Local Water Management Strategy

Kelmscott Activity Centre Precinct

Project No: EP21-032(01)

Prepared for City of Armadale
July 2022

Document Control

Doc name:	Local Water Management Strategy Kelmscott Activity Centre Precinct				
Doc no.:	EP21-032(01)--003 AJI				
Version	**Date**	**Author**		**Reviewer**	
1	May 2022	Fabio Hernandez	FMH	David Coremans	DPC
	Draft for issue to project team.				
A	July 2022	Fabio Hernandez	FMH	David Coremans	DPC
	Updated to address City of Armadale comments.				
B	July 2022	Fabio Hernandez	FMH	David Coremans	DPC
	Updated to address City of Armadale comments.				
C	July 2022	Fabio Hernandez	FMH	David Coremans	DPC
	Updated to address City of Armadale comments.				

Executive Summary

The Kelmscott Activity Centre (KAC) Structure Plan area (herein referred to as the 'site') covers approximately 57 ha within the City of Armadale (CoA). The site is located approximately 23 km southeast of the Perth Central Business District and includes the existing Kelmscott Town Centre (KTC) and residential/commercial lots to the south of Davis Road.

The site is currently predominantly zoned 'urban' under the Metropolitan Region Scheme and 'district centre' and 'residential' under the CoA Local Planning Scheme No. 4. The site largely consists of residential, retail, commercial, restaurants/cafes, medical and community related uses, and public open spaces (POS). It is immediately adjacent to a portion of the Canning River foreshore area. Several transport and commercial assets are located within the site including the Kelmscott train station, Kelmscott Plaza and the Stargate Kelmscott.

Taylor Burrell Barnett has prepared the KAC precinct plan on behalf of the CoA to provide a framework for the planning and development of the area by providing a holistic long term vision and implementation framework. The CoA currently has a total population of approximately 90,000 persons and is estimated to reach approximately 144,827 persons by 2036. Planning for the Structure Plan area is required to accommodate not only future growth of the centre, but also a changing appreciation for the urban form of the centre with a greater emphasis on inner city and higher density living in close proximity to public transport, commercial precincts and town centre locations. The Structure Plan is intended to guide decision making by all stakeholders, including Local and State Government, landowners, business owners, residents and investors.

This Local Water Management Strategy (LWMS) details the water management approach to support the KAC Structure Plan. This document is intended to satisfy the requirements to prepare a LWMS in accordance with Better Urban Water Management (WAPC 2008), and to address the expectations of the Department of Water and Environmental Regulation (DWER) and the CoA.

Water will be managed using an integrated water cycle management approach. The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. In summary, the environmental investigations conducted to date indicate that:

- Historical imagery indicates that the KAC was established prior to the earliest available imagery. The site has undergone significant development since initial settlement. Land uses within the area are a mixture of commercial and residential.
- The site receives an average annual rainfall of 866.6 mm with the majority of rainfall received between the months of June and August.
- Topography of the site ranges from 35 m AHD in the south, 25 mAHD in the north to 17 m AHD in the east, towards the Canning River. There is a localised high point along Albany Highway which slopes away to the north (from 28 mAHD to 23 mAHD in the most northern corner).
- Regional geological mapping indicates that soils beneath the site are highly variable and likely to be a mixture of sand, sandy clay, gravelly sandy clay and sandy silts. Given the historical development of the site of a long period of time, soils will likely include fill to variable depths and of variable quality.

- The western half of the site is classified as having 'moderate to low risk' of ASS occurring within 3 m of the natural soil surface, while the area abutting the Canning River foreshore is classified as 'high to moderate' risk of ASS.
- A contaminated lot, listed as 'remediated for restricted use', has been identified within the site boundary due to the presence of hydrocarbons in groundwater.
- Parts of the site (in the northeast and south) are classified as an environmentally sensitive area (ESA). This is primarily due to proximity to the Canning River.
- Bush Forever (BF) site 246 (vegetation within the flood plain of the Canning River) is within the site boundary.
- The entire site is classified as a sewage sensitive area under the Government Sewerage Policy.
- The Canning River floodway and flood plain areas (land adjacent to the River on both sides) are classified as conservation category wetland (CCW). The Canning River passes through a small section of the eastern boundary of the site (at Gilwell Avenue).
- Piped and open main drains from Water Corporation are found to cross the site boundary in the southern and eastern side, discharging to the Canning River via the Water Corporation Rundle Street Main Drain.
- Minor piped stormwater drainage from the CoA drainage network discharges directly in to the Canning River.
- Regional groundwater indicates that groundwater flows in a north easterly direction across the site (towards the Canning River), at elevation of approximately 23.5 m AHD to 19.5 m AHD.
- There is no groundwater quality available for the site.

The overall objective for integrated cycle management for urban development is to minimise pollution and maintain an appropriate water balance. The design objectives presented in this LWMS seek to deliver best practice outcomes using a water sensitive urban design (WSUD) approach, including detailed management objectives for:

- Water supply, conservation and wastewater
- Stormwater quantity and quality management
- Groundwater management.

Water supply and conservation

The overall approach to potable water supply is to utilise scheme water from the Water Corporation's integrated supply scheme and to implement water conservation measures (i.e. water efficient fixtures and appliances (WEFA)), waterwise gardening (WWG)/landscaping principles, encourage the use of rainwater tanks (RWT), and to adopt WSUD approaches within streetscapes to reduce water requirements.

Non-potable water demands for open spaces will continue to be met by the City's existing groundwater allocation, and appropriate and contemporary water usage rates will be adopted for open spaces.

Stormwater management

Lot scale water quality and flood detention will be required to be considered at the time of individual lot redevelopment, with the base expectation being that all lots will address the frequent rainfall event within the lot prior to any discharge from site. This may include surface based WSUD measures

and where soils permit may include localised soakage. The approach to road reserve stormwater management will retain the overall layout of the current drainage network. Within the existing KAC, at-source WSUD measures should be adopted when the road network is updated to facilitate the broader KAC implementation of water quality improvement. Where there is sufficient land area available, a WSUD approach should be taken to end of pipe discharges at the Canning River, and this would likely be within road reserve or other existing reserves within the KAC Precinct Plan Area. This will need to occur outside the existing Canning River foreshore area/reserve. The WSUD for both lot and local road scale measures will aim to treat and detain runoff at source or as close to source as possible, prior discharging into the Canning River.

A key opportunity exists for the retrofit of the Water Corporation Rundle Street Main Drain prior to discharge to the Canning River. This would need to occur within the existing drainage within the KAC Precinct Plan Area or immediately adjacent reserves within the KAC Precinct Plan area. The Water Corporation's piped network discharges to the open drain and the adoption of a Drainage for Liveability approach would significantly improve the water quality being discharged to Canning River and will increase the amenity of the open space within which it is located. Water Corporation and other relevant stakeholders should be engaged to facilitate an improved outcome for the Water Corporation Rundle Street Main Drain, and maintenance will be a key consideration.

Groundwater management

Groundwater management focuses on the use of structural measures to manage shallow groundwater conditions and non-structural measures to achieve groundwater quality criteria. The groundwater management will include the selective use of imported fill to maintain sufficient clearance to groundwater (or low permeability soils) in lower areas of the site, and the potential use of subsoil drains. This will ensure road pavement is provided with appropriate conditions and facilitate the at-lot management of frequent rainfall events. Groundwater quality will be addressed by the WSUD measures that will be adopted to address surface water quality.

The water management design criteria identified for the site, and the manner in which they are proposed to be achieved are presented in **Table E1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management for the development have actually been achieved.

There are a number of agencies that will have responsibility for implementation of, integration with or facilitation of the water management approaches in this LWMS, including CoA, Water Corporation, Main Roads WA, Perth Transport Authority (PTA), Department of Biodiversity Conservation and Attractions, DWER and others, in addition to private landowners/individual lot developers.

