the number of culverts within the run by one was sufficient to accommodate the additional flows. As such, a total of eight additional culverts are required for this scenario.

The 2090 scenario demonstrated additional deficiencies, with the number of locations exhibiting insufficient capacity increasing to eleven. Either one or two additional culverts were required at each of these locations to ensure the system has capacity to convey the increased flows.

6.1.3 Channel widths

Where the models indicated that a channel had insufficient capacity to accommodate the additional flows arising from the climate change scenarios, the width of the channel was progressively increased.

A total of four channels required widening for the 2050 scenario. These channels are located downstream towards the outlet, occurring in series, and require widening from 7 m to either 10 m or 15 m. Based on the existing length and depth of the channels, the additional volume of excavation (compared to the base scenario) needed to widen the channels was calculated to be 5,700 m^3 (an increase of 0.4%).

The 2090 model identified nine channels that needed widening. These include the four channels for the 2050 scenario, as well as five channels at the upstream end that require widening from 5 m to 7 m. The additional volume of earthworks (compared to the base scenario) associated with widening these channels is approximately 15,550 m^3 (an increase of 1.1%).

6.1.4 Cost estimate associated with climate change

In order to quantify the cost increase associated with the results of the climate change modelling, a unit rate for excavation works of $21.55/$m^3$ was assumed. On this basis, earthworks to accommodate the basin volumes for the 2050 scenario would cost an additional $3.5 million, while the 2090 scenario would cost an additional $8.1 million.

Based on the existing culvert sizes and lengths, the supply and installation of eight extra culverts associated with the 2050 scenario is anticipated to cost an additional $430,000. The additional culverts for the 2090 scenario are estimated to cost $800,000.

Using the unit rate for excavation works of $21.55/$m^3$, the additional costs associated with widening the channels for each climate change scenario are approximately $155,000 and $420,000, respectively.

The additional costs are summarised in Table 6.2. Cost estimates for several items (such as the bridge over the stormwater channel within the Pellew precinct) are not expected to be influenced significantly by climate change. These are incorporated within Table 6.2 as 'other items'.

Table 6.2 Cost estimates associated with climate change scenarios

	Initial estimate	Estimate for 2050 scenario	% Increase from initial	Estimate for 2090 scenario	% Increase from initial
Basin excavation	$21,184,000	$24,698,000	16.6%	$29,318,000	38.4%
Culverts	$8,030,000	$8,463,000	5.4%	$8,834,000	10.0%
Channel excavation	$51,388,000	$51,444,000	0.1%	$51,810,000	0.8%
Other items	$6,380,000	$6,380,000	-	$6,380,000	-
Sub-total (includes 10% preliminaries)	$95,680,000	$100,083,000	4.6	$105,976,000	10.8
Total (includes 20% contingency)	**$114,816,000**	**$120,100,000**	4.6%	**$127,171,000**	10.8%

7 Priorities, costings, responsibilities and consultation

7.1 Assessment of priorities

The priorities for the flood mitigation works have been determined based on their location relative to the trunk outfall. Works located at the downstream end of the trunk drain have been given a higher priority, as their completion will allow works further upstream to begin.

For the remaining works (i.e. non-flood mitigation works), ranking of priorities was undertaken using a multi-criteria assessment with consideration of the following criteria:

- Flood protection of development
- Runoff quality and impact on receiving environment
- Beneficial use of stormwater
- Social values
- Environmental benefit
- Economics

A summary of the multi-criteria assessment, including criteria weightings and overall results, is provided in Appendix G. The strategies outlined in this stormwater management plan will require implementation to be scheduled across many years, and the timing will be prioritised according to development needs, economic development benefits/opportunities to be realised and funding constraints.

7.2 Priorities for flood mitigation works

7.2.1 Priority F1 (high priority): St Kilda precinct trunk drainage

Trunk drainage infrastructure in the St Kilda precinct is the highest priority as it locks into place the main outfall works for the bulk of the catchment. Once it is completed it will unlock the potential for development in both the Greyhound and Port Wakefield precincts.

Some elements of the St Kilda precinct works could be deferred, such as the lateral drain that would serve the horticultural areas within the precinct (typically north of St Kilda Road).

7.2.2 Priority F2 (high priority): Greyhound precinct trunk drainage and detention storage

Development pressures within the Greyhound precinct are significant with a number of large developments currently proposed in the area. Once the trunk drainage system is constructed in this precinct it will give these developments something to discharge into which would prevent them having to provide significant amounts of on-site retention storage.

The main detention basin in the precinct could potentially be excavated in stages, as development proceeds in the catchment, to defer costs.

This system will rely on the completion of the trunk drain in the St Kilda precinct. It also needs to be in place such that the network can be extended north of the freight line into the Pellew precinct.

7.2.3 Priority F3 (high priority): Port Wakefield trunk drainage and detention storage

This region is likely to be attractive to developers and will also rely on the completion of the St Kilda trunk drain. This system may be relied upon by the NEXY South precinct, if that precinct utilises a pumped system to remove water from the NEXY South basin.

Similarly to the Greyhound precinct basin, the main detention basin in the precinct could potentially be excavated in stages to defer costs.

Once the above high priority works are completed it will have ‘unlocked’ development within the majority of the GEP and St Kilda catchment, from a drainage perspective.

7.2.4 Priority F4 (high priority): Education and awareness

For a relatively modest investment, a public education programme that raises awareness of flood risk and provides information to individuals and businesses that guides their response to floods can reduce flood damages. Increased public awareness of flooding allows a more effective response to flooding and has been demonstrated to result in lower damages. There is also the potential to educate the community about managing the quality of stormwater by changing their behaviours.

The community would also need to be informed about the potential for large scale capital works in the catchment and how they may be impacted by this (e.g. noise, traffic management etc.).

7.2.5 Priority F5 (medium priority): Pellew precinct trunk drainage and detention storage

The Pellew precinct will rely on the completion of trunk drains in both the St Kilda and Greyhound precincts before it has an outlet to connect into. A large basin at the downstream end of the precinct is the key component to ensure that the capacity of the existing cross drains under the freight line are not exceeded. No other precincts rely on drainage in the Pellew precinct as it is at the upstream end of the catchment. Based on constraints imposed by the RAAF site, it may not be viable to develop some portions of the Pellew precinct.

7.2.6 Priority F6 (medium priority): Symes precinct trunk drainage

The Symes precinct is isolated and not reliant on infrastructure within other precincts and therefore works could proceed based on demand for development within the precinct (likely to be in the form of hot house intensification) or as opportunities arise (such as at the naval facility west of Coleman Road). Due to significant capacity restrictions at the outlet of the catchment, the precinct will rely on development incorporating on-site detention systems. Further assessment should be undertaken to assess the viability of closing Brooks Road and constructing a new outfall channel along it, discharging to the existing syphon under the Bolivar outfall channel.

There is potential for the NEXY South precinct to capitalise on a new northern drain within the Symes precinct. If this gravity outfall drain was in place within the Symes precinct, the NEXY South precinct would not rely on having to either retain water on-site or pump water out to the major outfall channel along Jarmyn Road within the adjacent Port Wakefield precinct.

7.2.7 Priority F7 (medium priority): NEXY South precinct drainage and detention storage

The NEXY South precinct is a stand-alone precinct and either relies on the completion of the northern drain in the Symes Precinct or the trunk drain in the Port Wakefield precinct before it has an outlet.

The main detention basin in the precinct could potentially be excavated in stages to defer costs and initially could just be an infiltration system (which would not rely on any external drainage systems).

7.2.8 Priority F8 (medium priority): Review of Planning and Design Code

Review of the Planning and Design Code should be undertaken to assess its limitations in relation to flood controls.

7.3 Priorities for water reuse

7.3.1 Priority R1 (medium): Greyhound precinct MAR scheme

The major water harvesting scheme within the Greyhound precinct would only be viable once there is a large amount of upstream development to provide large volumes of water to be harvested. There is also the potential to progressively increase the size of the scheme to match the amount of development.

Discharging water into a well at this location is subject to the conditions specified in the Northern Adelaide Plains water allocation plan. The requirements of the plan are not expected to impact on the ability to implement this priority.

7.3.2 Priority R2 (low): Rainwater tank site harvesting

While the incorporation of rainwater tanks within future industrial areas will reduce the potable water demand, the yield from the catchment greatly exceeds the expected demand, and hence the uptake of rainwater tanks across the study area will do little to reduce the annual flows leaving the site.

7.4 Priorities for water quality

7.4.1 Priority Q1 (high priority): Greyhound and NEXY South wetlands

Wetlands within the base of the Greyhound and NEXY South basins should be incorporated. This will further improve the quality of runoff discharged from the basins.

7.4.2 Priority Q2 (medium priority): Raingardens

Currently there are very few roads with kerbs in the catchment. The majority of road runoff therefore drains along the roadside verges. There is also little directly connected catchment to the roads. However, as development proceeds it is likely that new kerbed roads will be installed to service the new industrial areas. As a part of these works raingardens should be incorporated into the road designs.

7.4.3 Priority Q3 (medium priority): Gross pollutant traps

The recommended location for GPTs is on the larger lateral drains before they discharge into the trunk drainage system. These drains can only be constructed once the trunk drainage system is in place.

7.4.4 Priority Q4 (medium priority): WSUD in the backyard

Council should work with Water Sensitive SA to promote the concept of WSUD in the backyard. Activities may include the preparation of information materials and periodic publicity to encourage residents to take action at a domestic scale which will improve water quality.

7.4.5 Priority Q5 (medium priority): Infiltration systems

Installation of infrastructure such as permeable paving and tree pits will allow stormwater to infiltrate into the soil. This can help to passively irrigate street trees and other landscaped areas. These systems should become a required component of all new road projects.

7.5 Priorities for environmental protection and enhancement

7.5.1 Priority E1 (medium priority): Utilisation of open space

Opportunities for providing enhancements to areas of open space must be considered when implementing the wetlands, swales and basins identified within this SMP.

7.5.2 Priority E2 (medium priority): Protection of coastal assets study

A study should be undertaken to consider in more detail the likelihood of pollutants entering and causing damage to the coastal environment. The study should include a risk assessment with identification of mitigation measures.

7.6 Priorities for asset management

7.6.1 Priority A1 (medium priority): Asset inspection program

Physical inspections of assets should be undertaken. Priority should be given to assets where failure could result in significant damages or reductions in water quality. An asset condition database with an inspection program should be undertaken.

7.7 Other priorities

7.7.1 Priority O1 (high priority): Land acquisition

For the stormwater management strategy to be implemented successfully, each Council will need to ensure that the acquisition of private property or creation of easements at key locations is undertaken in a timely manner. Key locations include:

- A continuous string of properties along the alignment of the trunk drainage system with a particular emphasis at the following locations:
  - Through Defence land at the downstream end of the St Kilda precinct.
  - Along the eastern and western sides of Greyhound and Jarmyn Road.
- At the major detention basin locations in the Greyhound, Port Wakefield, NEXY South and Pellew precincts.

7.7.2 Priority O2 (high priority): Groundwater testing at key locations

Shallow groundwater has the potential to significantly impact on the maximum depth and therefore size of some of the key elements of the drainage scheme, particularly towards the western end of the catchment. It is recommended that some continuous monitoring of groundwater levels at key locations commences to determine how much of a risk shallow groundwater poses. It may impact on the viability of incorporating a wetland and harvesting water from the catchment at the proposed Greyhound basin.

7.8 Proportion of the catchment that can be developed

Within the GEP and St Kilda catchment there will be areas that cannot be developed as the land is already part of a road reserve (total area determined based on existing cadastre data), or it is land that will be used as a drainage reserve (land required for channels or basins). A minor proportion of land will be both within a road reserve and within a drainage reserve. To prevent double accounting for these areas, they have been removed. The assumed reductions in the amount of developable land are summarised in Table 7.1, which indicates that approximately 88% of the study area is currently developable.

Table 7.1 Proportion of catchment that can be developed

Component	Hectares	Proportion of study area
Total study area size	2,362	100%
Area used for drainage reserves	187	7.9%
Area within road reserves	109	4.6%
Area within both drainage reserves and road reserves	(9)	(0.4%)

Component	Hectares	Proportion of study area
Total developable proportion	**2,075**	**88.0%**

7.9 Trunk drainage infrastructure costs

The DRAINS modelling undertaken as part of this project has been utilised to generate quantities to determine a cost estimate for the trunk drainage works, as outlined previously in the climate change analysis in Section 6.1.4. A detailed breakdown of the costs associated with each precinct for the 2050 climate change scenario is provided in this section. The main components that have been costed are:

- Open channels
- Basins
- Road culvert crossings

The total cost for each of the 6 precincts is shown in Table 7.2. The average cost per hectare (weighted by area) is $56,000. The costs include 10% preliminaries, a 20% contingency and allow for only 88% of the areas (as per Table 7.1) being developable. No specific allowance has been made for service relocation costs which could potentially be significant but would be very difficult to quantify accurately. Costing assumptions and qualifications have been provided in Appendix H.

Table 7.2 Total precinct costs

Precinct	Area (ha)	Developable land (ha)	Total cost ($ million)	Cost per hectare ($)
Pellew	397	349	$29.6	$85,000
Greyhound	482	424	$27.8	$66,000
Port Wakefield	248	218	$16.3	$75,000
St Kilda	570	502	$22.8	$45,000
NEXY South	175	154	$6.7	$44,000
Symes	489	430	$16.9	$31,000

The breakdown of total costs is shown in Table 7.3, with a summary of the costs per precinct provided in Appendix I. The costs include 10% preliminaries and 20% contingencies.

Table 7.3 Total costs

Component	Land acquisition component ($ million)	Civil works component ($ million)	Total ($ million)
Open channels	$27.0	$40.9	$67.9
Basins	$6.5	$26.1	$32.6
Pipes / culverts / concrete structures / bridges / outlet structures	$0	$19.6	$19.6
Total	**$33.5**	**$86.6**	**$120.1**

The total costs are relatively sensitive to a number of key unit rates that have been used for the costing exercise. These are shown in Table 7.4.

Table 7.4 Key unit rates

Component	Rate	10% preliminaries	20% contingency	Compensation / budget rate
Channel and basin excavation (cut to spoil)	$21.55/m^3$	$2.16	$4.74	$28.45/m^3$
Culverts (size and number dependent)	$2,000-$2,500/m	$200-$250	$440-$550	$2,640-$3,300/m
Land acquisition	$12/m^2$	$1.20	$2.64	$15.84/m^2$

7.10 Other costs

Greyhound precinct MAR scheme

A report undertaken by WGA as a part of this study (Wallbridge Gilbert Aztec, 2018) indicated that the capital cost estimate to build a harvesting scheme was $31.7 million with an annual operating cost of $0.81 million. This makes provision for a treatment system, such that the water is at a quality that it can be recharged.

Raingardens

Construction and establishment costs are estimated to be $63,000 per raingarden, with annual maintenance costs in the order of $300.

Gross pollutant traps

The supply and installation of GPTs is expected to cost in the order of $120,000 per GPT, servicing a contributing catchment with an area of up to 80 hectares. Annual maintenance costs are estimated to be around $7,000 per GPT.

Permeable paving

Melbourne Water (2012) estimates that porous engineering paving is likely to cost between $100-$120 per m^2.

Tree pits

The City of Melbourne (2015) estimates that tree pits cost between $4,000 and $8,000 per tree.

WSUD in the backyard

A program to raise community awareness about WSUD in the backyard will require time and effort to promote. The expenses incurred may include preparation of materials, articles in the News Review Messenger, community presentations and liaison with developers. It is estimated that the cost of this will be $20,000 in the first year, with ongoing annual costs of $10,000.

7.11 Cost sharing framework

7.11.1 GEP central catchment

A large portion of GEP relies on the same final outfall drain on the western side of Port Wakefield Road and it is considered that the areas contributing to this drain make a logical grouping, both in terms of cost sharing and for the establishment of an integrated central spine to the GEP drainage scheme. The larger combined catchment includes the following precincts:

- Pellew
- Greyhound
- Port Wakefield
- St Kilda

The combined infrastructure cost for these four precincts is estimated to be $96.5 million (for the 2050 climate change scenario). These precincts collectively cover an area of 1,697 hectares. If the total cost is equitably distributed across the developable area of this combined catchment, the total amount comes to $64,600/ha, as summarised within Table 7.5.

Table 7.5 Contribution rate for central catchment

Component	Hectares
Total catchment size	1,697
Maximum developable area (88% of area, as derived within Table 7.1)	1,493
Combined total cost	$96,500,000
Contribution rate of developable land (per hectare)	$64,600

7.11.2 Cost sharing between landholders within a precinct

To provide an equitable contribution from various landholders for the implementation of the trunk stormwater infrastructure, all land owners within a precinct or group of precincts will need to contribute to the upfront capital cost of the infrastructure. The initial cost also needs to allow for the value of land. Each land owner would then receive a rebate or offset (if applicable) based on the amount of land they have had to give up as part of implementing the regional drainage scheme. Some developers who have to give up land for regional drainage infrastructure could also potentially opt to construct the infrastructure within their land. The value of these capital works could be an additional offset for the developer.

A simplified equitable example of this framework is shown within Table 7.6 based on three lots, with a total area of 200 hectares having to contribute to a theoretical total capital cost of works of $12 million which comprises $10.1 million of capital works and $1.9 million of land acquisition. It is assumed that the lots contain no existing road reserves and that land has a compensation rate of $158,400 per hectare. The example shows that Lot 1 would receive an offset for both giving up land and opting to construct the regional infrastructure within their land. Lot 2 has no regional infrastructure within their land and has to pay the full contribution amount.

It is likely that land holders further upstream in the catchment will give up the least land and therefore have to provide the largest contribution. Some land owners, particularly ones where regional basins are proposed, could potentially receive money due to the value of the land given up exceeding their proportional contribution, such as Lot 3 within Table 7.6.

Table 7.6 Equitable cost sharing example

Lot	Lot size (ha)	Land given up for regional drainage infrastructure (ha)	Developable area (ha)	Contribution to total cost ($ million)	Land offset amount ($ million)	Capital works offset ($ million)	Total net contribution ($ million)
1	100	4	96	$6.13	$0.63	$1.00	$4.49

Lot	Lot size (ha)	Land given up for regional drainage infrastructure (ha)	Developable area (ha)	Contribution to total cost ($ million)	Land offset amount ($ million)	Capital works offset ($ million)	Total net contribution ($ million)
2	80	0	80	$5.11	nil	nil	$5.11
3	20	8	12	$0.76	$1.27	nil	-$0.50
Total	**200**	**12**	**188**	**$12.0**	**$1.9**	**$1.0**	**$9.1**

7.11.3 Cost sharing between Councils within the overall GEP area

Of these six precincts within the GEP and St Kilda catchment, four straddle the Council boundary between the City of Playford and the City of Salisbury. Councils will work together to facilitate the funding and implementation of the works.

Capital expenditure will be required to undertake engineering investigations, design and costings. This will provide the necessary technical information to support certain aspects of the Code Amendments, in particular the details around land acquisition requirements and infrastructure developer contributions. While the expenditure on investigations will generally be shared between Playford and Salisbury Councils, there may be changes to this if there are Council-specific interests.

Capital expenditure associated with the construction of the drainage infrastructure may be funded from other sources (outlined in Section 7.14), however the predominant source of funding will be via developer infrastructure contributions. As shown in Table 7.7, the funding apportioned to each Council area varies for each component of the drainage system and while figures in Table 7.7 are considered a starting point, the finalised cost sharing proportions will be guided by the SMA Guidelines.

Table 7.7 Cost sharing arrangement based on catchment area within each Council

Precinct	Total precinct size (ha)	City of Salisbury contribution (%)	City of Playford contribution (%)
Pellew	397	0	100
Greyhound	482	25	75
Port Wakefield	248	9	91
St Kilda	570	79	21
Symes	489	5	95
NEXY South	175	0	100

7.12 Timing issues

Ideally trunk drainage works will need to be in place within each precinct prior to development occurring, as without it, each site is likely to have to provide large retention basins. Therefore, the cost of the works will have been incurred before land can be developed. While land owners will potentially have gained a benefit by both having their land rezoned as industrial as well as being provided with a trunk drainage system that they can connect into, they will not necessarily have obtained any income from this. Therefore, they may not have the available resources to fund their contribution towards the trunk drainage system, particularly if they maintain their land in its undeveloped form.