This LWMS demonstrates that, by following the recommendations detailed in the report, the site is capable of being redeveloped in a manner which is cognisant of contemporary WSUD approaches and which provides a positive benefit to the Canning River.

Table E1: Water management criteria and compliance summary

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Water conservation	WC1	Use fit for purpose water sources throughout the development.	Scheme water utilised for potable and some non-potable uses.	Lot developer/owner	Detailed design and implementation
			Rainwater tanks promoted and used to supplement non-potable uses.	Lot developer/owner	Lot redevelopment
			Groundwater from existing allocations utilised to meet POS irrigation demand.	CoA	Already existing/ Lot redevelopment
	WC2	Residential consumption target for water of 100 kL/person/year, including not more than 40-60 KL/person/year of scheme water.	Use of WEFA by lot owners.	Lot developer/owner	Lot redevelopment
			Adoption of WWG practices by lot owners.	Lot developer/owner	Lot redevelopment
			Education regarding water conservation and waterwise practices.	Lot developer/owner	Lot redevelopment
				CoA	
	WC3	Adopt an average POS irrigation rate of 6,750 kL/ha/year.	Existing Fancote Park, drainage corridors, urban spaces and road reserves will be irrigated at a rates no greater than 6,750 kL/year/ha. This will be supplied from the existing groundwater licenses held by CoA.	CoA	Lot redevelopment
			Landscape design and streetscape will adopt WWG practices	CoA	Lot redevelopment

Table E1: Water management criteria and compliance summary (continued.)

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Stormwater management	SW1	Manage and treat the small (first 15mm) event runoff as close to source as practicable.	This could be achieved in residential and commercial lots by implementing localised soakage/storage. Infiltration based measures should be assessed in a case-by-case basis due to localised conditions.	Lot developer/ owner	Lot redevelopment
			For road reserves and the broader precinct, runoff from the small event can be managed by roadside bio-retention areas, tree pits and vegetated swales. Key opportunity is the retrofitting of the Water Corporation Rundle Street Main Drain as per a living stream.	CoA	Redevelopment of the broader KAC area
	SW2	Pre-development peak flow rates discharging into the Canning River in the minor (10% AEP) and major (1% AEP) event should be maintained.	WSUD features will facilitate the detention of runoff up to the 1% across the KAC area in order to maintain the peak discharge rates into the Canning River. The catchment is already 95% impervious with little water quality treatment measures or flood detention, and therefore any additional measures implemented will be an improvement on the current approach.	CoA	Redevelopment of the broader KAC area
	SW3	Finished floor levels must have a minimum of 500 mm clearance above the 1% AEP flood level of the Canning River.	Most existing finished floor levels of habitable buildings will already meet the required clearances to the Canning River.	Lot developer/ owner	Lot redevelopment
	SW4	Utilise best management practices to minimise pollutants to the Canning River.	At-source sediment control during earthworks and construction activities.	Developers/ contractors	Redevelopment of the broader KAC area
			Developments and construction activity should comply with City policy PLN2.5 Erosion Prevention and Sediment Control.	Developers/ contractors	Redevelopment of the broader KAC area
			Street sweeping in accordance with operational plans.	CoA	Redevelopment of the broader KAC area
			Maintenance of WSUD features to remove sediments, gross pollutants and hydrocarbons.	CoA	Redevelopment of the broader KAC area
			Minimising fertiliser use to establish and maintain vegetation POS, streetscaped areas and other landscaped areas.	CoA	Redevelopment of the broader KAC area

Table E1: Water management criteria and compliance summary (continued.)

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Stormwater management (continued.)	SW4	Utilise best management practices to minimise pollutants to the Canning River.	Utilising drought tolerant plant species that require minimal water and nutrients within WSUD features and the Water Corporation Rundle Street Main Drain living stream.	CoA	Redevelopment of the broader KAC area
			Education future lot owners, residents and tenants regarding fertiliser application and the use of nutrient absorbing vegetation.	CoA, Lot developer/owner	Lot redevelopment
Groundwater management	GW1	Provide 1.2 m clearance between habitable floor levels and MGL, the low permeability soil layer or subsoil drain inverts.	The utilisation of imported fill will be required to ensure adequate clearance to groundwater, impermeable soil layers and subsoil drains.	Lot developer/ owner	Lot redevelopment
	GW2	Groundwater quality beneath the site should be maintained or improved.	Treating runoff in WSUD features before infiltration of stormwater and/or conveyance to the Canning River.	CoA	Redevelopment of the broader KAC area
	GW3	Utilise best management practices to reduce the risk of nutrient loading to groundwater.	Street sweeping on a regular basis.	CoA	Redevelopment of the broader KAC area
			Maintenance of WSUD features.	CoA	Redevelopment of the broader KAC area
			Minimising fertiliser use to establish and maintain vegetation within POS, streetscapes and landscaped areas (e.g. within verge, lot etc).	CoA, Lot developer, lot owner and tenant	Redevelopment of the broader KAC area
			Utilising drought tolerant plant species that require minimal water and nutrients.	CoA	Redevelopment of the broader KAC area
			If utilised, turf species should be drought tolerant and require minimal water and nutrients.	CoA	Redevelopment of the broader KAC area
			Education of developers, lot owners, residents and tenants regarding fertiliser application and the use of nutrient absorbing vegetation.	CoA, Lot developer/owner	Redevelopment of the broader KAC area

Table E1: Water management criteria and compliance summary (continued.)

Management aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Groundwater management (continued.)	GW4	Where subsoil drains are adopted these are to have a free draining outlet.	Subsoils for the management of groundwater should have a free draining outlet within the existing stormwater network or at least 150 mm above the invert level of WSUD features to ensure free draining conditions.	CoA	Redevelopment of the broader KAC area

Table of Contents

List of Tables

List of Plates

Figures

Appendices

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
ANZECC	Australian and New Zealand Environment and Conservation Council
ABS	Australian Bureau of Statistics
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resources Management Council of Australian and New Zealand
BoM	Bureau of Meteorology
CoA	City of Armadale
DBCA	Department of Biodiversity, Conservation and Attractions
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
TBB	Taylor Burrell Barnett
WAPC	Western Australian Planning Commission

Table A2: Abbreviations – General terms

General terms	
ASS	Acid sulfate soils
BMP	Best management practice
BRA	Bioretention area
BUWM	Better Urban Water Management
CCW	Conservation category wetland
DA	Development approvals
ESA	Environmentally sensitive area
KAC	Kelmscott Active Centre
KTC	Kelmscott Town Centre
LWMS	Local water management strategy
MGL	Maximum groundwater level
MUW	Multiple use wetland
PDWSA	Public Drinking Water Source Area
POS	Public open space

Table A2: Abbreviations – General terms (continued)

General terms	
PRI	Phosphorus retention index
RWT	Rainwater tank
ST	Structure Plan
UWMP	Urban water management plan
WA	Western Australia
UFI	Unique feature identifier
WEFA	Water efficient fixtures and appliances
WSUD	Water sensitive urban design
WWG	Waterwise gardens

Table A3: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
kL	Kilolitres
kL/annum	Kilolitres per annum
kL/ha/annum	Kilolitres per square meter per annum
km	Kilometre
m	Metre
m AHD	Metres in relation to the Australian height datum
m/day	Metres per day
mm	Millimetre
mg/L	Milligrams per litre

Table A4: Terminology – design rainfall

Rainfall event	Annual exceedance probability (AEP)
Small	First 15 mm (1EY)
Minor (Residential)	20 %
Minor (Commercial and Industrial)	10 %
Major	1 %

1 Introduction

1.1 Background

The Kelmscott Activity Centre (KAC) Structure Plan area (herein referred to as the 'site') covers approximately 57 ha within the City of Armadale (CoA). The site is located approximately 23 km southeast of the Perth Central Business District and includes the existing Kelmscott Town Centre (KTC) and residential/commercial lots to the south of Davis Road.