The land owners or developers may not have sufficient capital to fund the external drainage works until the land is subdivided and sold. Therefore, each Council is likely to have to initially fund the trunk drainage works and then recoup the expenditure, based on the agreed cost sharing framework, once the site is developed.

7.13 Deferring costs

Some capital expenditure could potentially be deferred until it is required. Infrastructure to serve some of the smaller precincts could be deferred indefinitely until the first development occurs in the area. The construction of regional basins could be staged such that their size matches the amount of upstream development. The upper reaches of trunk drainage channels could also be deferred until development is proposed upstream of them. The water harvesting scheme within the Greyhound basin could also easily be deferred, until there is enough upstream catchment to make a scheme viable.

However, a number of elements cannot easily be deferred, which include the construction of the downstream open channels and the associated land acquisition and the main road culvert crossings.

7.14 Funding opportunities

The strategies and projects identified in the SMP are regional solutions and the funding required for implementation is significant. The approach to augmentation of the drainage scheme is important and a significant number of large projects along the lower section of the trunk main require implementation before major development of the catchment can commence. These projects will require substantial funding and there will be a need for external funding and partnerships with stakeholders.

7.14.1 Stormwater Management Authority

Stormwater management projects within catchments that have an area greater than 40 ha and are part of an endorsed SMP are eligible for SMA funding. The SMA typically prioritise funding towards schemes that provide a wide range of benefits including water quality and reuse. Given the large-scale strategies detailed within this SMP, it is recommended that SMA funding be sought.

7.14.2 Green Adelaide

The Green Adelaide board may provide funding that can be used to help support measures that will benefit natural resources management, including actions which improve the quality of water within the study area or that will facilitate an increase in stormwater reuse. The Board could potentially help to co-fund some of the works recommended as part of the SMP or provide in-kind support.

7.14.3 Developer contribution

Council is unlikely to make large capital investments in development without a guaranteed return from developer contributions in the short term. As has already occurred within the catchment, each Council will be able to request a stormwater infrastructure charge as a part of any development. Table 7.2 and Table 7.5 provide a guide as to how much should be collected to go towards the implementation of the regional drainage scheme for the catchment.

Developers may also contribute land to the overall scheme which would reduce the amount of their contribution and reduce land acquisition costs for Council.

7.14.4 Balance of cut and fill materials

The major capital works will result in the creation of extensive amounts of cut. If material is sought by developers, there may be the opportunity for developers to excavate this material at low or no cost if they are able to utilise it for their own projects. It is likely that large areas in the catchment will require site filling such that drainage to the proposed trunk outfalls can be achieved via gravity.

7.15 Timeframes

Construction of the trunk drainage system within the GEP and St Kilda catchment will require considerable expenditure and will need to be staged over a number of years to enable budgeting for the works to fit in with other Council priorities and to coincide with the rate of development within the catchment.

Table 7.9 presents a 10-year capital works plan to implement the recommendations within this report. The plan suggests a total expenditure of approximately $6.0-7.0 million per year and is based on completing all of the high priority works in the catchment within 10 years (which would unlock development potential for the majority of the catchment). This will either require developer contributions equivalent to about 100 ha per year or significant borrowing of funds. It is likely to be possible to initially build a smaller scheme that defers a lot of the costs, but still provides some form of outlet for development.

Given the scale of the project almost all of the works would potentially be SMA eligible. However, no allowance has been made for funding from the SMA in the capital works plan and the magnitude of the costs is likely to be well above what they could contribute towards.

Council undertakes operational and renewal stormwater works on an annual basis which forms part of Council's Four Year Delivery Plan and Annual Business Plan. At the time of preparing this report these works were determined to have an estimated cost of $67 million. The projects identified in the SMP are regional solutions that would need to be considered on a project-by-project basis and considered against other priorities within the annual budgeting cycle. The projects outlined above require a considerable expenditure and will need to be staged over several years and aligned with Council budget cycles. The timeframes outlined in this report are approximate and subject to Council's budget cycle and may be influenced by the timing of external funding opportunities.

7.16 Responsibilities

The GEP and St Kilda SMP provides a framework for the management of stormwater within the catchment. The Steering Committee which has overseen the development of the SMP comprises representatives from key stakeholder organisations that have responsibility for implementing the plan. These include the City of Playford, City of Salisbury, and representatives of the SMA. The projects outlined above require a considerable expenditure and will need to be staged over several years with consideration given to Council's priorities and long-term financial plans, noting external funding opportunities may influence timing.

Both Councils will also be required to play an important role in implementing water quality management within the catchment.

Based on the total cost of all of the works, and assuming a total budget of $7.0 million per year, it is estimated that it would take approximately 20 years to complete the implementation of all recommended works.

7.17 Consultation

The objectives of stakeholder consultation for the SMP are to:

- Communicate the SMP and its aims to stakeholders.
- Obtain stakeholder input to the SMP, specifically the identification of key stormwater management issues and opportunities.
- Obtain stakeholder feedback on structural and non-structural stormwater management measures developed for the SMP.

In addition to the relevant local governments (City of Playford and City of Salisbury), the following state government agencies have been identified as key stakeholders: SA Water, Department of Planning, Transport and Infrastructure, Department for Environment and Water, Coast Protection Board, Environment Protection Authority, Department of Primary Industries and Regions South Australia, Department of State Development. Additionally, consultation for the broader community will also be required.

Consultation on this SMP will be undertaken to inform the identified stakeholders about issues that may affect them. This is proposed through the following tasks:

- Development of a media release to be published on each Council's website.
- Advertisement in the local Messenger.
- Display of the draft SMP at Council libraries and offices.
- Letter or leaflet to landholders that may be affected by proposed management actions, informing them of the recommendations of the SMP and opportunities for feedback.
- Development of feedback forms.

7.17.1 Consultation undertaken to date

An initial stakeholder workshop was undertaken at the Tonkin office in October 2017. It covered both this catchment and the adjacent Adams Creek / Helps Road drain catchment with almost 70 issues and opportunities identified. Details of this workshop are included in Appendix J. The key SMP outcomes were voted on with the three most important being:

- Planning and development.
- Funding and costs.
- Receiving environments.

A meeting between the City of Playford and Kaurna representatives was held on 3 May 2019. It was recommended that a formal principles-based agreement (e.g. a memorandum of understanding) regarding Kaurna involvement in the SMP implementation and future reviews should be established. This is to ensure that, as the traditional owners of the Adelaide Plains, Kaurna values are respectfully recognised in the strategies included in the SMP.

7.17.2 Public consultation

A 28-day public consultation on the draft SMPs took place from 7 April 2022 to 9 May 2022 in accordance with the City of Playford Community Engagement Policy and Procedure.

The objective of the community engagement for the SMPs was to:

- **Inform** the wider community about the draft SMPs and build awareness of their role in guiding future decisions related to stormwater management.
- **Consult** the community on the draft SMPs, seeking views on the objectives of each SMP which have informed the priorities.

Through the public consultation process the wider community were informed about the draft SMPs and their role in guiding future decisions and investment related to stormwater management. A copy of the feedback received during this consultation period can be found in the What We Heard Report (Appendix K). Following review of the limited feedback received, it is considered that no further changes are required to the plan.

7.18 Summary of priorities

The summary of priorities is provided in Table 7.8.

Table 7.8 Summary of priorities

					Flood Mitigation Benefit		Water Harvesting Benefit		Water Quality Benefit		Other Benefits	
Priority	Project/ Activity Title	Capital Cost ($)	SMA Funding Eligible	Recurrent Cost ($ / annum)	Measure used?	Quantification or Description of Benefit	Measure used?	Quantification or Description of Benefit	Rating	Qualitative Description of Benefit	Rating	Qualitative Description of Benefit
					(D) – AAD Reduction (P) – Properties Affected (Q) – Qualitative		(V) Volumetric (Q) Qualitative		(H) – High (M) – Med (L) – Low		(H) – High (M) – Med (L) – Low	
O1 – High	Land acquisition plan	Incorporated in precinct costs	Y	Unspecified	-	-	-	-	-	-	H	Provides security that the drainage scheme can be built
O2 – High	Groundwater testing	$50,000	N	$5,000	Q	Provides guidance as to what can be built	Q	May impact on where a harvesting scheme can be located	-	May impact on what basins can have wetlands incorporated into them		
F4 – High	Education and awareness	$70,000	N	$10,000	Q	Likely to lower flood damages	-	-	M	Public better understand the implications of their actions on the receiving waters.	M	Public can better respond to flooding. Better community resilience to flooding.
F1 – High	St Kilda precinct trunk drainage	$22.8 m	Y	$0	Q	Trunk drainage infrastructure to serve upstream development.	-	-	M	Grassed channels facilitating vegetative filtering of low stormwater flows and encouraging infiltration.	L	Can improve amenity through creation of linear parks.
F2 – High	Greyhound precinct trunk drainage and detention storage	$27.8 m	Y	$4,000	Q	Trunk drainage infrastructure to serve upstream development, particularly the intermodal facility. Major detention storage required to enable discharge under Port Wakefield Road.	Q	Potential for harvesting once development commences	H	Treatment wetland will remove a large proportion of sediments and nutrients prior to discharge or reuse. Grassed channels facilitating vegetative filtering of low stormwater flows and encouraging infiltration.	L	Improved visual amenity and habitat creation in wetland.
F3 – High	Port Wakefield precinct trunk drainage and detention storage	$16.3 m	Y	$4,000	Q	Trunk drainage infrastructure to serve upstream development. Major detention storage required to enable discharge under Greyhound and Port Wakefield Roads.	Q	Potential for harvesting once development commences	M	Detention basin likely to act as a sedimentation basin. Grassed channels facilitating vegetative filtering of low stormwater flows and encouraging infiltration.	L	Can improve amenity through creation of linear parks.
Q1 – High	Greyhound and NEXY South wetlands	$250,000 each	Y	$10,000 each	Q	Detention storage provided	Q	Potential for harvesting once development commences	H	Wetland will provide large water quality improvements	H	Visual amenity and habitat creation
F5 – Medium	Pellew precinct trunk drainage and detention storage	$29.6 m	Y	$4,000	Q	Trunk drainage infrastructure to serve upstream development. Major detention storage required to prevent flooding of development upstream of the freight rail line.	Q	Potential for harvesting once development commences	M	Detention basin likely to act as a sedimentation basin. Grassed channels facilitating vegetative filtering of low stormwater flows and encouraging infiltration.	L	Can improve amenity through creation of linear parks.
F6 – Medium	Symes precinct trunk drainage	$16.9 m	Y	$0	Q	Trunk drainage infrastructure to serve upstream horticultural development.	-	-	M	Grassed channels facilitating vegetative filtering of low stormwater flows and encouraging infiltration.	L	Can improve amenity through creation of linear parks.
F7 – Medium	NEXY South precinct drainage and detention storage	$6.7 m	Y	$4,000	Q	Drainage infrastructure to serve upstream development. Major detention storage required to prevent increase in downstream flood risk.	-	Potential for harvesting once development commences if directed into the Port Wakefield precinct	M	Detention basin likely to act as a sedimentation basin. Grassed channels facilitating vegetative filtering of low stormwater flows and encouraging infiltration.	L	Can improve amenity through creation of linear parks.
F8 - Medium	Review of Planning and Design Code	$10,000	N	$0	Q	Identify potential changes to the code to provide better flood mitigation requirements for new developments	Q	Nil (unless required)	L	Potential to specify water quality requirements for new developments	-	-
R1 – Medium	MAR stormwater harvesting	$31.7 m	Y	$0.81 m	Q	Improves flood risk for the lower portion of the study area.	V	Estimated reliable supply of up to 1,090 ML/a across Greyhound, Port Wakefield and Pellew precincts.	M	Decreased volume of runoff discharged from site. MAR treatment system will improve water quality. Natural treatment processes in the aquifer can improve the quality of the water.	L	Increased water availability to meet need in times of demand.
Q2 – Medium	Raingardens	$63,000 each	N	$300 per raingarden	Q	Minor improvement to flooding	Q	Able to infiltrate water close to the source and assist with passive irrigation of street trees.	H	Large benefits if constructed in sufficient numbers.	M	Can improve amenity, reduce heat island impacts
Q3 – Medium	Gross pollutant traps	~$120,000 (Supply and installation of a single GPT unit)	Y	$7,000 per GPT	Q	No benefit	-	-	M	Removal of gross pollutants and sediments	L	Improved amenity with less gross pollutants washed downstream of GPT

Priority	Project/ Activity Title	Capital Cost ($)	SMA Funding Eligible	Recurrent Cost ($ / annum)	Flood Mitigation Benefit: Measure used? (D) – AAD Reduction (P) – Properties Affected (Q) – Qualitative	Flood Mitigation Benefit: Quantification or Description of Benefit	Water Harvesting Benefit: Measure used? (V) Volumetric (Q) Qualitative	Water Harvesting Benefit: Quantification or Description of Benefit	Water Quality Benefit: Rating (H) – High (M) – Med (L) – Low	Water Quality Benefit: Qualitative Description of Benefit	Other Benefits: Rating (H) – High (M) – Med (L) – Low	Other Benefits: Qualitative Description of Benefit
Q4 – Medium	WSUD in the backyard	$20,000	N	$10,000	Q	Minor reduction in the amount of runoff generated by a site	Q	Opportunities for water reuse at an individual lot scale (e.g. rainwater tanks)	H	Infiltration and vegetative filtering. Large benefits if constructed in sufficient numbers	M	Visual amenity
Q5 – Medium	Infiltration systems	Variable	N	Variable	Q	Minor improvement to flooding	Q	Able to infiltrate water close to the source and assist with passive irrigation of street trees	M	Large benefits if constructed in sufficient numbers across the catchment	M	Can improve amenity, reduce heat island impacts
E1 – Medium	Utilisation of open space	Unspecified	N	Unspecified	Q	Nil	Q	Nil	L	Green corridors may improve quality of runoff	M	Increase biodiversity, improve amenity, education opportunities, connect community, contribute to urban wildlife conservation
E2 – Medium	Protection of coastal assets study	$20,000	N	$0	Q	No direct improvements; study may identify need for additional flood mitigation measures	Q	Nil	M	Potential reduction of pollutants entering coastal outlet	M	Protection of coastal assets
A1 – Medium	Asset inspection program	$30,000	N	$30,000	Q	Potentially significant improvement if an asset is identified for remediation/replacement before it fails	Q	Nil	M	Inspections can ensure WSUD assets are performing as originally intended	L	Improve public safety, proactively identify issue
R2 – Low	Rainwater tank site harvesting	Unspecified	N	Unspecified	Q	Reduced catchment runoff	Q	Reduced potable water demand	L	Decreased volume of runoff discharged from site	M	Increased water availability to meet need in times of demand

The works shown in Table 7.8 are currently unfunded and would need to be considered as part of Council's budgeting process.

Table 7.9 10-year capital works plan (values in millions)

Priority	Works	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1	St Kilda precinct	7.6	7.6	7.6							
2	Groundwater testing	0.025	0.025								
3	Education and awareness	0.07									
4	Greyhound precinct				7.0	7.0	7.0	7.0			
5	Port Wakefield precinct								5.4	5.4	5.4
Total	**$67 million**	**7.695**	**7.625**	**7.6**	**7.0**	**7.0**	**7.0**	**7.0**	**5.4**	**5.4**	**5.4**

The works shown in Table 7.9 are currently unfunded and would need to be considered as part of Council’s budgeting process.

7.19 Attainment of the proposed levels of service

The proposed strategies in Section 5 have been compared against the catchment objectives outlined In Section 3 to see how well they have performed.

7.19.1 Service attribute 1: Flood management

The proposed scope of works is to provide a 100 year ARI design standard for the majority of the study area, with a 20 year ARI standard accepted in the primary production land within the Symes and St Kilda precincts. The sizing of trunk infrastructure has allowed for ultimate development conditions and climate change.

It is assumed that future development will be filled such that sites are able to grade towards the trunk drainage system. The lateral drainage system (which will connect into the major trunk drain) also has a 100 year ARI standard based on the combined capacity of underground drains and continuous overland surface flood flows paths. The proposed strategy is therefore in compliance with the identified levels of service relating to flood management.

Outputs from the DRAINS model demonstrating the design standard are provided in Appendix L.

7.19.2 Service attribute 2: Water quality improvement and re-use

Water quality modelling has been undertaken for the catchment. The results have shown that the treatment train will meet the pollution reduction targets.

The water quality is close to, but does not quite meet the concentration targets identified in Level of Service 2.2; modelled results show a 95% percentile total phosphorus concentration of 0.13 mg/L compared to the target of 0.10 mg/L, and a total nitrogen concentration of 1.7 mg/L compared to the target of 1.0 mg/L. Water quality improvement measures at the lot scale, in addition to those at the whole of catchment scale, will further assist with achieving these targets. Lot-scale modelling of water quality measures has not been undertaken, and hence the benefits from these measures have not been quantified. Additionally, non-structural measures will also provide benefits.

No direct assessment has been made in relation to the targets for turbidity or faecal coliforms which are not explicitly modelled within the MUSIC software.

In terms of water re-use, the sparse population density and large volume of runoff means that only a small fraction of on-site runoff can be captured and reused. The large harvesting scheme proposed in the catchment combined with the passive infiltration along the main grass lined channels results in a 58% reduction in runoff generated by the catchment (for the 2050 climate change scenario), which goes a long way towards meeting the 75% target.

7.19.3 Service attribute 3: Amenity, recreation and environmental enhancement

The creation of linear parks in parallel with the trunk drainage system will help to meet the targeted proportion of 90% of total stormwater management reserve areas that provide amenity or recreation opportunities.

Landscaping and planting of locally indigenous vegetation within the reserves that does not hinder their hydraulic functionality is also a strategy to increase the amount of habitat biodiversity of the area, which is currently likely to be low given the horticultural nature of the area.

7.19.4 Service attribute 4: Asset management

The majority of assets in the study area will be new assets and will therefore meet the required levels of service. It is essential that each Council provides enough resources to adequately maintain the new assets such that they are able to operate as originally intended and continue to provide the desired service level. It is also important that each asset is well-constructed initially such that they are likely to have a long design life.

7.20 Implications for adjoining catchments

Generally, the impacts of the proposed measures described within this SMP will be localised to the GEP and St Kilda catchment area. The NEXY North area will include two new detention basins to detain flows to a suitable level such that they can be conveyed by the existing cross drains under the Northern Connector. These flows will ultimately discharge into Smith Creek (as they do currently), at a controlled rate.

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Appendix A – GEP flood maps

Disclaimer

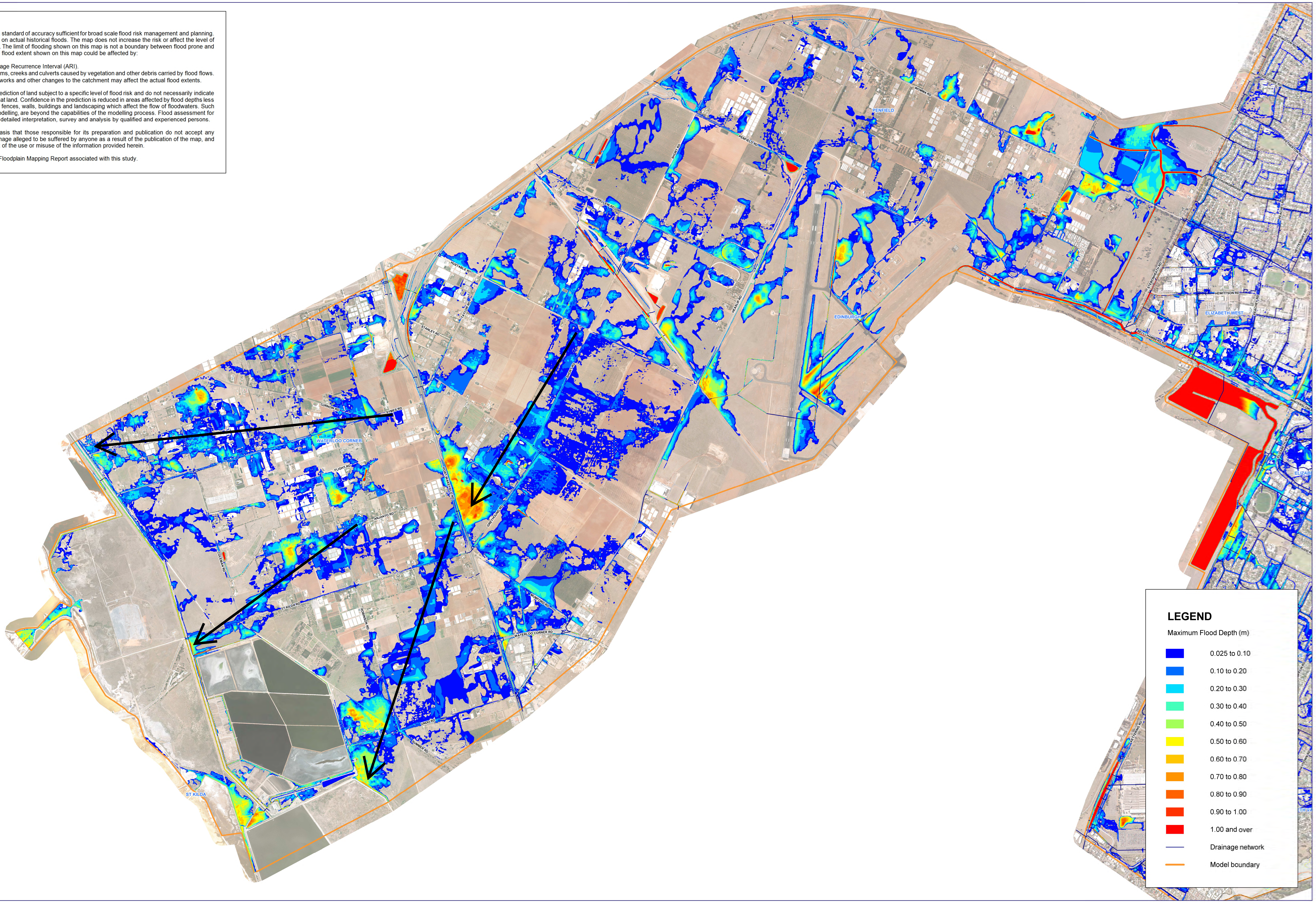
This map has been prepared to a standard of accuracy sufficient for broad scale flood risk management and planning. The flood extents are not based on actual historical floods. The map does not increase the risk or affect the level of flooding over an area or property. The limit of flooding shown on this map is not a boundary between flood prone and flood free land. Land outside the flood extent shown on this map could be affected by:

- Floods with a different Average Recurrence Interval (ARI).
- Blockages in drainage systems, creeks and culverts caused by vegetation and other debris carried by flood flows.
- Further development, earthworks and other changes to the catchment may affect the actual flood extents.

The flood extents shown are a prediction of land subject to a specific level of flood risk and do not necessarily indicate a threat to buildings located on that land. Confidence in the prediction is reduced in areas affected by flood depths less than 0.1 m, due to the effects of fences, walls, buildings and landscaping which affect the flow of floodwaters. Such effects, which require detailed modelling, are beyond the capabilities of the modelling process. Flood assessment for particular sites will require more detailed interpretation, survey and analysis by qualified and experienced persons.

This map is provided on the basis that those responsible for its preparation and publication do not accept any responsibility for any loss or damage alleged to be suffered by anyone as a result of the publication of the map, and the notations on it, or as a result of the use or misuse of the information provided herein.

More detail can be found in the Floodplain Mapping Report associated with this study.



Tonkin CONSULTING
a better approach

Job Number: 2011.0409
Filename: Playford_100yrARI_LT_A1.wor
Revision: D
Date: 2015-05-25
Drawn: JDN

N
Scale: 1 : 17,000
at A1

Data acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd
Drainage data supplied by City of Playford and City of Salisbury

City of Playford

ADAMS CREEK AND GREATER EDINBURGH PARKS FLOOD STUDY
100 YEAR ARI LONG-TERM FLOOD INUNDATION

Figure 2.2

Disclaimer

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- Floods with a different Annual Exceedence Probability (AEP).
- Blockage in drainage systems, creeks or culverts caused by vegetation or other debris carried by floodwaters.
- Further development, earthworks and other changes to the catchment that alter the actual flood extents.

The flood extents shown are a prediction of land subject to a specific level of flood risk and do not necessarily indicate a threat to buildings located on that land. Confidence in the prediction is reduced in areas affected by flood depths less than 0.1 m, due to the effects of fences, walls, buildings and landscaping which affect the flow of floodwaters. Such effects, which require detailed modelling, are beyond the capabilities of the modelling process. Flood assessment for particular sites will require more detailed interpretation, survey and analysis by qualified and experienced persons.

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More detail can be found in the report associated with this study.

City of Playford

Adams Creek, Helps Road Drain and Greater Edinburgh Parks Catchment
1% AEP Flood Depth - Existing Development Scenario

tonkin

Job Number: 20120712
Filename: 20120712GQ004RevA
Revision: A
Date: 2020-03-10
Drawn: Dylan Bone

Data Acknowledgement:
Aerial from MetroMap, 2017
Background data from DataSA, 2019

Map 1

Disclaimer

This map has been prepared to a standard of accuracy sufficient for broad scale flood risk management and planning. The flood extents are not based on actual historical floods. The map does not increase the risk or affect the level of flooding over an area or property. The limit of flooding shown on this map is not a boundary between flood prone and flood free land. Land outside the flood extent shown on this map could be affected by:

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More detail can be found in the report associated with this study.

Smith et al. (2014)

Legend

- Study area
- Underground drainage network
- Watercourse
- Arterial road / Highway
- Main road
- Local road (sealed)
- Local road (unsealed)
- Railway

Flood hazard category

- No hazard
- H1
- H2
- H3
- H4
- H5
- H6

0 500 1000 1500 2000 m

EPSG:28354

Job Number: 20120712
Filename: 20120712GQ004RevA
Revision: A
Date: 2020-03-10
Drawn: Dylan Bone

Data Acknowledgement:
Aerial from MetroMap, 2017
Background data from DataSA, 2019

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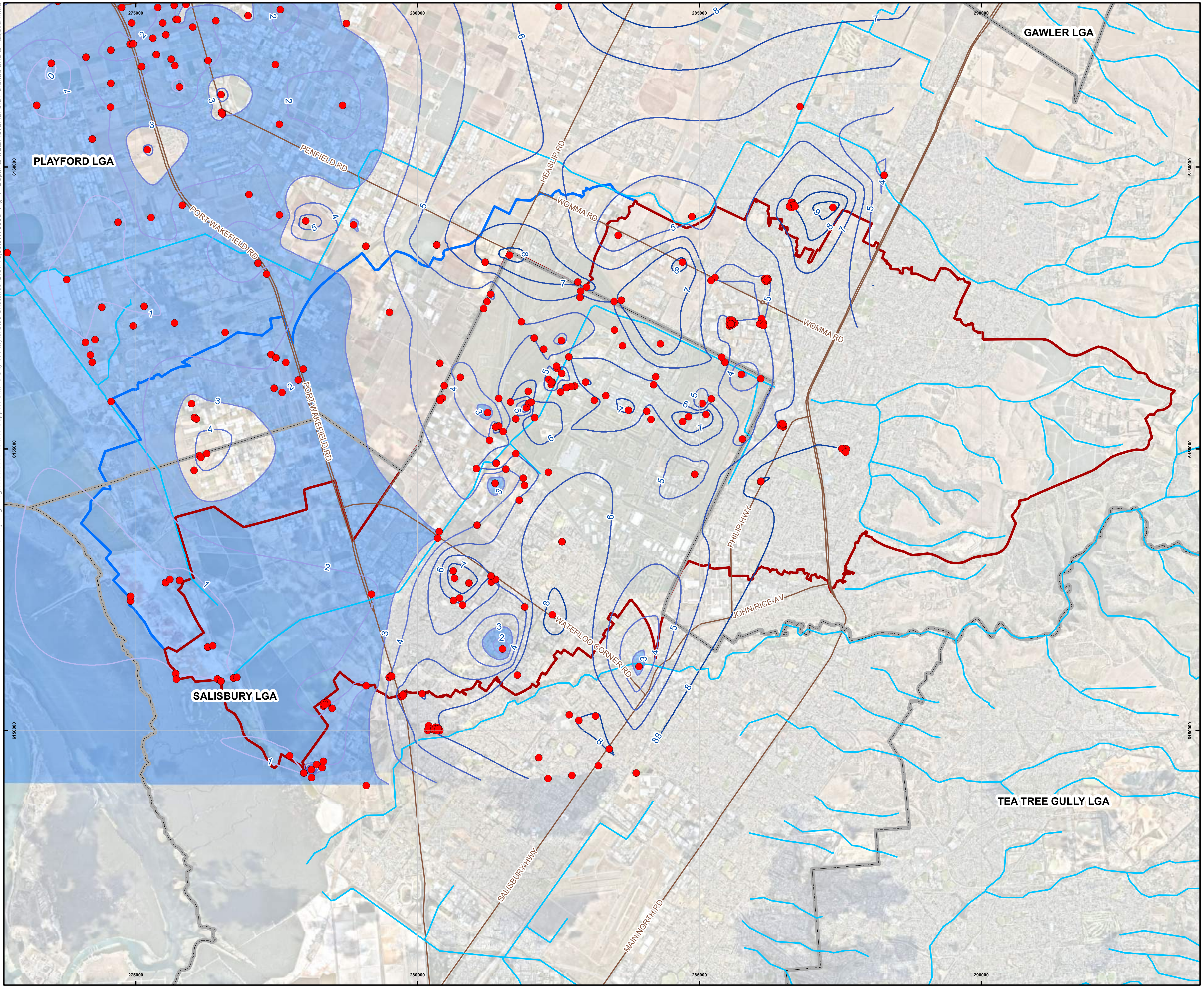
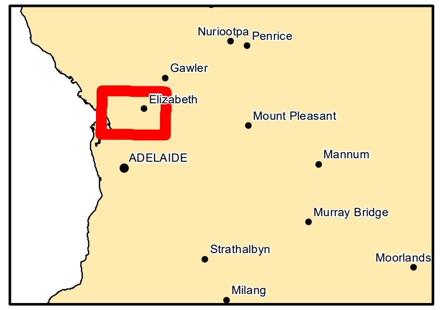
City of Playford

Adams Creek, Helps Road Drain and Greater Edinburgh Parks Catchment
1% AEP Flood Hazard - Existing Development Scenario

Map 2

Appendix B – Extract of WGA (2018) report





LEGEND

- Well
- Main Highway
- Watercourse
- LGA Boundary

Catchments

- Greater Edinburgh Parks Catchment
- Helps Rd/Adam's Creek Catchment
- Depth to Groundwater => 3m

Standing Water Level (m)

0, 1, 2, 3, 4, 5, 6, 7, 8, 9

N

0 1,000 2,000 3,000 m

Scale 1:65,000 @ A4

Coordinate System: GDA 1994 MGA Zone 54

WGA
WALLBRIDGE GILBERT AZTEC

Figure 7

Hydrogeological Assessment to Support SMP's City of Playford

Depth to Water Level for the Perched and Q1 Aquifer

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Appendix C – Environmental considerations (Tonkin, 2018a)

Given the anticipated depths of the proposed drains and basins, groundwater seepage rates (on average) are likely to be very low (in the order of 0.3 to 0.6 m/year) due to the low groundwater hydraulic gradient (approximately 0.095%) and low transmissivity of the upper Quaternary aquifers, however local variations will occur.

4.6 Environmental Considerations

The following direct and indirect environmental risks will need to be managed during construction and operation of drains and storage basins to deliver the GEP Stormwater Strategy.

4.6.1 Land zoning – The GEP project area is located on multiple land zonings

- Excluded (Federal / Defence)
- Urban Employment (Industrial)
- Primary Production – Mining (Horticulture)
- Mineral Extraction (Primary Production – Mining)
- Coastal Settlement (Country Township)
- Coastal Marine & Coastal Conservation (Environmental Constraint).

Construction and operation of the proposed drains and basins is not anticipated to permanently restrict or preclude any of the existing land zonings, but rather the drain will be actively supporting development of the area by providing adequate drainage infrastructure. Individual land owners or users in some areas will be temporarily or permanently impacted.

4.6.2 Aboriginal Heritage sites

There is potential for Aboriginal heritage sites or objects to be found within or near the project areas. A desktop assessment was undertaken for the portion of the proposed drain alignment that runs between Robinson Road and the coastline adjacent to salt pond PA6 (Tonkin Consulting, 2016). One listed Aboriginal heritage site is located on land adjacent to the proposed drain alignment, on property; parcel details CT 5723/299 F115108 AL 3. A Native title claim is also current for a portion of Pond PA6 (CR 5844/945 DP50216 A104).

A desktop review for all project areas is recommended to allow design considerations to minimise impacts on heritage sites and to prepare a response program in the event that unregistered heritage sites or objects are identified during investigation or construction stages.

4.6.3 Threatened or rare species (Flora and Fauna) listed under the EPBC Act

Ecological field investigations have not been undertaken for the project area to date. Desktop review of SA Water land (re-vegetated buffer zone) has indicated that, in this area the project is likely to significantly impact native trees, shrubs and grasses which provide habitat for threatened fauna or flora species. Threatened or rare species of flora and fauna occur to the west of Robinsons Road within SA Water land and the coastal zone, where remnant or re-vegetation land provides habitat. However, no threatened or rare species are listed for the land east of Robinson Road. Further details of flora and fauna within the site are provided in report Preliminary Site Investigation – Environmental Constraints (Tonkin Consulting, 2016).

This means that any clearing of native vegetation will require permission of the Native Vegetation Council (and stakeholders). The project must demonstrate a significant environmental benefit (SEB) offset to compensate for the impacts of an approved clearance activity.

The project is not anticipated to impact plantations established by the Adelaide Zoo that occur on land immediately to the south of the proposed drain alignment on SA Water land. Consultation with the Adelaide Zoo will be required to ensure that potential impacts to the Zoo's activities are identified and can be managed.

The spread and establishment of noxious weeds will need to be managed through construction and operation to:

- reduce the negative impacts of weeds on the environment and potentially on local horticulture/ agriculture and Adelaide Zoo operations
- prevent the establishment of new weeds
- manage the spread of widespread significant weeds from up-stream areas.

Noxious weed species may impact the hydraulic performance of the drain, culverts or syphon.

Due to the dry environment and saline nature of creeks or drains within the highly developed area, it is unlikely that any key fish habitats are remaining within the project area, with the exception of Gulf St Vincent. Potential exists for the project to create and improve aquatic habitat.

4.6.4 Management of Soil and Contaminated Land

Due to the large volume of waste soil anticipated to be generated during construction and the modified nature of the project area, there will be a need to undertake soil testing to classify materials according to; (i) the SA EPA (2013) “Standard for the production of Waste Derived Fill” guidelines for re-use or disposal and (ii) geotechnical classification to identify re-use options.

During excavation of drains and basins, it is likely that localised sources of site contamination will be identified. Without management, the excavation of a drain or basin through contaminated soils or intercepted groundwater has potential to further impact local groundwater quality or directly impact surface water quality in the drain.

Acid sulfate soils are unlikely to be disturbed in areas dominated by the Lower Alluvial Plain geomorphic unit due to the limited extent of acid sulfate soils expected within the depth of excavation or dewatering. Acid sulfate soils are likely to be disturbed during excavation of drains in the western portion of the project area where the Coastal Zone geomorphic unit is dominated by St Kilda Formation sediments. Additional detail on the distribution of acid sulfate soils for the area is presented in Tonkin Consulting (2016). In the western portion of the area the risk of disturbance (by excavation or dewatering) will be relative to the land surface and drain invert elevations. Construction of the SA Water outfall channel syphon will likely disturb a significant quantity of buried acid sulfate soil material due to the construction depth anticipated.

Sulfidic soils are likely to occur within 1 m of the surface in the lower lying samphire areas, where saline soils dominate (i.e. south of the Tramway Museum and adjacent to or within the Saltfields ponds.

Coastal wetland soils and sediments within ponds and drains surrounding the Saltfields are likely to be peaty mangrove soils and iron-monosulfide (Mono-sulfidic Black Ooze, or MBO). MBO presents a deoxygenation hazard to connected surface water bodies, if disturbance is unmanaged.

An acid sulfate soil management plan (in compliance with National and State Guidelines) will be required to manage hazards associated with their disturbance during construction and post construction to protect the environmental values and asset. The accumulation of acid sulfate soils within the drains and subsequent mobilisation during flood events or routine maintenance will need to be monitored and managed during operation of the drain.

4.6.5 Management of Water

The desktop assessment has identified potential for saline groundwater to be intercepted which will influence surface water quality of the drain during periods of low flow. Groundwater is most likely to be intercepted in the western portion of the project area due to shallower water tables. However, localised perched water tables are likely to be intersected in all areas. Salinity of groundwater generally increases toward the coastline (as described in Section 4.5).

The project has identified potential for stormwater to be captured for re-use as part of the development, by Council and or SA Water. Where groundwater is intersected, seepage rates may require management to; (i) protect the quality of captured stormwater and (ii) protect groundwater from being contaminated by surface water (i.e. protect beneficial uses of groundwater). Groundwater seepage to the drain or basins will be diluted during storm events.

Once operational, surface water flows from the largely industrial and horticultural catchment to the drain will be the dominant influence on stormwater quality. This could hasten the movement of contaminants that accumulate in the drain sediment to the coastal outfall. Poor surface water quality would also have potential to impact groundwater users.

Stormwater quality that will discharge to the Saltfields Pond PA6 and ultimately to the marine environment or a water harvesting scheme will need to be managed. Trash management and spills capture measures will need to be integrated into the drain design and operational management procedures. Integration of low flow channels, wetlands and vegetated ponds into the drainage system design would improve surface water quality. Water quality measures are described further in Section 4.8.2.

Due to the ephemeral nature of the drain and the future (proposed) environment being highly industrialised with the drain being diverted under roads and through culverts, it is unlikely that any key fish habitats will be developed by the project. The drain and basins may however provide a corridor between aquatic habitats of value. Furthermore, the drain and basins may provide habitat suitable for mosquitos and midge flies that may increase the nuisance and/or risk of disease to nearby receptors.

4.6.6 Environmental management

During design and before construction begins, the project will prepare a Construction Environmental Management Plan (CEMP) that will cover constructing and commissioning the project. It will include, but not be limited to mitigation measures for soils (erosion/sediment, contamination, acid sulfate soils), groundwater, pests, vegetation and heritage impacts, including traffic, noise and vibration. A number of specific management plans may be required to address residual risks and key issues. To ensure that appropriate measures to manage potential impacts are implemented, further environmental and heritage assessments will be required. Management measures will need to be developed through a stakeholder engagement process to support the planning, construction and operation stages of the project.

Operational management will include rehabilitation / re-vegetation following construction and any related environmental validation, monitoring and management work, such as routine maintenance dredging to remove weeds and sediment build-up in the channel or at discharge points into natural waterways that affect the hydraulic efficiency of the drainage system.

4.7 Existing Development Sites

There are four main sites within GEP that either can't or have limited opportunities to accommodate a stormwater drain and these include:

- Coleman Road landfill
- Bolivar Lagoons
- Penfield Intermodal site
- RAAF Base

The location of these sites are shown on Figure 4-1 and Figure 4-2 and have been taken into consideration when selecting an appropriate drain alignment.