The site largely consists of residential, retail, commercial, restaurants/cafes, medical and community related uses, and public open spaces (POS). It is immediately adjacent to a portion of the Canning River foreshore area. Several transport and commercial assets are located within the site including the Kelmscott train station, Kelmscott Plaza and the Stargate Kelmscott. The location and extent of the site is shown in **Figure 1.** The proposed re-development of the KAC is discussed further in **Section 2** and the KAC Structure Plan is provided in **Appendix A**.

1.2 Town planning context

The site is currently predominantly zoned 'urban' under the Metropolitan Region Scheme and 'district centre' and 'residential' under the CoA Local Planning Scheme No. 4. The site largely consists of residential, retail, commercial, restaurants/cafes, medical and community related uses, and public open spaces (POS) (CoA 2005). The CoA is currently the responsible authority for planning and development within its municipality, with the exception of those areas under the jurisdiction of DevelopmentWA pursuant to the provision of the Metropolitan Redevelopment Authority Act 2011. The CoA is likely to reassume planning control of the Redevelopment Area within the Kelmscott District Centre in the next 2-3 years.

1.3 Purpose

Taylor Burrell Barnett has prepared the KAC precinct plan on behalf of the CoA to provide a framework for the planning and development of the area by providing a holistic long term vision and implementation framework. The CoA currently has a total population of approximately 90,000 persons and is estimated to reach approximately 144,827 persons by 2036. Planning for the Structure Plan area is required to accommodate not only future growth of the centre, but also a changing appreciation for the urban form of the centre with a greater emphasis on inner city and higher density living in close proximity to public transport, commercial precincts and town centre locations. The Structure Plan is intended to guide decision making by all stakeholders, including Local and State Government, landowners, business owners, residents and investors.

This local water management strategy (LWMS) details the water management approach to support the KAC Precinct Plan and is intended to satisfy the requirements to prepare a LWMS in accordance with *Better Urban Water Management* (BUWM) (WAPC 2008), and to address the expectations of the Department of Water and Environmental Regulation (DWER) and the CoA.

1.4 Policy framework and previous studies

There are a number of State Government polices of relevance to the site. These policies include:

- *State Water Strategy* (Government of WA 2003)
- *State Planning Policy 2.9: Water Resources* (WAPC 2006a)
- *DRAFT State Planning Policy 2.9: Planning for Water* (WAPC 2021)
- *State Planning Policy 2.10 Swan-Canning River System* (WAPC 2006b)
- *Statement of Planning Policy No. 3: Urban Growth and Settlement* (WAPC 2006c)
- *State Water Plan* (Government of WA 2007)
- *Liveable Neighbourhoods (4th Edition)* (WAPC 2007, 2015)
- Gu*idance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Local Planning Strategy – Town Planning Scheme No.4* (CoA 2016)
- *Water Wise Perth-Two Year Action Plan* (Government of WA 2019)
- *Government Sewerage Policy* (DPLH 2019).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that urban developments should aim to achieve. These are key inputs that relate either directly or indirectly to the redevelopment of the site and include:

- *Australian Rainfall and Runoff* (Ball J *et al.* 2019).
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018)
- *Better Urban Water Management* (WAPC 2008).
- *Decision Process for Stormwater Management in Western Australia* (DWER 2017b)
- *Drainage for Liveability Fact Sheet* (Water Corporation 2017)
- *Local Biodiversity Strategy* (CoA 2009)
- *National Water Quality Management Strategy* (ANZECC and ARMCANZ 2000)
- *Swan Canning Water Quality Improvement Plan* (SRT 2009)
- *Stormwater Management Manual for Western Australia* (DoW 2007)

The guidance documents listed indicate a need for accurate baseline information prior to urban development. This will ensure that any future development is able to fulfill the stormwater management requirements of DWER and engineering standards specified by CoA but will also ensure that realistic water management criteria that are practically achievable are adopted.

1.5 LWMS objectives

In the absence of any overarching water management studies or documentation, this LWMS has been developed based on the objectives outlined in *Better Urban Water Management* (WAPC 2008). It is intended to support the KAC Structure Plan, and is further based on the following major objectives:

- Maintain the existing hydrological regime and provide protection to the Canning River.
- Provide a broad level stormwater management framework to support future urban development.

- Develop a water conservation strategy for the site that will ensure the efficient use of all water resources.
- Improve the existing stormwater network and retrofit where possible.
- Incorporate appropriate best management practices (BMPs) into the drainage system that address the environmental and stormwater management issues identified.
- Outline solutions within the KAC Precinct Plan to manage urban runoff prior to discharging into the Canning River.
- Reduce pollutant loads discharged from the development into the Canning River.
- Minimise ongoing operation and maintenance costs for the landowners and CoA.
- Explore and realise opportunities to work with stakeholders including the Water Corporation to improve drainage assets and amenity provided by these assets

The design objectives presented in this document seek to deliver best practice outcomes using a water sensitive urban design (WSUD) approach, including detailed management objectives for water supply, conservation and wastewater, stormwater quantity/quality management and groundwater management.

Detailed design criteria for water management within the site are further discussed in **Section 1.**

2 Proposed Development

The KAC Structure Plan project vision is to revitalise the town centre. The overall vision is to redevelop the Kelmscott Town Centre into a vibrant, progressive and prosperous centre comprising of a range of residential, commercial/retail, community and recreational spaces.

The existing KAC area (see **Figure 1**) will be planned (pending scheme amendment) to facilitate the establishment of land uses appropriate to mixed use residential while improving the amenities within the site and surrounds. Redevelopment and retrofitting will allow the accommodation of mixed-use areas throughout the existing Kelmscott Town Centre, the retention of key civic and community assets and the provision for retail frontage.

A key opportunity exists to improve the water quality being discharged to the Canning River and to improve amenity of the KAC Structure Plan area and the surrounding general area. The WSUD approaches that should be adopted include:

- At source management of frequent rainfall events within lots, both commercial and residential. This is likely to include some measure of at-source storage/infiltration – where soil types permit.
- At source management of frequent rainfall events within the road network. This may include measures such as tree pits, roadside swales/bio-retention areas, soakwell storage and other measures as appropriate to localised site conditions.
- End of pipe interception measures for local pipe networks. These will need to be considered in the context of land area available, as some outlets are significantly spatially constrained. Interception measures should adopt surface based and vegetated conveyance structures where adopted.
- Retrofit of the Water Corporation's Rundle Street Main Drain using a Living Stream approach. The Water Corporation can facilitate this outcome using its Drainage for Liveability program, acknowledging this will require coordination across stakeholders and land owners/managers.

In addition to the above WSUD measures, the CoA has advocated for completion of the infill sewer system in Kelmscott and surrounding suburbs, which will provide additional benefits to groundwater and surface water quality.

The proposed KAC precinct plan is included in **Appendix A**.

3 Existing Environment

3.1 Sources of information

The following sources of information were used to provide a broad regional environmental context for the site:

- *Weather and Climate Statistics* (BoM 2022)
- *LIDAR elevation dataset, Swan Coastal Plain* (DWER 2021a)
- *Geological survey of Western Australia* (Gozzard 1986)
- *Perth Groundwater Map* (DWER 2022b)
- *DWER floodplain mapping* (DWER 2022a)
- *Acid sulfate soils (ASS) risk mapping* (DWER 2017a)
- *Contaminated sites database* (DWER 2021)
- *Geomorphic wetlands of the Swan Coastal Plain database* (DBCA 2021)
- *Water Register* (DWER 2020b)
- *Water Information Reporting* (DWER 2020a)
- *Landgate Aerial Photography* (WALIA 2022)
- *National Water Quality Management Strategy (NWQMS)* (Australian Government 2018)

3.2 Historical and current land uses

A review of historical imagery (WALIA 2022) from 1965 indicates significant clearing and urbanisation occurred between 1965 and 1979 and reached the extent of the current day residential sprawl around 1991, which included Kelmscott Plaza and Stargate Kelmscott. Aerial imagery indicates some grouped buildings, recreational and community assets as well as the local road network, Albany Highway and Kelmscott train station. From 1991 the site has gone through significant commercial, road network and public transport modifications, including revamp of the Kelmscott Train Station and, more recently, the Denny Avenue Level Crossing Removal Project which closed the existing at-grade rail crossing, constructed a rail overpass for the Public Transport Authority (PTA) rail network and modified the Main Roads WA regional road network and local roads.