Appendix D – Water quality modelling setup

Water Quality Modelling Setup

Adams Creek and Helps Road Drain Catchment and Greater Edinburgh Parks Stormwater Management Plans

City of Playford and City of Salisbury

12 May 2021
Ref: 20170712R008Rev2

Building exceptional outcomes together

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
0	For use	MM	TAK	TAK	17 Oct 2019
1	Catchments updated	MM	TAK	TAK	11 May 2020
2	Description of rainfall data provided	MM	TAK	TAK	12 May 2021

Contents

Project: Water Quality Modelling Setup | Adams Creek and Helps Road Drain Catchment and Greater Edinburgh Parks Stormwater Management Plans
Client: City of Playford and City of Salisbury
Ref: 20170712R008Rev2

Tables

Figure

1 Introduction

This report describes the background to the water quality modelling undertaken as part of the Adams Creek and Helps Road drain (ACHRD) catchment and Greater Edinburgh Parks (GEP) stormwater management plans (SMP).

The stated water quality objectives for the study areas reflect South Australia's state wide performance targets for stormwater runoff quality (Department of Environment, Water and Natural Resources, 2013), as follows:

- 80% reduction in average annual total suspended solids
- 60% reduction in average annual total phosphorous
- 45% reduction in average annual total nitrogen, and
- 90% reduction in litter/gross pollutants.

The primary pollutants carried by stormwater within the study area are likely to be sediments (TSS), nutrients (TP and TN), pathogens, oxygen demanding substances and gross pollutants (GP).

The quality of runoff from the study areas was modelled using the eWater Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

There are currently no official guidelines for the use of MUSIC in South Australia. The adopted approach to modelling is therefore based on the recommendations made by the Goyder Institute in their report (Myers et al. 2015) which reviewed the use of MUSIC for the development of stormwater management plans. The report includes a comprehensive review of guidelines for the use of MUSIC in other regions and makes recommendations for MUSIC simulations in South Australia.

2 Model development

2.1 Inputs

Development of a MUSIC model requires the following data:

- Meteorological data
- Source node (catchment) data
- Definition of drainage links
- Water quality improvement measures.

2.2 Meteorological data

Review of the Bureau of Meteorology's weather station directory identified two stations within 25 km of the study area that have rainfall totals at six-minute intervals. The available data is summarised in Table 2.1.

Table 2.1 Summary of rainfall data available for MUSIC modelling

Station	Station number	Length of data record
Roseworthy AWS	023122	1/5/1999 to 30/6/2010
Edinburgh RAAF	023083	13/11/1979 to 31/3/2010

Review of the available six-minute data identified gaps in both records. The Edinburgh RAAF station had relatively complete data for the period 1990 to 1994, and for this reason this period was selected for the MUSIC modelling.

The five years of six-minute rainfall data used for the MUSIC modelling had annual totals varying from 239 mm to 653 mm, with an annual average of 410 mm. For comparison, the average annual rainfall found using daily rainfall data at the same station between 1973 and 2020 is approximately 425 mm. While the annual average rainfall for the modelling period is slightly lower than the long term average, the record contains high rainfall years and low rainfall years. It is therefore considered suitable for understanding the patterns of pollutant generation, relative impacts of development and the effectiveness of mitigation options within the study area.

The model uses monthly average evapotranspiration data for Gawler, extracted from the BoM's gridded data set for potential areal evapotranspiration. The annual average evapotranspiration is 1,130 mm.

2.3 Catchment data

The definition of catchment areas and characteristics (% impervious area) was based on the catchments in the TUFLOW and DRAINS models used for hydrological and hydraulic analysis. These catchments were group together based on location to form larger lumped catchments.

The effective impervious area for each lumped catchment was calculated using the proportional average of the directly connected impervious areas. The catchment zoning/surface type was based on a review of the land use layers. For the ACHRD study area, many catchments were identified as residential, with several pockets of industrial land use types. For the GEP study area, 'industrial' surface types were selected for each catchment within the model. The associated pollutant load parameters are consistent with the recommendations in Myers et al. (2015) for lumped catchment modelling for South Australian stormwater management plans.

The adopted water quality parameters for the land use types within the MUSIC models for the ACHRD and GEP SMPs are summarised in Table 2.2.

Table 2.2 Water quality parameters for lumped catchment modelling

Land use	Flow	TSS log_{10} values		TP log_{10} values		TN log_{10} values	
		Mean	SD	Mean	SD	Mean	SD
Urban residential	Baseflow	1	0.34	-0.97	0.31	0.2	0.2
	Stormflow	2.18	0.39	-0.47	0.32	0.26	0.23
Commercial	Baseflow	0.78	0.39	-0.6	0.5	0.32	0.3
	Stormflow	2.16	0.38	-0.39	0.34	0.37	0.34
Industrial	Baseflow	0.78	0.45	-1.11	0.48	0.14	0.2
	Stormflow	1.92	0.44	-0.59	0.36	0.25	0.32
Rural residential	Baseflow	0.53	0.24	-1.54	0.38	-0.52	0.39
	Stormflow	2.26	0.51	-0.56	0.28	0.32	0.30
Agriculture	Baseflow	1	0.13	-1.155	0.13	-0.155	0.13
	Stormflow	2.477	0.31	-0.495	0.3	0.29	0.26

The rainfall-runoff parameters adopted in the model are summarised below.

Impervious areas:

- Rainfall threshold 1 mm/day

Pervious areas:

- Soil storage capacity 40 mm
- Initial storage 30% of capacity
- Field capacity 30 mm

2.4 Drainage links

The drainage links within the MUSIC model were defined based on a review of the stormwater network and outflow points of the DRAINS catchments. No routing was applied. This is considered conservative, consistent with the recommendation of Myers et al. (2015) which states "routing is not required in South Australian MUSIC modelling undertaken for compliance with water quality targets to ensure results are conservative".

2.5 Climate change modelling in MUSIC

Review of the climate projections for the SSWFE region shows a significant variation in seasonal changes to rainfall, with the greatest reductions expected in winter and spring. As such, for the purpose of water balance modelling (i.e. water harvesting), the 2050 and 2090 seasonal average annual rainfall and evapotranspiration scaling factors shown in Table 2.3 have been applied to the historic rainfall data.

Table 2.3 Climate change factors applied to meteorological data in MUSIC

	2050	2090
Rainfall		
Summer	-3%	-3%
Autumn	+2%	+2%
Winter	-9%	-19%
Spring	-14%	-19%
Annual evapotranspiration	+5.1%	+10.2%

2.6 Model configuration

The configuration of the MUSIC models used for the ACHRD and GEP catchments are shown in Figure 2.1 and Figure 2.2, respectively.

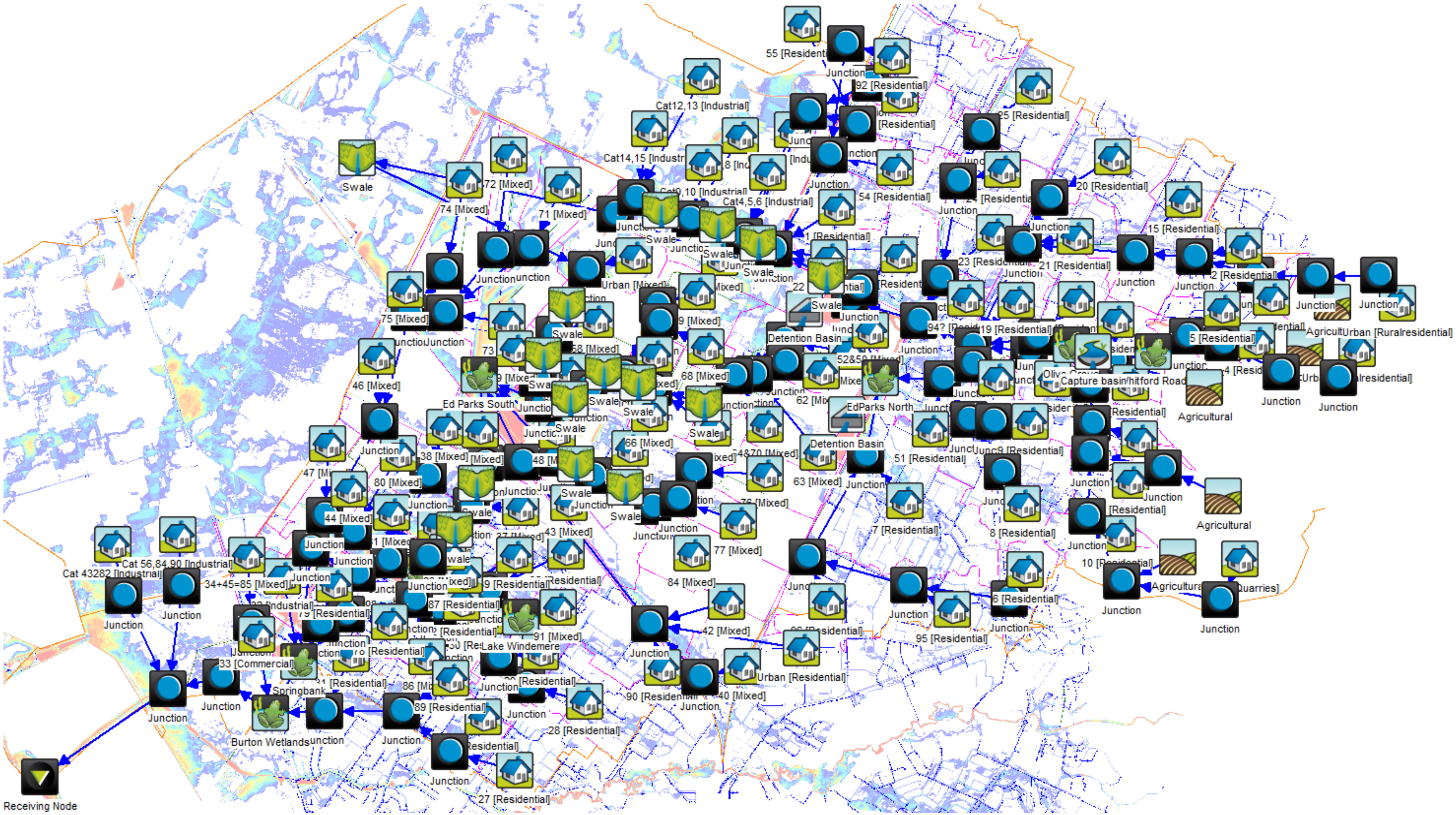


Figure 2.1 ACHRD catchment MUSIC model configuration

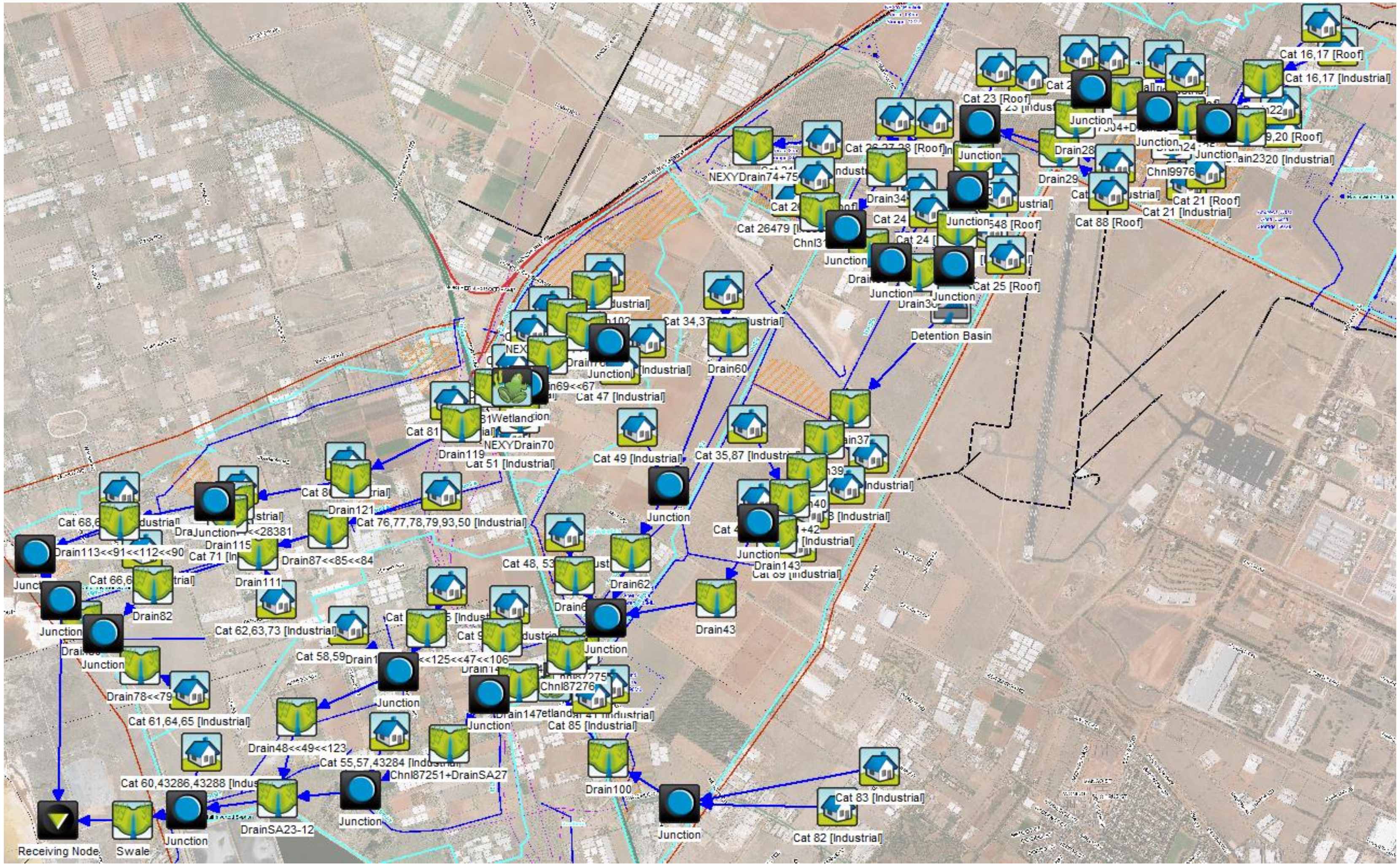


Figure 2.2 GEP catchment MUSIC model configuration

3 References

Myers, B, Cook S, Pezzaniti, D, Kemp, D, Neland, P 2015, *Implementing Water Sensitive Urban Design in Stormwater Management Plans*, Goyder Institute for Water Research Technical Report Series No. 16/7, Adelaide, South Australia.

Appendix E – MUSIC modelling results by precinct

Table E.1 Modelled annual pollutant loads by precinct (post-development including water quality improvement measures)

Precinct	Pollutant	Sources	Residual Load	% Reduction
Pellew	TSS (kg/yr)	119,000	18,000	85
	TP (kg/yr)	349	116	67
	TN (kg/yr)	2,820	1,330	53
Greyhound	TSS (kg/yr)	84,600	11,300	87
	TP (kg/yr)	207	69	67
	TN (kg/yr)	1,360	869	**36**
Greyhound and Port Wakefield*	TSS (kg/yr)	226,000	4,130	98
	TP (kg/yr)	583	38	94
	TN (kg/yr)	3,790	750	80
St Kilda	TSS (kg/yr)	100,000	10,300	90
	TP (kg/yr)	264	74	72
	TN (kg/yr)	1,700	912	46
NEXY South	TSS (kg/yr)	44,900	1160	97
	TP (kg/yr)	119	10	91
	TN (kg/yr)	753	121	84
Symes	TSS (kg/yr)	131,000	16,400	88
	TP (kg/yr)	343	106	69
	TN (kg/yr)	2,200	1,350	**39**

*The Greyhound precinct also contributes flows to the wetland at the downstream end of the Port Wakefield precinct

Appendix F – Safety in design register

SF71: WHS HAZARD RISK REGISTER

PROJECT OR DESIGN ELEMENT:	Client:	Project Number:
Greater Edinburgh Parks and St Kilda Catchment Stormwater Management Plan	City of Playford and City of Salisbury	20170712

This Workshop was attended by the representatives listed below.

Brief Description Of Design Element:	Brief Description of any specific Safety Focus or Requirements:
Stormwater elements described in SMP (ref. 20170712R002)	Construction, maintenance and operation

Workshop Organiser or Chair

Responsible Officer:	Project Role:	Organisation:
Tim Kerby	Project Leader	Tonkin

RISK ASSESSMENT

Activity or Task	Hazards or Environmental Impacts	Perceived Risk			Control Measures (Eliminate, Substitute, Isolate/Engineering Controls, Administrative Controls, PPE)	Residual Risk			Person responsible for Controls	Status
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating		
Construction	Flood event causing flooding of open channels during construction	2	3	6	Contractor to be aware of weather forecast and plan accordingly Schedule works in drier part of the year	2	2	4	Contractor	Identified
Construction	Damage to existing services causing injury to workers, in particular the high pressure gas mains pose high risk	4	3	12	DBYD and service locating to be carried out as part of the design Locate drain alignment away from services Minimise number of service crossings Contractor to do their own service locating Contractor to comply with service authority requirements and not to use mechanical excavation in vicinity of services Mark approximate location of services on drawings	4	2	8	Designer and Contractor	Identified
Design	New drains/channels located within private property	3	5	15	Council to negotiate for property easements or acquisition	2	5	10	Council	Action Assigned
Design	Deep excavation. Collapse of batters onto construction crew members	5	3	15	Trunk drain has relatively flat batters (1 in 5) which would minimise the potential for any batter collapse. Contractor to excavate channel in layers	3	1	3	Designer and Contractor	Action Assigned
Excavation, drainage installation and backfilling	Services - damage to or electrification from overhead power infrastructure in work area	5	3	15	Notes to be added to construction drawings to highlight the general location of overhead powerlines, as part of detailed design	5	2	10	Designer and Contractor	Action Assigned
Construction	Location - disgruntled stakeholders due to construction, restricted access and noise	3	3	9	Contractor/Council to provide adequate stakeholder notification/consultation prior to construction commencing. Works to be undertaken in discrete stages. Contractor to submit a detailed traffic control proposal to the superintendent.	2	2	4	Contractor and Council	Action Assigned
Construction	Contaminated groundwater / soil encountered on site	4	3	12	Investigations to be undertaken as part of detailed design	4	2	8	Council	Action Assigned
Construction	Shallow groundwater encountered on site	4	3	12	Responsibility for adequate shoring and dewatering during construction to be left with contractor. Design inverts to be kept relatively shallow.	4	2	8	Designer and Contractor	Action Assigned
Construction / Ongoing	Potential for pipe or culvert to crack during installation or ongoing life	3	3	9	Ensure adequate cover and bedding is specified Checks to be undertaken to ensure backfilling and pipe class consistent between design and drawings	3	2	6	Designer and Contractor	Action Assigned
Construction	Unknown service encountered during construction causing high relocation costs	4	4	16	DBYD to be undertaken by contractor prior to construction. Approximate location and depth of known services to be marked on drawings as part of further design development. Service locating to be undertaken if risk assessed as too high during detailed design.	4	3	12	Designer and Contractor	Action Assigned
Traffic Management	Working in close proximity to road. Workers hit by a vehicle.	5	3	15	Contractor to submit a detailed traffic control proposal to the superintendent	5	2	10	Contractor and Council	Action Assigned
Service and Maintenance	Sedimentation build up or vegetation growth within system preventing the drainage network from operating as originally intended	3	3	9	Open channel sections can be easily inspected visually. Adopted batter slopes will allow for easy maintenance. Regular inspection and cleaning to be specified.	3	2	6	Designer and Council	Action Assigned
Operation	Permanent water posing a drowning risk	5	3	15	Basins to be constructed with relatively flat batters. Potential for signage/fencing to restrict access.	5	2	10	Contractor and Council	Action Assigned
Operation	Drowning risk due to deep flows in channels	5	3	15	Channels to be constructed with relatively flat batters, possible signage/fencing	5	2	10	Contractor and Council	Action Assigned

SF71: WHS HAZARD RISK REGISTER

Activity or Task	Hazards or Environmental Impacts	Perceived Risk: Consequence	Perceived Risk: Likelihood	Perceived Risk: Risk Rating	Control Measures (Eliminate, Substitute, Engineering Controls, Administrative Controls, PPE)	Residual Risk: Consequence	Residual Risk: Likelihood	Residual Risk: Risk Rating	Person responsible for Controls	Status
Operation	Increased risk of bird strike due to permanent water near RAAF base	4	2	8	Limit ponding time to 48 hours after rain ceases, or use netting over basins within close proximity to RAAF base	4	1	4	Desginer	Action Assigned
Operation	Errant vehicles driving into channel from road	4	2	8	Extend culvert to beyond recommended safety buffer distance, or install crash barriers	3	1	3	Designer	Action Assigned
Construction	Creation of dust and sediment	3	4	12	Contractor to implement SEDMP during construction Time construction works to coincide with drier parts of the year. Work sequence to be undertaken from downstream to upstream.	3	3	9	Contractor	Action Assigned