Current land uses within the existing KTC area are predominantly commercial, retail, civic and POS areas, with a small portion of residential land uses along the Canning River and the railway line. The site area is surrounded by existing residential lots, the Kelmscott primary school and the Canning River to the east and the Kelmscott High School to the west.

3.3 Climate

The site experiences a dry Mediterranean climate of hot dry summers and moderately wet, mild winters. Long term climatic averages indicate that the site is located in an area of moderate to high rainfall, receiving an average of 866.6 mm annually (BoM 2022) with the majority of rainfall received between May and August. Mean maximum temperatures range from 18.7^{o}C in July to 33.1^{o}C in January, while mean minimum temperatures range from 8.8^{o}C in July to 18.8^{o}C in February. The region experiences rainfall of >1 mm on 77 days annually (on average) (BoM 2022).

3.4 Geotechnical conditions

3.4.1 Topography

Elevations across the site generally slope in a northerly and easterly aspect towards the centre of the site and/or Canning River, with the exception of a small portion on the eastern KAC area which slopes in a westerly aspect to towards the Canning River. Elevations range from 35 m Australian height datum (m AHD) in the southern, 28 mAHD to north in a localised high point along Albany Highway down to 17 m AHD on the eastern boundary and adjacently to the Canning River. The northern corner of the development slopes away to the north from 28 mAHD to 23 mAHD. Topographic contours are shown in **Figure 2**.

3.4.2 Regional Geology

The site is situated within the Swan Coastal Plan, with most of it within the Pinjarra Plain and a small portion of the southern corner in the Piedmont Zone geomorphological unit (Gozzard 1986). The Swan Coastal Plain Environmental geology for the site has been mapped by the *Geological Survey of Western Australia* (Gozzard 1986) and this indicates that the site is underlain by:

- S8 – Sand - white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin.
- Cs – Sandy clay - white, grey to brown, fine to coarse-grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp.
- Csg – Gravelly sandy clay – variable, with lenses of silt and gravel, quartz sand, subangular with eolian rounded component, heavy minerals common, gravel rounded, of colluvial origin.
- Ms4 – Sandy Silt - cream to pale brown alluvium, clayey in part, fine to medium-grained sand, of alluvial origin.

In addition to the above soils, it is likely that the site has been historically filled, and this fill will likely be of variable quality and permeability.

The anticipated soil types are more likely to have low permeability, which could limit the effectiveness of at-source water management measures that rely on infiltration, unless modification to the natural soil has or will occur with more permeable material.

Regional environmental geology across the site is shown in **Figure 3**.

3.4.3 Acid Sulfate Soil and contaminated lands.

The *Acid Sulfate Soil Risk Map* (DWER 2017a) classifies the majority of site as having ‘moderate to low risk’ of acid sulphate soils (ASS) occurring within 3 m of natural soil surface, with the exception of the foreshore area of the Canning River being classified as having ‘high to moderate risk’. Regional ASS risk mapping is shown in **Figure 4**.

The extent of ASS which is encountered and potentially disturbed and any management requirements will be largely dependent upon the future extent of excavation below the natural soil surface and any potential dewatering activities associated with redevelopment of the site, which will be outlined during detailed design. It is anticipated that the redevelopment of the KAC will largely utilise the existing sewer and drainage infrastructure alignments and depths, which will assist in

reducing the extent of ASS risk during construction. Where ASS is found to be a risk, an acid sulfate soil and dewatering management plan (ASSDMP) will be prepared to inform site works and monitoring, and monitoring requirements.

3.4.4 Contaminated land

A review of the DWER *Contaminated Sites Database* (DWER 2021) indicates that Lot 2877 Albany Highway (located to the southwest of the junction between Denny Avenue and Albany Highway) is listed as 'Remediated for restricted use' in accordance with the *Contaminated Sites Act 2003* (CS Act). This classification is due to the presence of hydrocarbons within groundwater beneath the site as a plume which extends off-site to the east (see **Figure 4**). It is understood that this lot has been used since the 1970's as a service station.

This classification places no restriction use for commercial and industrial uses however it would likely exclude sensitive uses such as childcare centres or schools. Additionally, the lot must not be developed for a more sensitive use such as recreational, open space areas, residential or childcare use without further contamination assessment and/or remediation. Due to the presence of hydrocarbons, groundwater should not be abstracted from the site without prior testing to ensure suitability for the proposed use. It is expected this to be addressed through relevant subdivision conditions and managed under the provisions of the *Contaminated Sites Act 2003*.

3.5 Environmental assets

3.5.1 Environmental sensitive areas

Where environmentally sensitive areas (ESAs) are identified, the Native Vegetation Clearing Permit exemptions listed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 do not apply. Two ESAs are identified within the site boundary, with one along the north-eastern boundary and adjacent to the Canning River, and another covering the majority of the KAC south of Davis Road, as shown in **Figure 5**.

3.5.2 Bush forever

Bush Forever (BF) site 246 ''Canning and Southern Rivers, Beckenham to Martin/Kelmscott'' has been identified to be within a small portion of the site, located on both sides of Gilwell Avenue around the Canning River and the closest open space to the south, as shown in **Figure 5**.

3.5.3 Sewage sensitive areas

The entirety of the site is classified as a sewage sensitive area according to the *Government Sewerage Policy* (DPLH 2019), as shown in **Figure 6**. The policy defines sewage sensitive areas geographically based on proximity to a variety of environmental assets and sensitivity to on-site sewage disposal. The two classifications of relevance to the site define a sewage sensitive area as:

- Estuary catchments on the Swan and Scott Coastal Plains.
- Within 1 km of a significant wetland.

Whilst identified as a sewage sensitive area, the entire site is serviced by existing sewer system. It is expected that at the design stage, further investigations are undertaken to determine the capacity of the existing sewerage system, and appropriate responses will be proposed to connect to the existing sewer network.

3.6 Surface water

3.6.1 Wetlands

Review of the *Geomorphic Wetlands of the Swan Coastal Plain* (DBCA 2021) dataset indicates that the land adjacent to both sides of the Canning River (floodplain areas) and main water way are classified under the Canning River flood plain conservation category wetland (CCW) (UFI 15644, 15655 and 15669). The three CCWs are observed within and small portion of the site. Sections of the eastern flood plain of the Canning River are also classified as a multiple use wetland (MUW) (UFI), however it is noted that none of these MUWs are within the site boundary. The location of the Canning River floodplain within and in proximity of the site are shown in **Figure 7**.

3.6.2 Existing hydrological features

The DWER *Hydrography Linear* (DWER 2018) dataset indicates a major perennial water course (UFI 15655) which corresponds to the Upper Canning River. These feature runs adjacently along the eastern boundary of the side crossing a small section of the at the level of Gilwell Avenue. The Upper Canning River flows to the northwest and ultimately discharges into the Swan River.

The DWER *Floodplain Mapping* (DWER 2022a) indicates that the flood level along Canning River after the major (1% AEP) rainfall event would vary between 22.69 m AHD (southernmost corner of the site) to 17.60 mAHD (northernmost corner – north of Turner Place Footbridge). Further, a flood level of 19.75 mAHD for the major event would be expected within the existing Water Corporation Rundle Street Main Drain.

Existing open drains and the Canning River are shown in **Figure 8**.

A Water Corporation main drain (Rundle Street Main Drain) is located through a portion of the southern end of the site, continuing along the eastern boundary before discharging to the Canning River. The lower section of the Water Corporation Rundle Street Main Drain combines the piped outflows from the Water Corporation Denny Avenue Branch Drain and the Water Corporation Rundle Street Branch Drain. The Water Corporation Rundle Street Main Drain is an open drain and is poor condition (weed infested, steep sided trapezoidal drain) and there is adjacent open space which could provide appropriate conditions for the Drain to be retrofitted using living stream principles. As indicated by Water Corporation (G. Undale [Water Corp.] 2022. Comm., 28 April) peak flows into the Canning River from the two Water Corporation drains are detailed in **Table 1.**

Table 1: Peak discharges into the Canning River from Water Corporation branch/main drains from small, minor and major rainfall events.

Rainfall event	Denny Avenue Branch Drain (m^3/s)	Rundle Street Main Drain (m^3/s)	Cumulative Peak flow discharge (m^3/s)
Small (i.e. first 15 mm)	1.6	3.3	4.9
Minor (10% AEP)	3.3	5.4	8.7
Major (1% AEP)	4	6.3	10.3

The condition of the Water Corporation Rundle Street Main Drain is poor; it is currently steep sided and weed infested. The condition of the open channel of the Water Corporation Rundle Street Main Drain is shown in **Plate 1**. Given the current condition of the drain, there is a prime opportunity to provide improvement to water quality and amenity to the KAC area and Canning River foreshore.

Plate 1: Water Corporation Rundle Street Main Drain condition

3.6.3 Existing piped drainage network

A review of the Water Corporation drainage gravity pipe system (Water Corporation 2022) and the CoA drainage infrastructure indicates that the entirety of KAC Structure Plan area is serviced with a traditional pit and pipe network. Recent works as part of the METRONET project included additional drainage pipe extensions and upgrades to existing pipes. This network includes little to no at-source water quality treatment or detention, and is purely a flood mitigation/conveyance system. The northern CoA drainage network discharges directly to the Canning River, meanwhile the southern (majority) portion of the KAC connects to the Water Corporation Branch Drains (i.e. gravity pipes and open drains), and ultimately discharges to the Canning River via the Water Corporation Rundle Street Main Drain. Existing drainage infrastructure within the KAC is illustrated in **Figure 8**. The peak flow

rates at each of the outlets to the Canning River can be estimated based on the size of pipe discharging to the river. These flow rates then form a basis for the modelling assessment of peak flow rates and potential changes to these resulting from the implementation of the KAC, as discussed in **Section 6**.

3.7 Groundwater

3.7.1 Groundwater resources

The *Water Register* (DWER 2021c) indicates aquifers beneath the site comprise of the following:

- Superficial Swan (unconfined)
- Leederville (confined)
- Yarragadee North (confined).

At the time of preparing this report all aquifers are recorded as fully allocated.

The CoA currently holds a groundwater licence (GWL160738) for 693,633 kL, and groundwater is currently extracted at Fancote Park for irrigation of Fancote Park landscaped areas. The groundwater use at Fancote Park is accounted for within the CoA existing allocation.

3.7.2 Regional groundwater levels

A review of the Gnangara Jandakot Water Table Elevation (DWER 2019) contours indicates the maximum groundwater levels ranging between 23 mAHD to 20 mAHD and that these flow in a north easterly direction across the site (i.e. approximately 2 m to 7 m below the natural surface) towards the Canning River. The available maximum groundwater levels only cover the western half of the site. It is anticipated that groundwater levels will be variable across the site, and likely to be affected by localised soil conditions.

The *Water Information Reporting* (DWER 2020a) indicates that there is no groundwater quality information available within the site.

Due to the lack of local groundwater information beneath the site, it is expected that groundwater monitoring and/or assessment of localised geotechnical conditions will be undertaken to determine the suitability of the site for onsite infiltration of stormwater.

3.8 Summary of existing environment

In summary, environmental analysis undertaken during the LWMS works indicate that:

- Historical Imagery indicates that the KAC was established prior to the earliest available imagery. Since then the site has seen significant development. Land uses within the area are a mixture of commercial, residential, medical and community related uses, and POS areas.
- The site receives an average annual rainfall of 866.6 mm with the majority of the rainfall received between the months of June and August.

- Topography of the site ranges from 35 m AHD in the south, 25 in the north to 17 m AHD in the east, towards the Canning River. There is a localised high point along Albany highway which slopes away to the north (from 28 mAHD to 23 mAHD) in the most northern corner.
- Regional geological mapping indicates that soils beneath the site are highly variable and likely to be a mixture of sand, sandy clay, gravelly sandy clay and sandy silts. Given the historical development of the site of a long period of time, soils will likely include fill to variable depths and of variable quality.
- The western half of the site is classified as having 'moderate to low risk' of ASS occurring within 3 m of the natural soil surface, while the area abutting the Canning River foreshore is classified as 'high to moderate' risk of ASS.
- A contaminated lot, listed as 'remediated for restricted use', has been identified within the site boundary due to the presence of hydrocarbons in groundwater.
- Parts of the site (in the northeast and south) are classified as an environmentally sensitive area (ESA). This is primarily due to proximity to the Canning River.
- Bush Forever (BF) site 246 (vegetation within the flood plain of the Canning River) is observed within the site boundary.
- The entire site is classified as a sewage sensitive area under the Government Sewerage Policy. The CoA has advocated to the Water Corporation and State Government to complete the infill sewer system in Kelmscott and surrounding suburbs.
- The Canning River floodway and flood plain areas (land adjacent to the river on both sides) are classified as flood plain (CCW). The Canning River passes through a small section of the eastern boundary of the site (at Gilwell Avenue).
- Piped and open main drains from Water Corporation are found to cross the site boundary in the southern and eastern side, discharging to the Canning River via the Water Corporation Rundle Street Main Drain.
- Peak discharge into the Canning River from the site and upstream catchments in the Rundle Street Main Drain (during the 1% AEP rainfall event) is expected to be 10.3 m^3/s.
- Flood levels within the Canning River (adjacent to the site) varies between 22.69 mAHD in the south to 17.60 mAHD in the north.
- Minor piped stormwater drainage form the CoA drainage network connects to the Water Corporation drainage network (southern half of the site), meanwhile the northern half discharges directly into the Canning River.
- Regional groundwater indicates that groundwater flows in a north easterly direction across the site (towards the Canning River), at elevation of approximately 23.5 m AHD to 19.5 m AHD.
- There is no groundwater quality available for the site.

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this LWMS and future water management plans must achieve. The design criteria have been adopted to reflect site-specific environmental attributes outlined in **Section 3** and current best practice. The design objectives presented in this LWMS seek to deliver best practice outcomes using a WSUD approach, including detailed management objectives for water supply, conservation and wastewater, stormwater quantity/quality management and groundwater management.

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) and *BUWM* (WAPC 2008) endorses integrated water cycle management and application of WSUD principles to provide improvements in the management of surface water, and to increase the efficient use of other existing water supplies. The key principles of integrated water cycle management include:

- Considering all water sources, including wastewater, surface water and groundwater.
- Integrating water and land use planning.
- Allocating and using water sustainably and equitably.
- Integrating water use with natural water processes.
- Adopting a whole catchment integration of natural resource use and management.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Water management design objectives should therefore seek to deliver best practice outcomes in terms of:

- Potable water consumption
- Surface water management
- Groundwater management.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3**. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines, as well as previous studies relevant to the site. These were detailed in **Section 1.4** and **Section 1.5,** respectively.