Workshop Attendees

Name of Attendee	Name of Employer	Project Role	Relevant Qualifications	Date	Time	Signature to acknowledge
Tim Kerby	Tonkin	Project Leader	Qualified Engineer, MIEAust, CPEng	17-06-19	10:00 AM	
Michael McEvoy	Tonkin	Civil Engineer	Qualified Engineer	17-06-19	10:00 AM	

RISK ASSESSMENT GUIDE

SAFETY AND ENVIRONMENTAL HAZARD IDENTIFICATION/RISK ASSESSMENT

LIKELIHOOD

5	**Event will occur**	The event is a common occurrence on all projects
4	**Event almost certain to occur**	The event will probably / is likely to occur at least once during most projects
3	**Event may occur**	The event is possible to / might occur during some projects
2	**Event not likely to occur**	The event is unlikely to occur (though it could occur during similar work activities)
1	**Event rarely occurs**	The event could occur, but it is rare / only in exceptional circumstances

PROJECT (Level 1) RISK RATINGS

1-4	Low	*Broadly acceptable - managed by routine procedures*
5-8	Medium	*Tolerable - managed with general controls*
9-15	High	*Undesirable - managed with specific controls*
16-25	Extreme	*Intolerable - design to be changed or do not start activity*

	DESCRIPTOR	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
5	Event will occur	5 MEDIUM	10 HIGH	15 HIGH	20 EXTREME	25 EXTREME
4	Event almost certain to occur	4 LOW	8 MEDIUM	12 HIGH	16 EXTREME	20 EXTREME
3	Event may occur	3 LOW	6 MEDIUM	9 HIGH	12 HIGH	15 HIGH
2	Event not likely to occur	2 LOW	4 LOW	6 MEDIUM	8 MEDIUM	10 HIGH
1	Event rarely occurs	1 LOW	2 LOW	3 LOW	4 LOW	5 MEDIUM

Lowest Level of Control ← → **Highest Level of Control**

PPE — Administration — Isolation/Engineering — Substitution — Elimination

Level	Descriptor	CONSEQUENCE / SEVERITY / IMPACT
5	**Catastrophic**	*Loss of human life, complete design failure, loss of security and safety or extensive financial or social loss*
4	**Major**	*Major and permanent injury, hospitalisation, partial design failure, major system damage or major financial or social loss*
3	**Moderate**	*Moderate injury or illness, medical treatment required, degradation of design or moderate financial or social loss*
2	**Minor**	*Minor injury or illness, First Aid required, minor impact on design performance or operator inconvenience*
1	**Insignificant**	*No injury, inconvenience caused by event, virtually no impact*

Appendix G – Multi-criteria assessment

Option	Criteria	Flood Protection of Development		Runoff Quality and Effect on Receiving Waters					Beneficial Use of Stormwater			Social values					Environmental Benefit			Capital, Benefit Cost Ratio and Maintenance Cost				Total Criteria Weighting
	Sub-Criteria	Improved flood protection	Criteria weighting	Reduction in gross pollutants	Reduction in suspended solids	Reduction in nutrients	Reduction in phosphorus	Criteria weighting	Direct Infiltration	Storage and Reuse	Criteria weighting	Improved visual amenity	Improved public safety	Additional useful open space	Disruption during implementation	Criteria weighting	Habitat creation	Increased biodiversity	Criteria weighting	Capital Cost	Economic viability	Recurring / Maintenance Cost	Criteria weighting	Total Weighted Score
	Sub-criteria Weighting	100	**30**	10	40	25	25	**25**	25	75	**10**	20	30	30	20	**5**	50	50	**5**	50	40	10	**25**	**100**
Greyhound and NEXY South wetlands	Score (max=4)	3	**22.5**	2	4	4	4	**23.75**	3	3	**7.5**	4	3	4	2	**4.13**	4	4	**5.00**	2	2	2	**12.50**	**75.4**
	Weighted Score	22.5		1.25	10	6.25	6.25		2	5.63		1.00	1.125	1.5	0.50		2.50	2.50		6.25	5.00	1.25		
Development controls	Score (max=4)	2	**15**	2	2	2	2	**12.5**	0	2	**3.75**	1	1	0	3	**1.38**	0	0	**0**	4	4	4	**25**	**57.6**
	Weighted Score	15		1.25	5	3.125	3.125		0	3.75		0.25	0.375	0	0.75		0	0		12.5	10	2.50		
Raingardens	Score (max=4)	1	**7.5**	0	2	2	2	**11.25**	4	1	**4.375**	4	1	0	2	**1.88**	2	2	**2.5**	3	2	3	**16.250**	**43.8**
	Weighted Score	7.5		0	5	3.125	3.125		2.5	1.875		1	0.375	0	0.50		1.25	1.25		9.375	5	1.88		
Greyhound precinct MAR scheme	Score (max=4)	1	**7.5**	1	2	2	2	**11.875**	4	4	**10**	0	0	0	2	**0.50**	0	0	**0**	2	2	2	**12.50**	**42.4**
	Weighted Score	7.5		0.625	5	3.125	3.125		2.5	7.5		0	0	0	0.50		0	0		6.25	5	1.25		
WSUD in the backyard	Score (max=4)	1	**7.5**	0	2	2	2	**11.25**	3	2	**5.625**	3	1	0	2	**1.63**	0	0	**0**	3	2	3	**16.250**	**42.3**
	Weighted Score	7.5		0	5	3.125	3.125		1.875	3.75		0.75	0.375	0	0.50		0	0		9.375	5	1.88		
Infiltration systems	Score (max=4)	1	**7.5**	0	1	1	1	**5.625**	4	1	**4.375**	0	1	0	3	**1.13**	0	0	**0**	4	2	3	**19.375**	**38.0**
	Weighted Score	7.5		0	2.5	1.5625	1.5625		2.5	1.875		0	0.375	0	0.75		0	0		12.5	5	1.88		
Gross pollutant traps	Score (max=4)	0	**0**	4	1	1	1	**8.125**	0	0	**0**	3	0	0	4	**1.75**	0	0	**0**	4	4	3	**24.375**	**34.3**
	Weighted Score	0		2.5	2.5	1.5625	1.5625		0	0		0.75	0	0	1.00		0	0		12.5	10	1.88		
Utilisation of open space	Score (max=4)	0	**0**	0	0	0	0	**0**	0	0	**0**	4	0	4	3	**3.25**	4	3	**4.375**	4	4	4	**25**	**32.6**
	Weighted Score	0		0	0	0	0		0	0		1	0	1.5	0.75		2.5	1.875		12.5	10	2.50		
Rainwater tank site harvesting	Score (max=4)	0	**0**	0	1	1	1	**5.625**	0	3	**5.625**	0	0	0	3	**0.75**	0	0	**0**	3	3	3	**18.750**	**30.8**
	Weighted Score	0		0	2.5	1.5625	1.5625		0	5.625		0	0	0	0.75		0	0		9.375	7.5	1.88		

Appendix H – Cost estimation assumptions and qualifications

General assumptions:

- No contaminated soil on site. This would largely affect the disposal price.
- Soil is 'light' as referenced to in Rawlinsons.
- Culverts are all separate projects. The number of culverts ordered at one time affects the price of the culverts. Price is for 4 ordered at a time.
- Basins have only bank stabilisation included in landscaping.
- Contingency is 20%.
- Preliminaries are 10%.
- Private land is assumed $12/m^2$.
- Government land is assumed $6.50/m^2$.
- There is potential for some extra soil cut will not have to be taken to a dump and could be disposed at other closer locations for other contractors/works.

Drains assumptions:

- Freeboard is 0 m.
- 10 m either side of the drain is acquired also.
- It is assumed that the volume for the 200 mm topsoil that is stripped and stockpiled is equal to that of the volume for the 150mm topsoil that is respread over the drain walls.

Culverts assumptions:

- The road plus 5 m either side is government land. The rest is assumed private.
- 20 m of guard rail each side of the road crossing the culvert location.
- 300 mm added each side of the culvert for excavation purposes.
- 200 mm below culvert added for bedding materials for excavated purposes.
- Headwall cost is assumed to be the multiple of how many runs there are.

Pipes assumptions:

- Cost of some pipe sizes have been interpolated.
- Cost of some headwall sizes have been interpolated and extrapolated.
- The road plus 5 m either side is government land. The rest is assumed private.
- 20 m of guard rail each side of the road crossing the pipe location.
- 150 mm added each side of the culvert for excavation purposes.
- 200 mm below culvert added for bedding materials for excavated purposes.
- Headwall cost is assumed to be the multiple of how many runs there are.

Basin assumptions:

- 3 natural surface levels were taken for each basin to determine roughly how much, if any, overburden removal will be required.
- An allowance has been made for approximately 300mm of freeboard above the 100yr ARI flood level in the basins.
- No planting required for banks due to outer metro area.
- All land is private land and none is acquired from government.

- It is assumed that the volume for the 200 mm topsoil that is stripped and stockpiled is equal to that of the volume for the 150 mm topsoil that is respread over the basin walls.

Cost estimates provided by Tonkin are based upon historic cost information and experience, and do not allow for:

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- Approvals for these works
- Site contamination and remediation testing, remediation action plan.
- Design, construction, project management
- Tree removal
- Disposal of contaminated material
- The staging of these works

- **Preliminaries include:**
- Establishment
- Insurances
- Site facility and security
- Site management (QA, OHS&W)
- Environmental management provisions, CEMP, stockpile management
- Traffic and pedestrian management
- Set out survey
- As-built verification survey plans
- Compaction testing
- Locate and protect existing overhead and underground services
- Resident notification
- De-mobilisation including removal of compound and site tidy up

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin recommends that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

Appendix I – Summary of costs per precinct

CONSTRUCTION COST ESTIMATE

Project: **GEP SMP**
Job No: 20170712
Date: 02-04-20
Revision: A
Summary of works: Works recommended in SMP
Estimated: MM
Review: TAK

Item No	Description	Comment		Cost
1.0	**Pellew**			
1.1	Preliminaries	Assumed to be 10% of estimate	$	2,245,872.66
1.2	Contingency	Assumed to be 20% of estimate	$	4,940,919.85
1.3	Channels		$	9,330,341.63
1.4	Pipe / RCBC		$	1,102,034.98
1.5	Basins		$	7,026,350.00
1.6	Bridge		$	5,000,000.00
	Sub-Total		**$**	**29,645,519.13**
2.0	**Greyhound**			
2.1	Preliminaries	Assumed to be 10% of estimate	$	2,108,709.38
2.2	Contingency	Assumed to be 20% of estimate	$	4,639,160.64
2.3	Channels		$	9,200,064.41
2.4	Pipe / RCBC		$	994,569.07
2.5	Basins		$	10,892,460.33
	Sub-Total		**$**	**27,834,963.83**
3.0	**Port Wakefield**			
3.1	Preliminaries	Assumed to be 10% of estimate	$	1,238,241.08
3.2	Contingency	Assumed to be 20% of estimate	$	2,724,130.37
3.3	Channels		$	6,754,595.62
3.4	Pipe / RCBC		$	1,521,716.38
3.5	Basins		$	4,106,098.75
	Sub-Total		**$**	**16,344,782.19**
4.0	**St Kilda**			
4.1	Preliminaries	Assumed to be 10% of estimate	$	1,723,545.14
4.2	Contingency	Assumed to be 20% of estimate	$	3,791,799.30
4.3	Channels		$	13,360,310.87
4.4	Pipe / RCBC		$	1,674,641.43
4.5	Syphon		$	1,700,499.08
4.6	Outlet		$	500,000.00
	Sub-Total		**$**	**22,750,795.82**
5.0	**NEXY South**			
5.1	Preliminaries	Assumed to be 10% of estimate	$	509,859.46
5.2	Contingency	Assumed to be 20% of estimate	$	1,121,690.82
5.3	Channels		$	2,425,851.05
5.4	Basins		$	2,672,743.59
	Sub-Total		**$**	**6,730,144.92**
6.0	**Symes**			
6.1	Preliminaries	Assumed to be 10% of estimate	$	1,283,064.82
6.2	Contingency	Assumed to be 20% of estimate	$	2,822,742.60
6.3	Channels		$	9,646,414.20
6.4	Pipe / RCBC		$	3,184,233.96
	Sub-Total		**$**	**16,936,455.57**
		Grand Total	**$**	**120,242,661.46**

Note:

Cost estimates provided by Tonkin are based upon historic cost information and experience, and do not allow for:

- Latent conditions
- Changes in scope
- Market conditions (i.e. competition, escalation)
- No allowance for approvals for these works
- No allowance for site contamination and remediation or disposal of contaminated material
- No allowance for land acquisition
- No allowance has been made for the staging of these works
- No allowance has been made for landscaping works
- No allowance has been made for service depthing, liaison with service authorities, design of service relocations
- No allowance has been made for project delivery costs including project management
- Calculations assume clay soil and no rock will be encountered

These estimates are to be considered as indicative only, and are not purported to represent anything more than an indication of the cost of the scope of the work.

Tonkin recommends that an appropriately qualified quantity surveyor be consulted to provide detailed market cost inputs.

Appendix J – Initial stakeholder consultation workshop

WORKSHOP NOTES

Project	Stormwater Management Plans – Adams Creek and Helps Road Drain catchment Greater Edinburgh Parks and St Kilda catchment
Date	25 October 2017
Location	Tonkin Consulting, 66 Rundle Street, Kent Town SA
Project Reference	2017-0231

Attendees

Braden Austin	City of Playford	Martin Fidge	DPTI
Paul Johnson	City of Playford	Ruth Ward	EPA
Andrew Smith	City of Playford	Colin Martin	Martin Real Estate
Peter Jansen	City of Salisbury	Yun Lian	Martin Real Estate
Bruce Naumann	City of Salisbury	Simon Tonkin	Masterplan
Harry Pitrans	City of Salisbury	Gerry Davies	PIRSA
Jason Tamas	City of Salisbury	Jason Rollison	Renewal SA
Dameon Roy	City of Salisbury	Harry Roberts	SA Water
Murray Townsend	Coast Protection Board	Claudio Cordillo	SCT
Greg Ahrens	Department of Defence	Tim Kerby	Tonkin Consulting (Consultant Team PM)
Alex Frolow	Department of Defence	Samantha West	Tonkin Consulting
Damian Moroney	DEWNR - Natural Resources AMLR	Zoe Hambour	URPS (Facilitator)
Rachel Murchland	DEWNR	Angela Hazebroek	URPS (Facilitator)
		Anna Pannell	URPS (Facilitator)

1. Objectives of workshop

The objectives of the workshop were to:

- Provide stakeholders and community representatives with information about the project team's approach to the project.
- Discuss desired outcomes for stormwater management in the catchment.
- Identify and document existing and potential development and stormwater issues in the catchments.
- Identify and document options for stormwater management including flood mitigation, water quality improvement and stormwater harvest and reuse.

2. Introduction and Background

Braden Austin (City of Playford) provided an introduction to the stormwater management planning project and its objectives, noting the concurrent development of a stormwater management plan for the Smith Creek catchment to the north.

Tim Kerby (Tonkin Consulting, Consultant Team Project Manager) provided a summary of the previous investigations including flood modelling. Tim gave a brief description of the catchment, identifying key features and areas subject to flooding.

Anna Pannell (URPS) described the engagement activities planned for the project and the objectives of the workshop.

3. Desired outcomes for stormwater management

To assist in developing objectives for the SMPs, attendees were asked:

"What are your desired outcomes for stormwater management?"

The workshop facilitators collated the outcomes and grouped them by theme as shown in the table below. These were used later in the workshop as the basis for a discussion about stormwater management priorities.

THEME	DESIRED OUTCOMES
Funding and costs	• Certainty of costs to land-owners • Understanding of compensation/equalisation mechanisms among landowners • Funding – SMA funds committed next 20 years • Location of infrastructure vs who pays vs who is impacted by reduced land area • Existing and approved development not funding reuse or water quality improvement
Physical infrastructure	• Integrate channels into future road layout, rather than through sites • More trash racks and sediment traps within catchments • All flood retention and detention basins as close to source as possible • Better defined and maintained drainage channels • Detention basin design that creates or enhances shorebird habitat • Ability to manage runoff given landscapes minimal natural fall / gravity • Interaction with evaporation ponds • Reduce existing detention basins • Timing critical – infrastructure needed now (SMP may delay)
WSUD	• Excellent WSUD in developing areas • Retrofit WSUD in existing development in catchments
Harvesting and reuse	• Water quality required for ASR • Alternate water supply source (harvesting) • Potential to make use of water in horticulture • Existing stormwater harvesting schemes, no negative impact on water quality • Increase in stormwater treatment and MAR • Maximise water capture and reuse for food production
Economic development	• Enabler for economic development • Priority of Northern Economic Plan
Runoff	• No discharge or deposition of pollution or waste on to SA Water Bolivar site

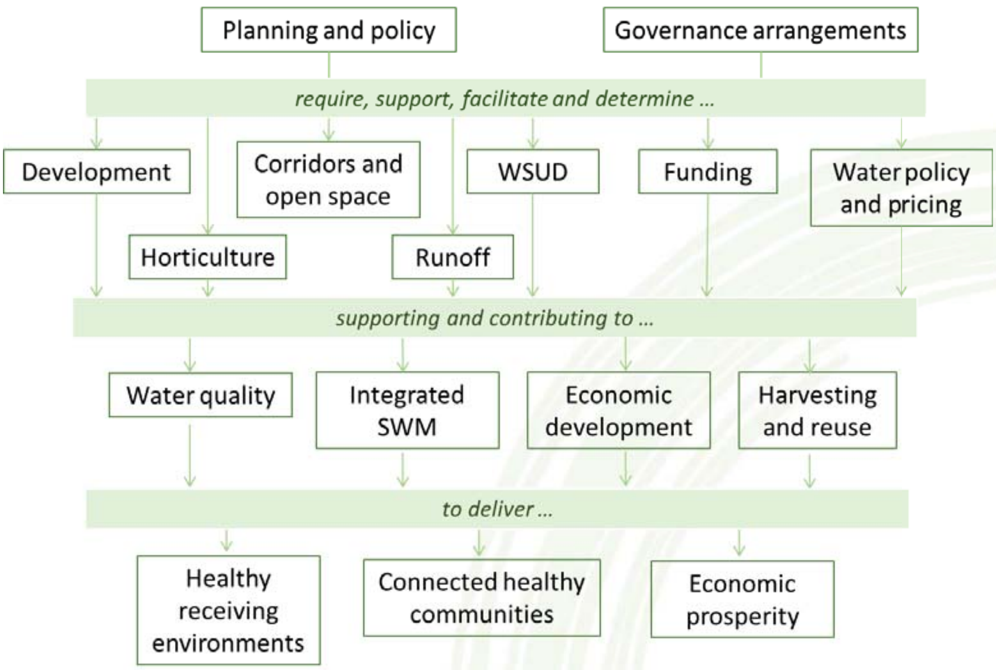
	• NRM Target – 75% reduction in stormwater runoff – achieve while runoff rates increase greatly from 2-5mm per year to 200-400mm per year • Manage stormwater runoff in greenhouse areas
Contamination	• Consideration of legacy contamination • Manage / mitigate contamination pathways • Defence contamination and wider PFAS contamination
Corridors and open space	• Active green space that doubles as drainage corridors • Improved amenity for residents through better multi-objective open space opportunities • Use of stormwater infrastructure for passive and active pursuits, formal and informal spaces and corridors • Linked corridors, green trails and biodiversity links • Consideration, implementation and prioritisation of multiple objectives including reuse, water quality, flow management, green space for recreation, aesthetics and cooling • Airfield management and operations eg wildlife, glare • Bird and wildlife control – airfield operations
Receiving environments	• Reduce sediment outflows to the gulf • Minimise impacts to Gulf waters • Quality discharge is a key consideration, meaning reducing flows as much as possible and achieving multiple objectives • Minimise discharge to Gulf and maximise water quality • SA Water not a receiving site for stormwater • Marine receiving waters
Planning and development	• Safeguards for vacant land for future stormwater infrastructure • Pre-defined corridors for regional drainage scheme • Consider likely increases in urban density • Flexibility to adapt for unintended growth/development • Employment/industry area – all land needs to be drained • Improvements in existing development occur concurrently with multi-objective stormwater management in newly developed areas • Residential land use within area between Waterloo Corner, Heaslip, Port Wakefield and Northern Expressway using stormwater within the development • Confirmation of proposed drainage reserves/easements for future planning • Long term plan that links to Development Assessments to ensure developer/Federal funding sources are channelled appropriately • Clarity of information for translation into development policy
Drainage and flooding	• Flood protection of Defence estate and infrastructure • Stormwater passes through Bolivar without breaking drain boundaries • Short-medium-long term strategy for flood issues currently experienced • Deal with rising water table in some areas, integrate with surface water drainage • Protect horticulture from flooding
Horticulture	• High quality farm land is still important • Manage impacts on food bowl
Integrated SW management	• Integrated water management with SA Water and councils • Integrated stormwater infrastructure as part of a developed community • Connected communities with stormwater being one catalyst for that connection
Governance	• Relationship of SMA with Regional Authority and Planning and Design Code

Following the issues and opportunities identification (see items 4 and 5), attendees were asked to vote on which outcomes they thought were the most important. Each attendee was given three votes to allocate to outcome themes and the votes allocated are shown in the table below. A discussion of the voting scores and themes was facilitated and the links between each of the outcomes were discussed.