4.2 Water conservation

Water conservation design criteria have been determined in line with the guidelines presented in *BUWM* (WAPC 2008). This LWMS proposes the following water conservation criteria:

Criteria WC1 Use fit for purpose water sources throughout the development.

Criteria WC2 Residential consumption target for water of 100 kL/person/year, including not more than 40-60 KL/person/year of scheme water.

Criteria WC3 Adopt an average POS irrigation rate of 6,750 kL/ha/year

4.3 Stormwater management

The principle behind stormwater water management at the site is to mimic the pre-development hydrological conditions, as described in **Section 3**. This principle and the guidance documents detailed in **Section 3.1** have guided the stormwater management criteria. This LWMS proposes the following stormwater design criteria:

Criteria SW1 Manage and treat the small (first 15mm) event runoff as close to source as practicable

Criteria SW2 Pre-development peak flow rates discharging into the Canning River in the minor (10% AEP) and major (1% AEP) event should be maintained.

Criterial SW3 Finished floor levels must have a minimum of 500 mm clearance above the 1% AEP flood level of the Canning River.

Criteria SW4 Utilise best management practices to minimise pollutants to the Canning River.

4.4 Groundwater management

The principle behind the groundwater management strategy is to maintain the existing groundwater conditions relevant to the Canning River, and to manage localised groundwater conditions to facilitate an appropriate level of protection of the built form and infrastructure from groundwater. This LWMS proposes the following groundwater management criteria:

Criteria GW1 Provide 1.2 m clearance between habitable floor levels and MGL, the low permeability soil layer or subsoil drain inverts.

Criteria GW2 Groundwater quality beneath the site should be maintained or improved.

Criteria GW3 Utilise best management practices to reduce the risk of nutrient loading to groundwater.

Criteria GW4 Where subsoil drains are adopted these are to have a free draining outlet

5 Water Source Allocation, Infrastructure, Fit-for-Purpose and Water Use

5.1 Fit-for-purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not unnecessarily used/wasted. Fit-for-purpose principles are proposed in the water conservation strategy for the site and will help to achieve **Criteria WC1** and **WC2**.

5.1.1 Scheme water

The KAC operates within the Water Corporation's Integrated Water Supply System (IWSS) and therefore lots are (and will continue to be) supplied with scheme water to meet potable and some non-potable uses.

5.1.2 Groundwater

The *Water Register* (DWER 2020b) indicates that the site is located above a multi-layered system comprising of the Superficial Swan, Leederville and Yarragadee aquifers. At the time of preparing this report all aquifers are fully allocated.

As indicated by the CoA and confirmed onsite, approximately 1.7 ha of POS located in the northeast of the site (Fancote Park) is irrigated with groundwater. Whilst the *Water Register* (DWER 2020b) does not indicate any active licenses within Fancote Park, it is understood that GWL160738 held by CoA (for 693,633 KL/year) is currently used for irrigation of the POS. This is expected to continue in the future.

5.1.3 Rainwater tanks

Harvest of runoff from roof surfaces can be undertaken, with this water stored within rainwater tanks (RWTs) for later use. Harvested rainwater may be used for lot scale irrigation purposes however this will likely need to be supplemented with scheme water during the lower rainfall months. This water is of high quality and can be used to substitute non-potable water requirements. During the higher rainfall months the majority of the stored rainwater can potentially be used to supplement internal building non-potable uses. The water efficiency strategy for this LWMS recommends that rainwater is promoted for use in washing machines, toilets and hot water systems of residential lots and commercial buildings.

5.2 Water conservation approach

The lot and POS landscape and streetscape approach within the KAC will utilise water wise garden (WWG) principles. Water efficient fixtures and appliances (WEFA) will also be promoted to ensure that the development minimises the use of water.

5.2.1 Water efficient fixtures, fittings and applications

Significant reduction in internal uses can be achieved with the use of WEFA. The water conservation strategy proposes that all dwellings and commercial premises use WEFA. Water efficient fittings will be implemented by the lot owner/developer during building construction, while uptake of water efficient appliances can be encouraged by provision of educational material. Based on typical uptake rates informed by Australian Bureau of Statistics (ABS) reports (ABS 2013), 40% of residential dwellings will utilise water efficient appliances.

5.2.2 Waterwise gardens

Employing WWG measures can significantly reduce total water usage within residential lots. Water use can also be reduced within streetscapes and landscaped areas of mixed use, civic and commercial lots, within verges and POS areas. WWG principles will be utilised within POS and road reserves and an average irrigation rate of 6,750 kL/ha/year areas should be adopted. It is assumed that 50% of private residential lots will implemented these practices (as informed by ABS studies (ABS 2013)).

A WWG approach may include the following measures:

- Improve soil with conditioner certified to Australian Standard AS4454 to a minimum depth of 50 mm where turf is to be planted and a minimum depth of 75 mm for garden beds.
- Mulch garden beds to 75 mm with a product certified to Australian Standard AS4454.
- Minimise the amount of turf areas where possible and adopt xeriscaped gardens (garden beds are landscaped using ‘waterwise plants’).
- Implementation of hydrozoning design practices, which will group plant species with similar irrigation requirements.
- Retain remnant native trees and vegetation within POS, streetscapes and carparks where possible. This will provide shade and reduce water requirements during POS establishment and provide greater amenity in other areas.
- Garden beds within POS and WSUD features will utilise ‘waterwise’ plants, which are locally native species or plants from regions with similar climates. These plants require less water input than exotic species.
- Design and install the irrigation system according to best water efficient practices:
  - Control systems must be able to irrigate different zones with different irrigation rates.
  - Emitters should preferentially disperse coarse droplets or be subterranean.
  - Irrigation will not be utilised during winter months.
  - Rain sensors may be utilised to avoid irrigation when rainfall can meet water demand.
- Minimise water requirements for POS maintenance. This will be achieved by implementing an appropriate management and maintenance program for POS.

5.2.3 Education

CoA has recently committed to participate in the Water Corporation's 'Waterwise Council Program', which it is designed to support the council to improve their water efficiency and water management with the aim of crating waterwise communities. Consequently, the community have access to special waterwise education resources and workshops, in addition to opportunities to participate in liveability projects and trials.

Further to the above, future lot developers can provide educational material to lot purchasers/tenants on water efficiency and quality protection measures that they can implement within both residential and commercial lots. Specific water conservation and protection topics that should be addressed include:

- Behaviours which reduce potable water use
- Water efficient technologies, rebates and programs
- Preferable plant species
- Fertiliser and pesticide use
- WWG practices.

5.3 Water use

5.3.1 Lot scale water use analysis

It is anticipated that water use within residential lots across the KAC area will readily be able to achieve the state water consumption target of no more than 100 kL/per/year, given the relatively smaller lot sizes proposed (i.e. in comparison to traditional larger residential lots). Further, if households adopt the water conservation measures described in **Section 5.2,** the *BUWM* (WAPC 2008) aspirational goal of 40-60 kL/person/year for residential lots would be met. It is expected that at development stage an in-depth calculation of the water consumption at lot scale will be conducted, and this will assist in satisfying **Criteria WC1** and **Criteria WC2.**

5.3.2 Water use within existing KAC precinct area

POS within the site will continue to be serviced by the groundwater allocation held by CoA (GWL160738). Any additional irrigation of POS, drainage corridors, streetscapes, urban spaces and road reserves areas proposed as part of the KAC Structure Plan will be of a temporary nature (i.e. for establishment purposes). Non-potable water demands for open spaces will continue to be met by the City's existing groundwater allocation, and appropriate and contemporary water usage rates (6,750 kL/ha/year) will be adopted for open spaces.

The above measures will assist in achieving **Criteria WC3**.

The irrigation measures will be outlined further when landscaping is known and this will be documented in a successive urban water management plan (UWMP) or documentation accompanying other planning/landscape design approvals.