OUTCOME THEME	VOTES
Planning and development	11
Funding and costs	8
Receiving environments	6
Physical infrastructure	5
Drainage and flooding	5
Economic development	4
Contamination	4
Harvesting and reuse	3
Corridors and open space	3
Integrated SW management	3
WSUD	2
Runoff	2
Governance	2
Horticulture	1

Attendees noted the difficulty in separating some of the themes, and the links between themes, especially that the achievement of some outcomes, for example the improved quality of discharges to receiving environments requires management of runoff through physical infrastructure and WSUD, which are facilitated by supportive planning policy and development.

During the write-up of the workshop notes, the project team developed the following diagram which indicates some of the links and hierarchy discussed at the workshop.



4. Issues for stormwater management

Attendees were asked to consider issues for stormwater management across the two catchments by placing numbered dots on maps of the catchment corresponding to particular issues. Comments relating to each issue were noted.

Map 1 shows the identified issues.

5. Opportunities for stormwater management

Attendees were asked to consider opportunities for stormwater management across the two catchments by placing numbered dots on maps of the catchment corresponding to particular issues. Comments relating to each opportunity were noted.

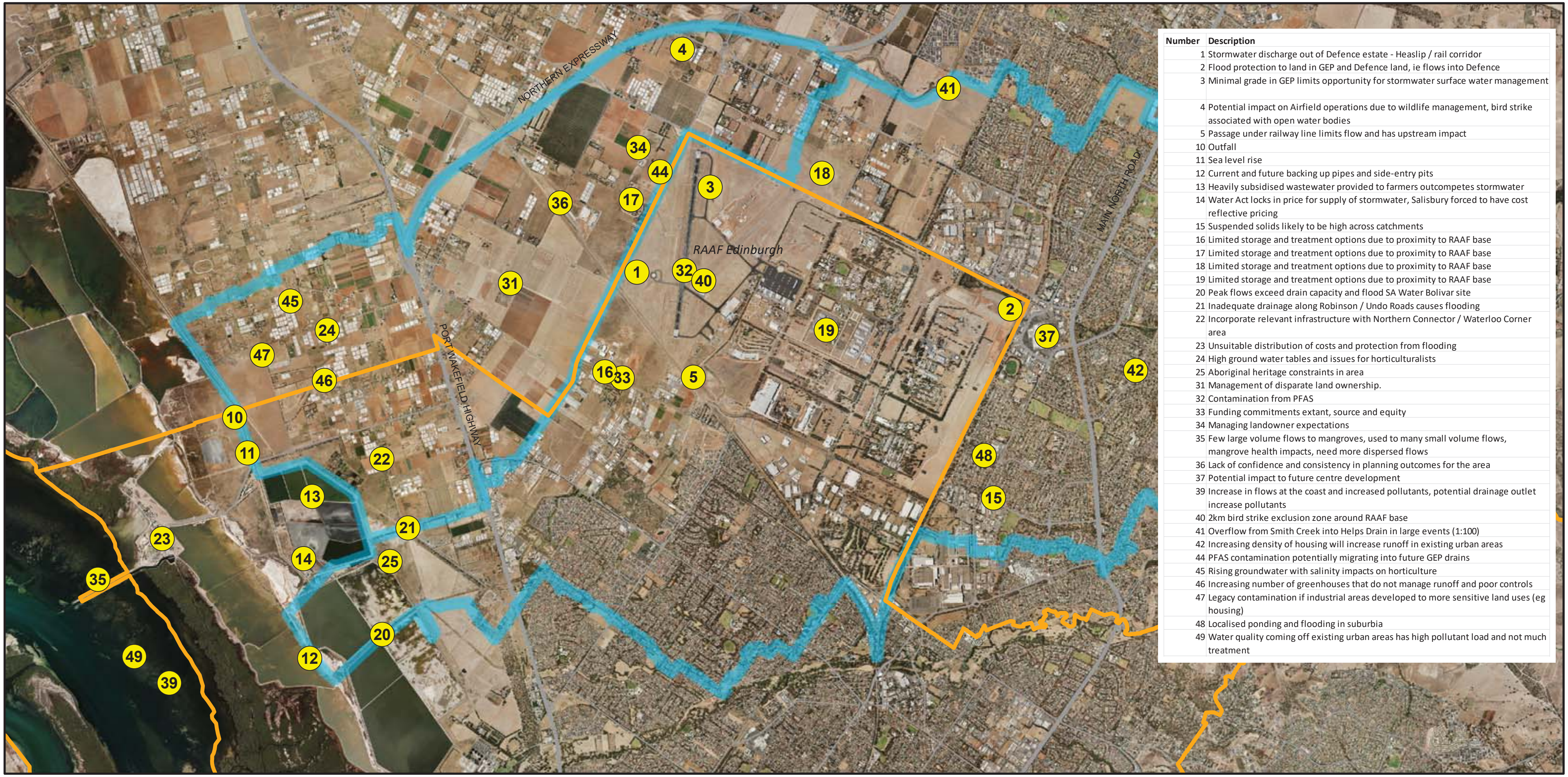
Map 2 shows the identified opportunities.

7. Next steps and further information

The project team described key next steps and invited attendees to provide further feedback.

Comments or issues relating to technical issues should be directed to the Tonkin Project Manager, Tim Kerby (Tonkin), ph 8273 3100 or email Tim.Kerby@tonkin.com.au

Comments or issues relating to engagement activities should be directed to Anna Pannell (URPS), ph 8333 7999 or email anna@urps.com.au.



Number	Description
1	Stormwater discharge out of Defence estate - Heaslip / rail corridor
2	Flood protection to land in GEP and Defence land, ie flows into Defence
3	Minimal grade in GEP limits opportunity for stormwater surface water management
4	Potential impact on Airfield operations due to wildlife management, bird strike associated with open water bodies
5	Passage under railway line limits flow and has upstream impact
10	Outfall
11	Sea level rise
12	Current and future backing up pipes and side-entry pits
13	Heavily subsidised wastewater provided to farmers outcompetes stormwater
14	Water Act locks in price for supply of stormwater, Salisbury forced to have cost reflective pricing
15	Suspended solids likely to be high across catchments
16	Limited storage and treatment options due to proximity to RAAF base
17	Limited storage and treatment options due to proximity to RAAF base
18	Limited storage and treatment options due to proximity to RAAF base
19	Limited storage and treatment options due to proximity to RAAF base
20	Peak flows exceed drain capacity and flood SA Water Bolivar site
21	Inadequate drainage along Robinson / Undo Roads causes flooding
22	Incorporate relevant infrastructure with Northern Connector / Waterloo Corner area
23	Unsuitable distribution of costs and protection from flooding
24	High ground water tables and issues for horticulturalists
25	Aboriginal heritage constraints in area
31	Management of disparate land ownership.
32	Contamination from PFAS
33	Funding commitments extant, source and equity
34	Managing landowner expectations
35	Few large volume flows to mangroves, used to many small volume flows, mangrove health impacts, need more dispersed flows
36	Lack of confidence and consistency in planning outcomes for the area
37	Potential impact to future centre development
39	Increase in flows at the coast and increased pollutants, potential drainage outlet increase pollutants
40	2km bird strike exclusion zone around RAAF base
41	Overflow from Smith Creek into Helps Drain in large events (1:100)
42	Increasing density of housing will increase runoff in existing urban areas
44	PFAS contamination potentially migrating into future GEP drains
45	Rising groundwater with salinity impacts on horticulture
46	Increasing number of greenhouses that do not manage runoff and poor controls
47	Legacy contamination if industrial areas developed to more sensitive land uses (eg housing)
48	Localised ponding and flooding in suburbia
49	Water quality coming off existing urban areas has high pollutant load and not much treatment

Map 1 Issues Identification Stormwater management planning stakeholder workshop

0 500 1,000 2,000 3,000 m

Identified issues (refer table for description)

LGA boundary

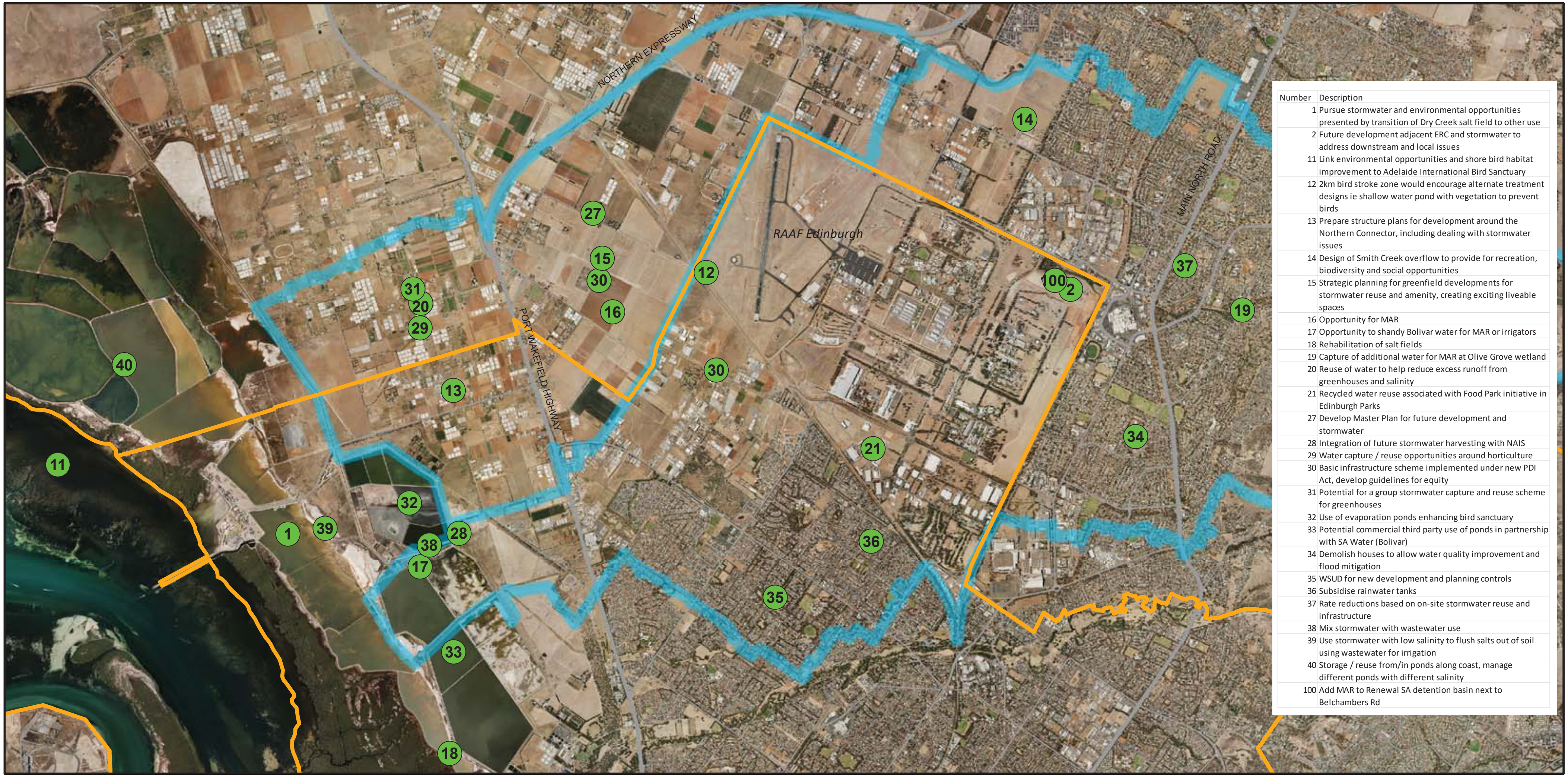
Catchment boundary

Highway, Freeway

Arterial, Subarterial Road

JOB REF.	17ADL-0231
PREPARED BY	AP
DATE	26.10.2017
REVISION	1
DATA SOURCE	DPTI, DEWNR

URPS



Number	Description
1	Pursue stormwater and environmental opportunities presented by transition of Dry Creek salt field to other use
2	Future development adjacent ERC and stormwater to address downstream and local issues
11	Link environmental opportunities and shore bird habitat improvement to Adelaide International Bird Sanctuary
12	2km bird stroke zone would encourage alternate treatment designs ie shallow water pond with vegetation to prevent birds
13	Prepare structure plans for development around the Northern Connector, including dealing with stormwater issues
14	Design of Smith Creek overflow to provide for recreation, biodiversity and social opportunities
15	Strategic planning for greenfield developments for stormwater reuse and amenity, creating exciting liveable spaces
16	Opportunity for MAR
17	Opportunity to shandy Bolivar water for MAR or irrigators
18	Rehabilitation of salt fields
19	Capture of additional water for MAR at Olive Grove wetland
20	Reuse of water to help reduce excess runoff from greenhouses and salinity
21	Recycled water reuse associated with Food Park initiative in Edinburgh Parks
27	Develop Master Plan for future development and stormwater
28	Integration of future stormwater harvesting with NAIS
29	Water capture / reuse opportunities around horticulture
30	Basic infrastructure scheme implemented under new PDI Act, develop guidelines for equity
31	Potential for a group stormwater capture and reuse scheme for greenhouses
32	Use of evaporation ponds enhancing bird sanctuary
33	Potential commercial third party use of ponds in partnership with SA Water (Bolivar)
34	Demolish houses to allow water quality improvement and flood mitigation
35	WSUD for new development and planning controls
36	Subsidise rainwater tanks
37	Rate reductions based on on-site stormwater reuse and infrastructure
38	Mix stormwater with wastewater use
39	Use stormwater with low salinity to flush salts out of soil using wastewater for irrigation
40	Storage / reuse from/in ponds along coast, manage different ponds with different salinity
100	Add MAR to Renewal SA detention basin next to Belchambers Rd

Map 2 Opportunities Identification
Stormwater management planning stakeholder workshop

0 500 1,000 2,000 3,000 m

Identified opportunities (refer table for description)

LGA boundary

Catchment boundary

Highway, Freeway

Arterial, Subarterial Road

JOB REF.	17ADL-0231
PREPARED BY	AP
DATE	26.10.2017
REVISION	1
DATA SOURCE	DPTI, DEWNR

URPS

Appendix K – What We Heard Report

CITY OF Playford

Draft Stormwater Management Plans 2022/23

Community Engagement What We Heard Report

June 2022

Draft Stormwater Management Plans

What We Heard Report

June 2022

Contents

1. What we asked

Council's draft Stormwater Management Plans (SMPs) are regional level stormwater catchment studies and have been prepared in accordance with Stormwater Management Authority (SMA) Guidelines. Alignment with these guidelines achieves best practice but further ensures future works arising from such plans are eligible for funding from the SMA.

The City of Playford has been working with the City of Salisbury, Town of Gawler, the SMA and Green Adelaide in developing three Regional SMPs, with a first round of community and stakeholder engagement occurring during the development of the draft plans. This included:

- Targeted public and private sector stakeholder workshop in 2017 including Elected Member information sessions.
- Community engagement about key issues, desired outcomes and opportunities for the SMPs in 2018. This engagement consisted of an online and hard copy feedback form, print and social media promotion. Social media reached around 9,000 people but engaged only 0.33% of those. Only five survey responses were received across the three Council areas.

The SMA Planning Guidelines outline that a second round of community engagement is required prior to the SMA approving the SMPs.

The objectives of community engagement for the draft SMPs were to:

- **Inform** the wider community about the draft SMPs and build awareness of their role in guiding future decisions related to stormwater management.
- **Consult** the community on the draft SMPs, seeking views on the objectives of each SMP which have informed the priorities.

The following table identifies what we engaged the community on for the Stormwater Management Plans:

What we need information on and how we will use it	Negotiables	Non-Negotiables
Understanding the level of priority for objectives detailed in the draft Stormwater Management Plans. Community feedback may be used to refine SMPs and will be shared with Council to support decision making when seeking endorsement of SMPs Community objective priorities will be considered when assessing and determining strategy and future planning	Determining which objectives the community feels are most important	The extent or effect of flooding or water quality The stormwater management planning approach Individual measure identified Objectives and levels of service

2. How we asked it (engagement approach)

An overview of the Community Engagement Plan is provided below. These activities were delivered between 7 April and 9 May 2022**.**

Engagement and communication activity included:

Activity	Details
Online Engagement	The Engagement Hub webpage went live on 7 April and formed the central location for all engagement documents including simplified summary document (snapshot) and feedback form.
Feedback Form (online and hard copy)	Updated information on Council's corporate website with links to online engagement listing.
Face to Face Engagement	Three drop-in sessions were held for community members to meet with Council staff, ask questions about the plans and provide feedback in person.
Website Article	Updated information on Council's corporate website with links to online engagement listing.
Social Media	Three dedicated social media posts on City of Playford official social media channels communicating the commencement of community consultation and sharing details of community engagement activities and feedback options.
eNewsletter	An eNewsletter article in Playford eNews to all registered subscribers.
Council Sites	Relevant documents pertaining to the plans and engagement process were displayed at Customer Contact locations and other Council sites.

3. What we heard

Description	Channels	Performance
Aware visitors (number of those who visited Council's online engagement page, saw social media posts or visited the web article online)	Engagement Hub page views Website Article views and average time on page Social Media Reach (three Facebook posts)	562 173 visits with an average of 2:54 minutes spent on page 7,501
Informed visitors (number of those who downloaded a document or visited the FAQs on Engagement Hub)	Document downloads	168
Engaged visitors (number of those who provided feedback in some way – either in the survey, via email or at the community drop-in session	Feedback Forms Attendance at Drop Ins Social Media Engagement (reactions, comments and shares across three Facebook posts) Emails	5 4 613 0

Feedback Forms
Number of responses: 5

Representation from:

Suburb	Count
Angle Vale	3
Elizabeth Downs	1
Virginia	1

Feedback on:

Draft Stormwater Management Plan	Count
Smith Creek Catchment	4
Adams Creek & Helps Road Catchment	1

Feedback Specific to Smith Creek Catchment

Most important
1. Flood management
2. Asset management
3. Water reuse
4. Improve water quality*
4. Protect the Environment*

*Improve water quality and protecting the environment were ranked equally important.

Reason for ranking of importance
"Angle Vale has little to no stormwater management. Do some!"
"We currently have no stormwater scheme, so a start is good."

Feedback Specific to Adams Creek & Helps Road Catchment

Most important
1. Water reuse
2. Protect the environment
3. Improve water quality
4. Asset management
5. Flood management

Reason for ranking of priorities
N/A

Community Drop-in Sessions

Session 1: Virginia Horticultural Centre - 19 May 2022
Number of attendees: 1

Concern/Suggestion	Council Response
Discussed the Smith Creek and Greater Edinburgh Park SMPs.	Council's Stormwater Planner outlined the purpose of the Regional SMPs in setting out a stormwater strategy for the council.
Expressed concerns around the impact of Smith Creek widening on properties and whether this was the only opportunity to comment. Expressed appreciation of our time and the work done to prepare the plans.	Council will consult with the community on projects identified within the regional SMPs when they are planned for delivery through future annual business planning processes and through the design phase where appropriate.

The session was also attended by Cr Marsh who discussed the regional plans and how they will form part of Council's strategic document suite.

Session 2: Civic Centre Library – 21 April 2022
Number of attendees: 0

There were no community members attending this session.

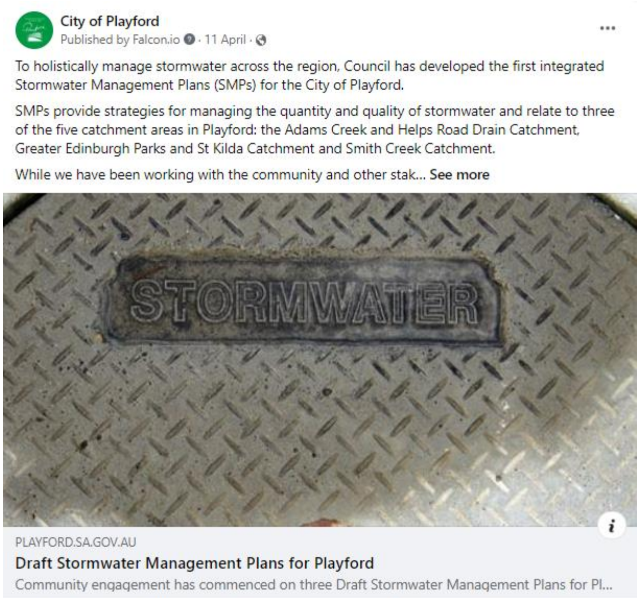
This session was attended by Cr Onuzans. Our Stormwater Planner was able to outline the purpose of the regional SMPs and how it addressed stormwater management across the Adams Creek and Helps Road Catchment.

Session 3: Civic Centre Great Hall – 5 May 2022
Number of attendees: 1

Concern/Suggestion	Council Response
Discussed the Smith Creek SMP.	Council staff outlined the diverse levels of stormwater management within the Council area ranging from nuisance flooding to large scale flood management. This discussion leads into the work behind the regional SMPs and next stages of endorsement by the SMA.
Expressed concerns around stormwater issues relevant to Angle Vale.	Comprehensive SMPs have been developed for the growth areas.

Social Media Summary

Facebook Post One – 11 April, 2022



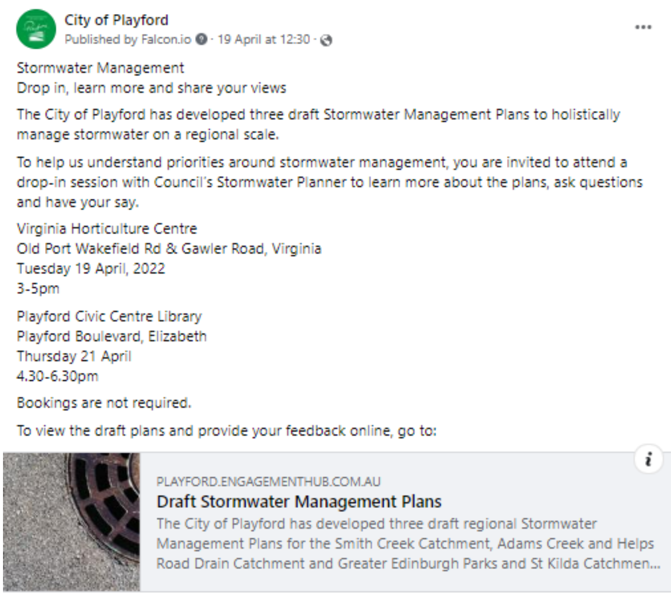
Engagement (Engaged Visitors) - 131
Reactions – 13
Comments –14
Link clicks – 17
Shares – 3

Reach (Aware Visitors) – 1,825

Summary of comments
The comments were mainly questions about specific issues across the city – from requests for a new playground and connecting recycled rainwater.

There was a request for an additional drop-in session which we held in May based on this feedback.

Facebook Post Two – 19 April, 2022



Engagement (Engaged Visitors) - 38
Reactions – 12
Comments – 3
Link clicks – 8
Shares – 8

Reach (Aware Visitors) – 1,666

Summary of comments
The comments were on post shares and therefore not viewable.

Facebook Post Three – 02 May, 2022

City of Playford
Published by Falcon.io · 2 May at 11:00

Drop in, learn more and share your views

The City of Playford has developed three draft Stormwater Management Plans to holistically manage stormwater on a regional scale. The plans are currently open for the community to share their views.

We have organised an additional drop-in session with Council's Stormwater Planner, Shaun (pictured here), so you can learn more about the plans, ask questions and provide feedback.

Thursday 5 May
3:30pm – 5:30pm
Playford Civic Centre – Great Hall
10 Playford Boulevard, Elizabeth

Bookings are not required - simply drop by for a chat.

Can't make it but want to be involved?

You can also speak to our Stormwater Planner via phone or in person – call or email to arrange a time to meet Shaun that suits you on 8256 0333 or publicconsultation@playford.sa.gov.au

To read the draft plans and share your thoughts online, visit the project page here 👉 https://fal.cn/3oelS

Consultation closes Monday 09 May.

Engagement (Engaged Visitors) - 444
Reactions – 78
Comments – 34
Link clicks – 14
Shares – 6

Reach (Aware Visitors) – 4,010

Summary of comments
The majority of comments on this post were on shares and therefore not viewable.

There was a query about a specific drainage problem which was addressed offline.

Summary

Given the complex and targeted nature of the content, the SMP social media posts achieved a pleasing level of reach and engagement. As expected, most comments on posts related to specific issues around Playford and were not specifically related to stormwater management.

There was no feedback provided as to the support or otherwise of the draft SMPs via this channel.

Post number three – featuring an image of Stormwater Planner Shaun Fielding – was the best-performing post. It achieved significant reach and engagement, having 1.4 times more impressions than other posts within 10 days of publishing. This is a reminder that content featuring images native to Facebook and of the real people behind the projects can help achieve greater reach, engagement and awareness.

4. What we will do /our response

The purpose of the community engagement was to inform the community about the regional SMPs that Council had developed for the three major catchment areas in Playford. We also provided the opportunity for the community to tell us what stormwater objectives were important to them in these plans as outlined in the feedback section.

A summary of the community engagement undertaken will be incorporated into the three SMPs. The SMPs will then be submitted to the Elected Members for endorsement to the SMA.

Once the plans are endorsed by the SMA it will enable the council to achieve the following:

- The SMPs will form part of our long-term strategic document suite that will inform stormwater planning for future years
- Apply for funding of the stormwater projects identified in the SMPs through the SMA (SA Government)
- The council can recover funding from the SMA for the preparation of the SMPs as part of the grant agreement between Council and the SMA.

The feedback provided will also assist Council in determining the priorities of projects identified in the plans. This will enable Council to select stormwater projects that service the community in line with the Playford Community Vision 2043 and Strategic Plan. Council will engage with the relevant stakeholders on a more detailed level on each project.

5. Appendix

5.1 Marketing and communications collateral

Engagement Hub

Draft Stormwater Management Plans

Overview

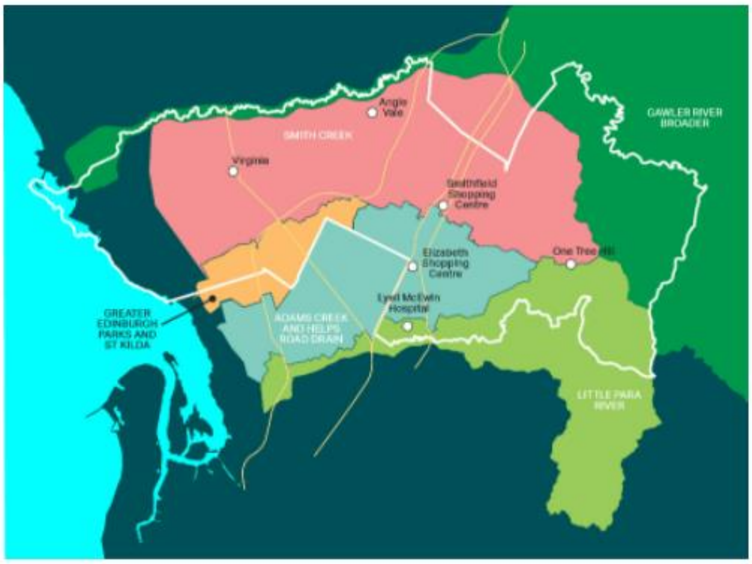
The City of Playford has developed three draft regional Stormwater Management Plans for the Smith Creek Catchment, Adams Creek and Helps Road Drain Catchment and Greater Edinburgh Parks and St Kilda Catchment. To help us understand priorities around stormwater management, we are sharing the draft plans with the community and seeking your input.

Background Information | **Key Dates**

Like other councils around Australia, the City of Playford uses Stormwater Management Plans to holistically manage stormwater across the city.

Council has developed three draft SMPs for three of the five catchments that impact the city, including:

- Adams Creek and Helps Road Drain
- Greater Edinburgh Parks and St Kilda
- Smith Creek



The SMPs focus on resolving large scale flooding issues in an integrated way and minimise the adverse impacts flooding events can have on homes and businesses.

Each SMP has its own objectives and strategies that inform land use planning, minimise flooding impacts, protect and enhance ecosystems, minimise costs and take advantage of opportunities for reuse, recreation and amenity.

Provide your feedback here

We encourage you to have a read of the summary document 'Stormwater Management - a guide to understanding stormwater in Playford' and relevant draft stormwater management plans located on the right of this page before you provide your feedback.

This survey will close 5pm Monday 9 May 2022.

Take the survey

Key Documents

Summary - Stormwater in Playford

A Guide to Understanding Stormwater in Playford

Printable Survey Form

Printable Survey Form

Stormwater Management Plans

- Adams Creek & Helps Road Drain Catchment - Draft SMP
- Greater Edinburgh Park and St Kilda Catchment - Draft SMP
- Smith Creek Catchment - Draft SMP

Community Drop In Sessions

Drop In Session - Virginia Horticulture...
From : Tue, 19 Apr 2022 03:00 PM
To : Tue, 19 Apr 2022 05:00 PM
At : Virginia

Drop In Session - Playford Civic Centre...
From : Thu, 21 Apr 2022 04:30 PM
To : Thu, 21 Apr 2022 06:30 PM

Feedback Form

Draft Stormwater Management Plan Survey

Consultation close date: Monday 5pm 9 May 2022

The City of Playford has developed three draft regional Stormwater Management Plans for the Smith Creek Catchment, Adams Creek and Helps Road Drain Catchment and Greater Edinburgh Parks and St Kilda Catchment. To help us understand your priorities around stormwater management, we are sharing the draft plans with the Playford community.

What we are seeking feedback on
We have identified 5 objectives we need to address in each draft plan. These are flood management, protecting the environment, water reuse, improving water quality and asset management and are referenced in more detail on the following page.

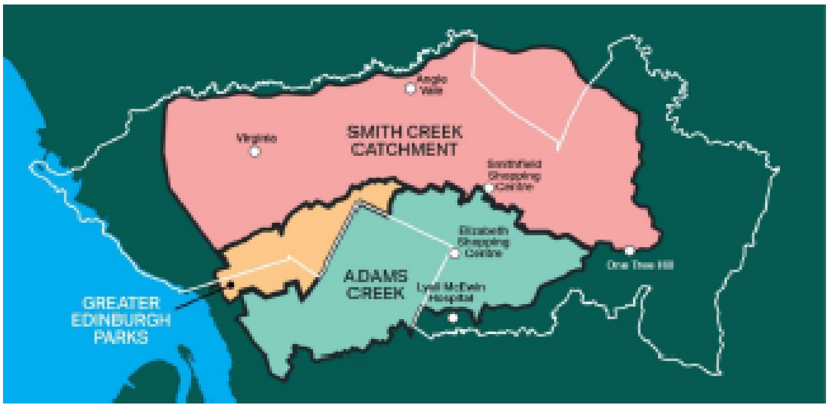
We now need your input to determine what objectives are most important to you. In this survey you will be asked to rank the objectives in order of importance to you and you are welcome to provide any additional comments.

This feedback will inform Council decision making around stormwater management and the prioritisation of stormwater projects in the future.

1. Your suburb: ______________________________________

2. Tick the Draft Stormwater Management Plans (SMP) you would like to provide feedback on. A map is below to help you make your selection.

☐	Smith Creek Catchment
☐	Adams Creek and Helps Road Drain Catchment
☐	Greater Edinburgh Parks and St Kilda Catchment



Draft Stormwater Management Plan Survey

Reference - Stormwater Objectives	
Flood management	The protection of buildings and properties from flooding through the construction of detention basins and open channel upgrades.
Improve water quality	Reducing pollution of stormwater from various sources such as roads and farming activities.
Water reuse	The collection of stormwater in our wetlands system that is then treated and reused for irrigating our reserves.
Protect the environment	Improving the health of our creeks and waterways through the removal of rubbish and weeds, revegetating programs and managing erosion.
Asset management	An asset management system for our stormwater network to ensure it is renewed appropriately.

3. Rank the following priorities from 1-5, with 1 being the most important to you. You only need to do this for the plans you would like to provide feedback on.

	Smith Creek Catchment
	Flood management
	Improve water quality
	Water reuse
	Protect the environment
	Asset management

Reason for your ranking (optional)

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2

Draft Stormwater Management Plan Survey

Adams Creek and Helps Road Drain Catchment	
☐	Flood management
☐	Improve water quality
☐	Water reuse
☐	Protect the environment
☐	Asset management

Reason for your ranking (optional)

Greater Edinburgh Parks and St Kilda Catchment	
☐	Flood management
☐	Improve water quality
☐	Water reuse
☐	Protect the environment
☐	Asset management

Reason for your ranking (optional)

CITY OF Playford

Draft Stormwater Management Plan Survey

4. Do you have additional feedback about the draft Stormwater Management Plans? (Optional)

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Thank you for your time and participation.

Your feedback will be used to refine our plans and help us understand what we need to consider in any future planning around stormwater management in Playford. A summary of our community's feedback and the refined plans will be shared to Council for their consideration and endorsement in June-July 2022 before going to the Stormwater Management Authority and Green Adelaide for final approval. Once approved, final plans will be published and made available on Council's website later this year.

How to submit this form:

- Drop off: Playford Civic Centre or Stretton Centre customer service desks
- Post: Attn: Draft Stormwater Management Plans, 12 Bishopstone Road, Davoren Park SA 5113
- Email: publicconsultation@playford.sa.gov.au

Need more information?

If you need further information or have questions, you are welcome to call us on 8256 0333 and leave your contact details and times of availability. Our Urban Infrastructure Planner, Shaun Fielding, can then reach out for a chat.

Want to be kept up to date on this project? Leave your details below:

Name:	
Phone:	
Email:	

I would like to be kept up to date on other engagements ☐ **Yes** ☐ **No**

4

Appendix L – DRAINS model results

DRAINS model results: 100 yr ARI

DRAINS results prepared from Version 2019.09

100 yr ARI, future development, 2050 climate change

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Node55	3.19		1.188				
NSA11	3.18		25.649				
NSA9	3.07		26.856				
NSA8	3.03		26.5				
N136434	2.95		27.494				
N136435	2.91		0				
N136436	2.79		26.627				
N136437	2.7		28.544				
N136438	2.64		28.594				
N136439	2.55		30.174				
N136440	2.23		32.429				
N136442	1.42		29.607				
Node26	21.64		4.308				
N19215	21.55		0				
Node27	21.49		7.81				
Node185	21.14		0				
Node28	20.35		12.409				
Node36	20.27		10.562				
Node29	20.23		23.954				
N22183	19.88		20.732				
Node31	19.57		22.62				
Node32	17.69		22.553				
Node182	17.31		27.633				
N20192	16.8		0				
Node33	15.33		26.369				
Node181	13.27		0				
N16286	11.77		11.266				
Node43	11.72		0				
Node44	11.56		10.944				
Node45	11.12		17.133				
N21172	10.92		0				
Node46	9.21		15.203				
Node178	9.1		29.013				
N21174	8.78		0				
N131866	8.01		0				
HW5	7.67		13.507		1.83	0	None
N131872	7.6		0				
N5019	7.46		14.141				
Node50	7.36		0				
NSA33	6.81		19.96				
NSA32	6.76		0				
N127721	6.75		18.528				
N131853	6.35		17.665				
HW4	5.91		19.494		0.89	0	None
NSA25	5.85		0				
NSA23	5.61		18.063				
NSA21	5.41		17.246				
NSA20	5.38		17.159				
NSA17	5.02		16.565				
NSA16	4.99		16.53				
HW1	4.96		16.459		0.98	0	None
N57567	4.81		0				
NSA14	4.26		16.423				
NSA13	4.05		16.855				
HW3	3.7		17.233		0.1	0	None
N57565	3.63		22.592				
Node193	17.88		4.539				
Node64	6.28		5.218				
Node156	6.14		6.664				
Node51	5.95		11.603				
Node166	5.86		11.319				
Node52	5.8		11.256				
Node144	5.21		15.391				
Node53	4.33		14.902				
Node54	3.64		22.904				
Node66	20.7		4.422				
Node134	11.82		0				
Node133	11.56		6.334				

Node68	11.31	6.223
Node137	10.73	17.005
N21177	10.62	0
N21176	9.32	14.712
Node70	9.13	13.522
N131874	8.3	0
N40398	8.3	2.815
Node71	10.12	7.437
Node73	9.65	7.774
Node176	8.83	0
Node85	9.63	1.919
N87222	9.39	0
N7M01	9.33	0
N81667	9.25	0
N81671	8.34	4.089
Node158	6.14	13.84
Node159	5.91	0
Node160	5.59	14.408
Node161	5.31	0
Node117	4.97	16.479
Node116	4.88	0
Node115	4.67	16.058
N38324	4.35	15.982
N38325	4.22	0
Node154	3.96	16.109
Node151	3.76	17.266
N38326	3.28	0
Node114	2.8	17.167
Node150	2.78	17.688
Node105	2.54	40.884
Node106	1.42	40.808
Node94	11.41	5.398
Node93	11.29	4.641
N40403	10.98	0
Node81	10.76	8.748
Node80	10.54	12.335
Node95	7.73	5.142
Node97	7.64	3.802
Node98	7.38	1.647
Node99	6.75	10.295
Node100	6.24	0
Node101	5.14	11.196
Node102	4.34	19.527
Node103	4.14	0
Node148	3.67	21.469
N38322	3.57	0
Node104	2.79	21.151
Node107	4.4	4.632
Node110	2.86	4.558
Node147	2.85	3.279
Node132	12.64	2.171
Node138	13.2	2.23
Node76	12.43	3.638
Node77	11.99	3.481
Node78	11.48	3.383
Node79	11.47	6.052
Node165	5.06	2.323
Node145	5.22	5.305
Node146	5.5	3.368
Node153	3.96	0.999
Node157	6.76	1.917
Node172	8.23	3.903
Node170	7.46	5.413
Node187	9.14	14.662
Node192	8.24	6.643
NSA34	8.15	16.488
Node127	12.22	0
Node130	11.9	5.389
Node131	11.38	0
N3005	10.25	1.627
Node142	8.17	0
N18244	7.85	1.609
N12409	20.43	12.093
N17262	20.42	2.716

Node25	20.37	0
N43543	14.36	3.237
N43541	14.3	2.755
Node39	13.85	0
Node38	13.85	6.418