5.4 Wastewater management

The KAC Structure Plan area will continue to be serviced by the Water Corporation existing sewerage system. At the time of the redevelopment, close consultation with Water Corporation is recommended to ensure that there is appropriate capacity within the sewerage network. If this were not to be the case the onus would be on the lot developer to negotiate and implement an outcome to the satisfaction of the Water Corporation.

5.5 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria and how these are addressed within the site is provided in **Table 2**.

Table 2: Water conservation compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
WC1	Use fit for purpose water sources throughout the development.	Scheme water utilised for potable and some non-potable uses.
		Rainwater tanks promoted and used to supplement non-potable uses.
		Groundwater from existing allocations utilised to meet POS irrigation demand.
WC2	Consumption target for water of 100 kL/person/year, including not more than 60 kL/person/year of scheme water.	Use of WEFA by lot owners.
		Adoption of WWG practices by lot owners.
		Education regarding water conservation and waterwise practices.
WC3	Adopt an average POS irrigation rate of 6,750 kL/ha/year.	Existing Fancote Park, drainage corridors, urban spaces and road reserves will be irrigated at a rates no greater than 6,750 kL/year/ha. This will be supplied from the existing groundwater licenses held by CoA.
		Landscape design and streetscape will adopt WWG practices.

6 Stormwater Management Strategy

The principle behind the stormwater management strategy is to maintain the existing hydrology of the site by retaining existing outflow locations to the Canning River and ensuring that the post-development peak flow rate for the major (1% AEP) rainfall event is not increased above the pre-development (existing KAC) environment. Further, the stormwater management strategy aims to treat and retain runoff up to the small (first 15 mm) rainfall event generated from the site wherever possible, as is unlikely to be currently undertaken, however is contemporary best practice.

The small rainfall event (i.e. the first 15 mm) will be captured and treated as close to source as practicable to ensure runoff is treated before entering the drainage system or ultimately into the Canning River. All remaining runoff up to the major (i.e. 1% AEP event) will be conveyed through the existing drainage network (CoA, Main Roads WA and Water Corporation) and ultimately discharged into the Canning River.

There are some minor but limited opportunities for end of pipe intervention and therefore the at-source treatment of runoff within both lots, carparks and streetscapes will be important.

A key opportunity exists for the retrofit of the Water Corporation Rundle Street Main Drain prior to discharge to the Canning River. The Water Corporation's piped network discharges to the open drain and the adoption of a living stream approach would significantly improve the water quality being discharged to Canning River and will increase the amenity of the open space within which it is located. Water Corporation and other relevant stakeholders should be engaged to facilitate an improved outcome for the Water Corporation Rundle Street Main Drain, and this could potentially occur through the Water Corporation's Drainage for Liveability program.

WSUD measures that will be utilised to manage stormwater runoff from the site therefore include:

- Soakwells within lots and carpark areas
- Rainwater storage/detention tanks
- Improvement to the existing pit and pipe network that may include:
  - Roadside bioretention areas/swales
  - Tree pits
  - Vegetated swales (in carpark areas)
  - Vegetated flow pathways/swales at piped outlets
- Retrofit of Water Corporation Rundle Street Main Drain as a living stream

These measures and how they might be implemented across the development are further detailed in the following sections. Existing stormwater network for the site is shown in **Figure 8** and identified sub-catchment areas across the KAC are shown in **Figure 9.** The analysis of peak flow rates at outlets is currently underway and will be included in supplementary information to this LWMS.

6.1 Lot drainage

Residential and commercial lots across the site should aim to manage the small (i.e. first 15mm) rainfall event within the lot prior discharging into the existing network. It is expected that appropriate lot scale measures would be implemented at the time of lot redevelopment, and not

retrofitted to existing built structures and carparks. Given localised soil conditions and the already built status of the KAC area, the full 15mm of runoff may be difficult to achieve, and it should be acceptable for some concession to the full volume to be made on a case-by-case basis, given there is currently very little at source treatment and any intervention will be an improvement. The at lot management of frequent event runoff may be achieved via surface based WSUD measures and where soils permit may include localised soakage. Lots will still require an overflow provision to the road drainage network for events which exceed the capacity of lot scale measures.

The implementation of on-lot treatment will be responsibility of the lot owner/developer and should be designed in consideration of individual lot characteristics. The design of lot drainage will need to be submitted to and approved by the CoA at the redevelopment (DA) stage. Treating runoff from the small event at source will assist in achieving Criteria **SW1**, **SW5** and **GW2.**

6.2 KAC and road reserve drainage

Future redevelopment/retrofitting of streetscapes/road reserves and POS within the KAC should adopt WSUD principles for the management of runoff onsite. The KAC will be required to treat runoff from the small rainfall event at source and this will also provide some measure of detention of larger less frequent rainfall events. Given that the site currently has little or no stormwater quality treatment or detention, any measure of intervention will be an improvement on the existing situation, and could be expected to assist in maintaining the flow regime discharging into the Canning River.

Where there is sufficient land area available, WSUD approaches at the end of pipe treatment should be considered prior to discharge to the Canning River. This is likely to be limited to the minor discharge outlets along Gilwell Avenue or potentially within the downstream end of Fancote Park as these are areas with potential land area available. If this were to be proposed each approach should be assessed on a case by case basis given the KAC build status and soil conditions.

The spatial constraints to end of pipe approached reiterate the importance of implementing at source WSUD measures when redevelopment of road reserves and streetscapes occur, so that appropriate protection of the Canning River is provided. WSUD measures should ideally aim to manage the first 15 mm of runoff at source, however given spatial constraints and other competing requirements (e.g. parking, footpaths, retention of existing trees) a lesser amount could be considered to still provide a positive water quality benefit.

Some of the WSUD measures that are envisaged may be appropriate are outlined in the following sections.

6.2.1 Roadside bio-retention areas

Surface runoff from the road pavement can be conveyed to bio-retention areas located within verges via slotted or flush kerbing (see example in **Plate 2**). Bio-retention areas can contribute to the treatment of the first 15 mm of runoff generated within the KAC road reserves. These would typically be located adjacent to side entry or gully pits so that once they are at capacity, stormwater can overflow to the piped drainage network or overflow onto the adjacent road surface.

Bio-retention areas within road verges can be designed to inundate to a maximum depth of 300 mm and should be vegetated with plant species suitable for the removal of nutrients from surface runoff, consistent with the *Vegetation guidelines for stormwater biofilters in the south-west of Western Australia* (Monash University 2014). Vegetation selected should also be hardy and capable of surviving in the longer term without irrigation. Bio-retention areas should be underlain with an engineered or amended soil for nutrient treatment purposes as in the case the naturally occurring soils do not exhibit a high phosphorus retention index (PRI). Soil investigation to determine the PRI levels of the existing soils might be required, and given the prevalence of clayey soils they may need to be underlain by subsoil drains to ensure that they are able to function appropriately.

Plate 2: Example of bio-retention area in road verge

6.2.2 Tree-pits

Tree-pits can be either stand alone measures or can be combined with side entry pits. These could potentially be located within KAC road reserves to provide at source detention and capture of small events (see **Plate 3** for an example design). Tree-pits provide minor storge volume individually, however collectively they can assist in achieving infiltration and treatment higher up in the catchment. Tree-pits can receive runoff via direct sheet flow over flush kerbing and/or via online connection to the stormwater treatment train. Amended soils might be required depending on the PRI conditions of the beneath soil.

Plate 3: Tree pit example

6.2.3 Roadside swales and median swales

Vegetated swales within the KAC area can be implemented within road medians (where sufficient width in road reserves exists) and along road reserve verges at the time of redevelopment. Similar approaches can also be implemented at the downstream end of carpark areas (if retrofitted) or at the end of pipe outlets (see **Plate 4** for an example design). The designs for these should consider similar principles to bio-retention areas (for vegetation, soil and subsoil drains), and these would typically be up to 500 mm deep, with 1:6 side slopes. Importantly, these will need to be designed in accordance to CoA requirements.