SUB-CATCHMENT DETAILS

Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm
	Flow Q	Max Q	Max Q	Tc	Tc	Tc	
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)	
Cat60	1.188	0	1.188	0	40	0	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat43288	0.534	0	0.534	15	40	0	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat96	1.426	0	1.426	0	60	0	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat97	2.24	0	2.24	0	60	0	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat98	2.267	0	2.267	0	60	0	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat16	4.308	4.308	0.212	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat17	4.563	4.563	0.154	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat19	4.181	4.181	0.143	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat18	7.166	7.166	0.361	22	37	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat22	4.323	4.323	0.146	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat23	9.702	9.702	0.489	22	37	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat10548	3.038	2.897	0.34	20	15	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat25	11.997	11.997	0.376	27	42	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat36	11.458	11.458	0.583	23	38	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat38	1.651	1.651	0.057	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat39	5.116	5.116	0.175	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat40	14.164	14.164	0.455	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat41	12.694	12.694	0.726	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat85	6.242	6.242	0.357	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat55	6.957	6.957	0.541	23	38	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat43284	0.992	0	0.992	20	60	5	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat43286	0.872	0	0.872	20	60	0	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Cat88	4.539	4.539	0.223	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat74	5.218	5.218	0.392	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat75	1.955	1.955	0.088	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat54	5.97	5.97	0.449	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat59	5.332	5.332	0.241	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat58	10.758	10.758	0.456	25	40	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat34	4.422	4.422	0.156	15	30	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat42	11.225	11.225	0.36	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat49	13.522	13.522	0.434	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat53	11.108	11.108	1.282	22	37	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat48	7.437	7.437	0.375	22	37	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat86	0.876	0.876	0.054	16	31	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat51	1.919	1.919	0.117	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat52	6.703	6.703	0.227	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat81	13.84	13.84	0.593	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat80	5.078	5.078	0.382	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat72	6.47	6.47	0.498	22	37	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat70	3.49	3.49	0.262	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat69	1.512	1.512	0.07	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat68	2.187	2.187	0.1	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat67	1.556	1.556	0.072	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat7M01	3.536	1.607	3.3	20	120	0	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Cat43	5.398	5.398	0.183	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat47	4.641	4.641	0.157	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat76	5.142	5.142	0.253	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat93	2.833	2.833	0.171	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat79	1.647	1.647	0.076	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat78	1.911	1.911	0.088	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat73	6.535	6.535	0.28	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat66	2.271	2.271	0.104	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat61	4.632	4.632	0.36	23	38	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat64	0.953	0	0.953	0	75	0	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Cat65	1.204	0	1.204	0	80	0	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Cat37	2.171	2.171	0.107	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat44	2.23	2.23	0.077	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat45	1.53	1.53	0.053	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat46	4.933	4.933	0.167	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat57	2.323	2.323	0.107	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat63	5.305	5.305	0.404	21	36	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat62	3.368	3.368	0.253	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat71	0.999	0.999	0.046	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat77	1.917	1.917	0.087	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6

Cat82	3.903	3.903	0.132	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat83	5.413	5.413	0.609	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat89	14.662	14.662	0.471	24	39	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat92	6.643	6.643	0.225	19	34	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat91	10.424	10.424	0.525	22	37	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat87	3.118	3.118	0.155	21	36	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat35	5.789	5.789	0.288	21	36	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Cat50	1.627	1.627	0.1	17	32	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat21	12.093	12.093	0.384	25	40	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat20	2.716	2.716	0.093	18	33	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat26479	3.237	3.237	0.114	15	30	5	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Cat24	5.284	5.284	0.259	20	35	5	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6

Outflow Volumes for Total Catchment (1565 impervious + 938 pervious = 2503 total ha)

Storm	Total Rainf	Total Runo	Impervious	Pervious Runoff
	cu.m	cu.m (Runc	cu.m (Runc	cu.m (Runoff %)
AR&R 100	3001120	2229237.0	1975714.8	253522.17 (22.5%)
AR&R 100	2874968	2168267.2	1891960.5	276306.78 (25.6%)
AR&R 100	2726790	2083713.2	1793730.0	289983.31 (28.4%)
AR&R 100	2532305	1909269.1	1664690.0	244579.08 (25.8%)
AR&R 100	2270489	1735697.8	1491008.2	244689.59 (28.7%)
AR&R 100	1156374	784472.69	751913.56	32559.13 (7.5%)
AR&R 100	1302822	929132.25	849064.50	80067.73 (16.4%)
AR&R 100	1411703	1037390.0	921302.50	116087.51 (21.9%)
AR&R 100	1569393	1182839.5	1025913.8	156925.64 (26.7%)
AR&R 100	1745856	1336753.0	1142983.0	193770.02 (29.6%)
AR&R 100	1892283	1456858.3	1240111.5	216746.84 (30.6%)
AR&R 100	2101410	1608806.0	1378862.1	229943.92 (29.2%)

PIPE DETAILS

Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)	
Pipe34106	28.442	1.88	2.949	2.906	AR&R 100 year, 3 hours storm, average 20.9 mm/h, Zone 6
Pipe2380	4.314	2.28	21.641	21.549	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe2382	7.719	3.3	21.488	21.283	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe2544	25.714	2.98	17.305	16.799	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe13	9.209	2.51	13.391	13.274	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
EXPipe195	10.405	1.97	11.768	11.72	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Pipe2715	15.43	2.38	11.122	10.921	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe2720	27.608	2.84	9.098	8.783	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe32692	10.42	2.07	8.09	8.005	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Pipe32695	13.477	1.39	7.626	7.599	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
Pipe254	14.07	1.93	7.462	7.365	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
Pipe31340	18.706	1.44	6.81	6.757	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
PipeSA4	18.49	1.43	5.862	5.85	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
PipeSA3	16.455	2.26	4.829	4.806	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
PipeSA2	18.829	1.19	3.64	3.634	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe17	4.638	2.15	17.878	17.685	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
EXPipe667	4.419	6.95	20.703	11.91	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe2736	16.092	2.21	10.734	10.62	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe2729	14.72	2.02	9.315	9.134	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe533	2.918	2.29	8.458	8.305	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Pipe269	2.775	2.18	8.298	8.005	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
Pipe2726	5.452	2.88	9.647	8.825	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
P19648	4.089	1.82	9.478	9.388	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
EXPipe78	4.089	1.82	9.388	9.331	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
P17971	4.089	1.6	9.331	9.253	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Pipe6143	11.871	2.44	6.138	5.909	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe6145	12.704	2.61	5.585	5.312	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe6147	16.085	2.23	4.975	4.879	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe6149	15.905	2.81	4.351	4.222	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe6152	16.9	2.98	3.755	3.275	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe6688	5.399	2	11.414	11.286	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe6691	10.041	3.72	11.286	10.977	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain89	5.148	2.72	7.732	7.64	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Northern C	7.812	1.61	7.64	7.38	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe6137	11.292	3.29	6.754	6.242	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe6139	20.728	1.92	4.337	4.136	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe6141	21.264	2.46	3.669	3.573	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe6402	3.712	1.37	2.849	2.785	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Pipe6683	4.589	2.12	11.472	10.761	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain109	5.311	2.81	5.225	5.145	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain108	3.368	7.14	5.505	4.337	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6

Drain117	1.92	0.79	6.764	6.754	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe8124	3.903	1.92	8.225	8.076	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
EXPipe1	0.65	1.17	12.391	12.267	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
EXPipe6	0.209	0.78	12.261	12.221	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
EXPipe11	4.51	2.95	11.904	11.548	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
EXPipe265	1.627	2.26	10.251	9.63	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe2092	2.709	2.21	20.418	20.372	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Pipe7543	1.948	2.75	14.299	13.887	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
Drain51	1.743	0.27	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
DrainSA10	26.856	1.04	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
DrainSA8	26.5	1.04	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Chnl90045	27.494	1.07	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Chnl90069	26.627	0	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Chnl90046	27.466	0.5	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Chnl90049	28.594	0.54	AR&R 100 year, 3 hours storm, average 20.9 mm/h, Zone 6
Chnl90050	28.581	0	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Chnl90052	30.814	0	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Chnl90056	29.607	0	AR&R 100 year, 3 hours storm, average 20.9 mm/h, Zone 6
Drain21	3.909	0.46	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain22	7.154	1.07	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain24	10.562	0.91	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain25	9.873	0.44	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Ch17304	20.732	1.26	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain26	20.793	1.64	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain28	22.553	1.77	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain29	23.442	1.22	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain30	25.274	1.85	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain31	26.124	2.48	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain37	9.21	1.13	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Drain39	10.401	0.89	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Drain40	10.61	0.91	AR&R 100 year, 24 hours storm, average 4.5 mm/h, Zone 6
Drain41	15.203	1.25	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain42	15.754	1.26	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain43	27.547	1.81	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Chnl87275	13.19	0.83	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
Chnl87276	13.484	0.73	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
Drain147	14.068	1.19	AR&R 100 year, 30 hours storm, average 3.8 mm/h, Zone 6
Chnl84680	18.528	0.36	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Chnl87251	17.665	0.94	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
DrainSA27	16.432	0.89	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA23	18.063	0.88	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA22	17.246	0.83	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA19	16.759	0.75	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA18	16.565	0.94	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA15	16.167	0.93	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA14	16.459	0.94	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA13	16.423	1.11	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA12	16.397	1.07	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA24	17.233	1.24	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
DrainSA11	23.914	1.28	AR&R 100 year, 2 hours storm, average 28.2 mm/h, Zone 6
Drain116	4.871	0.6	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain58	6.312	0.78	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain125	11.319	1.03	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain47	11.256	1.04	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain106	11.082	1.03	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain48	14.902	1.24	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain49	14.518	1.2	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain123	22.592	1.71	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain59	4.272	0.88	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain98	6.223	1.45	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain101	5.784	0.89	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain60	14.712	1.23	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain62	22.727	1.28	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Chnl29715	2.815	0.35	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Drain104	7.028	1.17	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain63	4.823	0.77	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
NEXYDrain	1.903	0.46	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Chnl55818	4.089	0.99	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Chnl55819	4.088	0.98	AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6
Drain119	10.66	0.75	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6

Drain121	12.677	0.84	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain92	16.058	1.26	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain114	15.982	1.25	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Ch28381	15.805	1.29	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain113	15.678	1.32	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain91	16.592	1.22	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain112	16.778	0.75	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain90	17.382	1.15	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Chnl6404	40.808	6.23	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain76	8.748	0.69	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
NEXYDrain	12.335	1.18	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
NEXYDrain	12.294	2.76	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain87	8.844	22.72	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain85	11.196	1.17	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain84	14.483	1.3	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain111	20.441	1.23	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain82	21.151	1.61	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain80	23.367	1.23	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain78	4.558	1	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain79	2.824	0.39	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain97	2.153	0	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
NEXYDrain1	2.166	0.77	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
NEXYDrain	3.481	0.87	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
NEXYDrain	3.383	0.92	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
NEXYDrain	2.671	0.95	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain107	2.297	0.96	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain115	0.895	0.07	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain100	7.795	0.6	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain143	13.312	0.88	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain148	6.112	0.74	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
DrainSA34	15.133	1.97	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
EXChnl186	0.44	0.34	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain96	4.12	0.72	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain105	1.609	0.71	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Chnl14467	1.58	0.66	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Chnl9976	9.807	0.72	AR&R 100 year, 1.5 hours storm, average 34.7 mm/h, Zone 6
Drain23	2.248	0.43	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Chnl31664	2.755	0.68	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain35	2.049	0.53	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6
Drain36	6.127	0.73	AR&R 100 year, 1 hour storm, average 46.2 mm/h, Zone 6

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF2459	0	0	0	0	0	0	0	
OF25	0	0	0	0	0	0	0	
OF17	0	0	0	0	0	0	0	
OF19	0	0	0	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q	Max Q	Max Q
			Total	Low Level	High Level
PellewBasi	13.85	147890.1	9.209	9.209	0
Greyhound	8.42	244732.8	10.42	10.42	0
PWR	8.82	114773.9	2.918	2.918	0
NexySouth	9.63	47367.2	4.089	4.089	0
EXBasin4	12.45	6777.3	0.65	0.65	0
EXBasin2	12.27	6254.7	0.209	0.209	0

CONTINUITY CHECK for AR&R 100 year, 6 hours storm, average 12.6 mm/h, Zone 6

Node	Inflow	Outflow	Storage Ch	Difference
	(cu.m)	(cu.m)	(cu.m)	%
Node55	5674.41	5576.29	0	1.7
NSA11	442852.3	439071.2	0	0.9
NSA9	439071.2	437921.7	0	0.3
NSA8	437921.7	436731.8	0	0.3
N136434	436731.8	436500.9	0	0.1
N136435	436500.9	436089.1	0	0.1
N136436	436089.1	429063.7	0	1.6
N136437	436675.2	430122.5	0	1.5
N136438	430122.5	424162.7	0	1.4
N136439	436122.1	424710.6	0	2.6
N136440	436813.1	431673.2	0	1.2
N136442	431673.2	431673.2	0	0

Node26	15015.43	15008.89	0	0
N19215	15008.89	14852.67	0	1
Node27	30660.43	30514.88	0	0.5
Node185	30514.88	30350.13	0	0.5
Node28	53707.06	53306.51	0	0.7
Node36	53306.51	52768.31	0	1
Node29	124462.5	122685.4	0	1.4
N22183	122685.4	122207.7	0	0.4
Node31	137182.9	136718.5	0	0.3
Node32	152524	151561.3	0	0.6
Node182	186876.7	186306.6	0	0.3
N20192	186306.6	185738.1	0	0.3
Node33	196098.5	195320.2	0	0.4
PellewBasi	269790.7	191533.7	77499.99	0.3
Node181	191533.7	189454.5	0	1.1
N16286	231979.9	229403.5	0	1.1
Node43	229403.5	228433.5	0	0.4
Node44	233933.3	230933.6	0	1.3
Node45	268604.8	265257.2	0	1.2
N21172	265257.2	261366.2	0	1.5
Node46	261366.2	257360.3	0	1.5
Node178	364403.8	359662.6	0	1.3
N21174	359662.6	351539.8	0	2.3
Greyhound	404147.2	191161.1	204618.7	2.1
N131866	255680.3	252707.3	0	1.2
HW5	278574.8	275121.8	0	1.2
N131872	275121.8	273168.5	0	0.7
N5019	300238.8	288204.8	0	4
Node50	288204.8	285084.5	0	1.1
NSA33	344880.2	340118.6	0	1.4
NSA32	340118.6	338825.8	0	0.4
N127721	338825.8	334901.1	0	1.2
N131853	334901.1	328240.2	0	2
HW4	355157.1	349194.4	0	1.7
NSA25	349194.4	345903.3	0	0.9
NSA23	345903.3	340880.2	0	1.5
NSA21	340880.2	337742.7	0	0.9
NSA20	343036.6	337805.9	0	1.5
NSA17	337805.9	333576.1	0	1.3
NSA16	341355	340088.5	0	0.4
HW1	340088.5	339801	0	0.1
N57567	339801	337986.6	0	0.5
NSA14	337986.6	335237.9	0	0.8
NSA13	339892.5	336984.6	0	0.9
HW3	336984.6	331606.3	0	1.6
N57565	437917.9	434726.7	0	0.7
Node193	15818.93	15805.45	0	0.1
Node64	18957.43	18819.77	0	0.7
Node156	25881.05	25648.35	0	0.9
Node51	47337.98	47153.17	0	0.4
Node166	47153.17	47092.32	0	0.1
Node52	47092.32	46826.12	0	0.6
Node144	66081.55	65556.39	0	0.8
Node53	65556.39	64852.71	0	1.1
Node54	107745.5	106312.3	0	1.3
Node66	14053.48	14038.21	0	0.1
Node134	14038.21	13986.04	0	0.4
Node133	21540.4	21471.46	0	0.3
Node68	21471.46	21279.97	0	0.9
Node137	63610.18	63387.22	0	0.4
N21177	63387.22	62488.89	0	1.4
N21176	62488.89	61435.19	0	1.7
Node70	112427.6	107759.9	0	4.2
PWR	177768.1	68549.23	93325.55	8.9
N131874	68549.23	66731.2	0	2.7
N40398	66731.2	64518.84	0	3.3
Node71	27068.3	26912.93	0	0.6
Node73	30050.81	29546.11	0	1.7
Node176	29546.11	25576.41	0	13.4
Node85	7171.45	7013.06	0	2.2
NexySouth	92868.32	74300.64	18198.36	0.4
N87222	74300.64	74273.53	0	0
N7M01	74273.53	74236.48	0	0
N81667	74236.48	73903.02	0	0.4

N81671	73903.02	72708.78	0	1.6
Node158	127111.2	125991.6	0	0.9
Node159	125991.6	124409.8	0	1.3
Node160	142859.7	141292.4	0	1.1
Node161	141292.4	140243.7	0	0.7
Node117	164792.5	163866.1	0	0.6
Node116	163866.1	163524.3	0	0.2
Node115	163524.3	162998	0	0.3
N38324	162998	162700.6	0	0.2
N38325	162700.6	162368.3	0	0.2
Node154	165886.4	165206.9	0	0.4
Node151	177888.2	177502.3	0	0.2
N38326	177502.3	176924.9	0	0.3
Node114	182175.9	181524.6	0	0.4
Node150	189274.6	188764.9	0	0.3
Node105	340575.1	340268.3	0	0.1
Node106	340268.3	340268.3	0	0
Node7M01	36051.71	36051.71	0	0
Node94	18697.7	18674.11	0	0.1
Node93	34749.77	34755.07	0	0
N40403	34755.07	34296.51	0	1.3
Node81	63456.36	62893.55	0	0.9
Node80	62893.55	62635.59	0	0.4
Node95	17922.86	17922.67	0	0
Node97	34561.75	34375.66	0	0.5
Node98	40094.51	39759.97	0	0.8
Node99	53315.86	53058.76	0	0.5
Node100	53058.76	52743.78	0	0.6
Node101	72450.66	71839.46	0	0.8
Node102	109763.3	109243.3	0	0.5
Node103	109243.3	108790.9	0	0.4
Node148	116841.4	116471.8	0	0.3
N38322	116471.8	116161.7	0	0.3
Node104	146773.5	146405	0	0.3
Node107	17919.55	17735.65	0	1
Node110	23509.2	23208.14	0	1.3
Node147	30757.76	30611.75	0	0.5
Node132	7566.01	7554.31	0	0.2
Node138	7428.35	7377.01	0	0.7
Node76	12475.47	12378.5	0	0.8
Node77	12378.5	12249.62	0	1
Node78	12249.62	12140.51	0	0.9
Node79	29230.03	29159.85	0	0.2
Node165	8069.16	7778.2	0	3.6
Node145	19713.79	19706.92	0	0
Node146	12236.27	12236.25	0	0
Node153	3539.77	3517.9	0	0.6
Node157	6923.95	6920.42	0	0.1
Node172	13519.31	13508.34	0	0.1
Node170	34243.19	27070.22	0	20.9
Node187	55291.52	53629.62	0	3
Node192	23011.07	22912.84	0	0.4
NSA34	60855.61	59795.73	0	1.7
EXBasin4	11113.37	5745.5	5366.1	0
EXBasin2	5745.5	79.68	5659.58	0.1
Node127	79.68	42.35	0	46.9
Node130	20677.93	20497.49	0	0.9
Node131	20497.49	20277.36	0	1.1
N3005	5955.42	5951.49	0	0.1
Node142	5951.49	5934.13	0	0.3
N18244	5934.13	5854	0	1.4
N12409	46254.48	45612.45	0	1.4
N17262	9235.15	9238.99	0	0
Node25	9238.99	9140.86	0	1.1
N43543	10287.15	10222.68	0	0.6
N43541	10222.68	10113	0	1.1
Node39	10113	9711.81	0	4
Node38	28128.3	26945.33	0	4.2

Run Log for GEP RevB run at 07:33:33 on 17/4/2020

Channels Drain114, Drain92, Drain119, Drain96, Drain58, Drain123, Drain49, Drain125, Drain40 spilled.
Above drains are located within the horticultural precinct
Flows were safe in all overflow routes.