Plate 4: Example of vegetated swales.

6.2.4 Assessment of changes due to the KAC implementation

The potential impacts of changes to the peak flow regime leaving the KAC area as a result of the implementation of the KAC are anticipated to be minimal, given that most of the KAC area is already fully impervious. It is expected that the eventual adoption of at-lot storage for such areas will only result in a reduction to peak flow rates to the Canning River. It is however possible that the increased density of the few remaining low density residential lots to higher density residential land uses could result in a change to peak flow rates if not mitigated. In order to assess this, a surface runoff modelling assessment is being undertaken of key indicative catchments within the KAC area. This assessment will demonstrate the mitigative effects that introducing the retention of the first 15 mm will have, and will provide an indication of whether additional measures/increased storage needs to be adopted within lots or within the broader KAC area.

6.2.5 Water Corporation Rundle Street Main Drain as Living Stream

Retrofitting of the Water Corporation Rundle Street Main Drain as per a living stream prior discharge to the Canning River as an end of pipe treatment will improve significantly the quality of surface runoff that is currently discharged into the Canning River. Addressing water quality from the contributing catchments to these drains would provide some measure of water quality treatment to most catchment areas in the KAC. It would also provide some mitigation of the major rainfall event as well as increasing the amenity and biodiversity of the open space within which is located.

Given the flow rates identified in the Water Corporation Rundle Street Main Drain (of 10.3m^3/s in a 1% AEP event) a channel design is likely to require a flood width of approximately 12-15 m, depending on the design approach taken. Further land area would also be required if other living stream features (e.g. meanders) were to be incorporated.

Retrofitting of the Water Corporation Rundle Street Main Drain could potentially be achieved through the Drainage for Liveability program, however it is noted that consideration of stakeholder requirements, tenure, funding (the Water Corporation drainage rates charged in the area could be used for this purpose) and ongoing management responsibility will need to be considered and resolved. Whatever design is adopted it will need to meet Water Corporation's flood conveyance requirements, and facilitate a management approach that is acceptable to CoA and the Water Corporation. Location of the Water Corporation Rundle Street Main Drain is shown in **Figure 8.**

6.3 Non-structural water quality measures

The structural measures proposed within the site provide both a storage and treatment function to stormwater runoff, as detailed in **Sections 6.1**, **6.2** and **6.3**. Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007).

A number of non-structural measures will be implemented within KAC to help reduce nutrient loads within stormwater runoff. These measures include:

- At-source sediment control during earthworks and construction activities (including finalisation of landscaping).
- Developments and construction activity should comply with City policy PLN2.5 Erosion Prevention and Sediment Control.
- Street sweeping in accordance with operational requirements.
- Maintenance of WSUD features to remove sediments, gross pollutants and hydrocarbons.
- Minimising fertiliser use to establish and maintain vegetation within POS, streetscapes and other landscaped areas (i.e. within verge, lots etc).
- Utilising drought tolerant plant species that require minimal water and nutrients within WSUD features and the Water Corporation Rundle Street Main Drain living stream.
- If utilised, turf species should be drought tolerant and require minimal water and nutrients.
- Education of developers, lot owners, residents and tenants regarding fertiliser application and the use of nutrient absorbing vegetation.

6.4 Stormwater design criteria compliance summary

A summary of the proposed stormwater management design criteria and how these are addressed within the KAC redevelopment area is provided in **Table 3**.

Table 3: Stormwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Manage and treat the small (first 15mm) event runoff as close to source as practicable.	This could be achieved in residential and commercial lots by implementing localised soakage/storage. Infiltration based measures should be assessed in a case-by-case basis due to localised conditions.
		For road reserves and the broader precinct, runoff from the small event can be managed by roadside bio-retention areas, tree pits and vegetated swales. Key opportunity is the retrofitting of the Water Corporation Rundle Street Main Drain as per a living stream.

Table 3: Stormwater management compliance summary (continued.)

Criteria number	Criteria description	Manner in which compliance will be achieved
SW2	Pre-development peak flow rates discharging into the Canning River in the minor (10% AEP) and major (1% AEP) event should be maintained.	WSUD features will facilitate the detention of runoff up to the 1% across the KAC area in order to maintain the peak discharge rates into the Canning River. The catchment is already 95% impervious with little water quality treatment measures or flood detention, and therefore any additional measures implemented will be an improvement on the current approach.
SW3	Finished floor levels must have a minimum of 500 mm clearance above the 1% AEP flood level of the Canning River.	Most existing finished floor levels of habitable buildings will already meet the required clearances to the Canning River.
SW4	Utilise best management practices to minimise pollutants to the Canning River.	At-source sediment control during earthworks and construction activities.
		Developments and construction activity should comply with City policy PLN2.5 Erosion Prevention and Sediment Control.
		Street sweeping in accordance with operational requirements.
		Maintenance of WSUD features to remove sediments, gross pollutants and hydrocarbons.
		Minimising fertiliser use to establish and maintain vegetation POS, streetscaped areas and other landscaped areas.
		Utilising drought tolerant plant species that require minimal water and nutrients within WSUD features and the Water Corporation Rundle Street Main Drain living stream.
		Education future lot owners, residents and tenants regarding fertiliser application and the use of nutrient absorbing vegetation.

7 Groundwater Management Strategy

The principle behind the groundwater management strategy is to maintain the existing groundwater conditions relevant to the Canning River, and to manage localised shallow groundwater/soil conditions to facilitate an appropriate level of protection of the built form and infrastructure from groundwater. Given the anticipated low permeability soil types, it is likely that groundwater observed at the site are more a reflection of localised perching, rather than the superficial aquifer.

Groundwater management for the KAC area will adopt the use of structural measures to manage shallow groundwater conditions and a combination of structural/non-structural measures to achieve groundwater quality improvements.

7.1 Groundwater level management

Groundwater level management will include the localised use of imported fill to maintain sufficient clearance to groundwater and/or low permeability soil conditions and the potential use of subsoil drains to ensure road pavement is provided with appropriate moisture conditions. This will facilitate the at-lot management of frequent rainfall events, though it is noted that this may not be possible for some highly constrained sites, and that some sites have recently been constructed and such upgrades may not occur for some time.

7.1.1 Imported fill

When groundwater is less than 1.2 m below the surface or the lot underlain by a low permeability soil layer the utilisation of imported sands may be required in order to maintain an adequate clearance.

Based on the limited publicly available groundwater information, it is expected that further monitoring investigations are undertaken to determine the proximity of groundwater to the surface and as well as geotechnical investigation to establish the localised soil conditions/permeability.

7.1.2 Subsoil drains

Where the finished road network or lot levels will be <1.2m from the localised MGL or low permeability soils, groundwater rise beneath the infrastructure should be controlled through the installation of subsoil drains.

Subsoil drains will be proposed on a case-by-case scenario due to localised site constraints, and the ability to connect the subsoils to an appropriate discharge location/elevation. If proposed, subsoil drains should discharge either to the stormwater network or to WSUD features ensuring they have a minimum clearance of 150 mm to the invert level of the asset as this will provide a free flowing outfall.

It is anticipated that subsoil drains will be proposed to lower the existing superficial groundwater levels as they will be set at or above MGL. Their main purpose will be the management of localised groundwater and improved infiltration efficiency of WSUD structures.

7.2 Groundwater quality management

The main objective for the management of the groundwater quality is to maintain or improve the existing groundwater quality which discharges to the Canning River. Groundwater quality will be addressed by treating surface runoff via adopted WSUD measures that will be adopted to address surface water quality. This will help to reduce the total nutrient load into the shallow groundwater that originates from the site and that eventually will discharge into the Canning River.

Once the site reaches the redevelopment stage (which is likely to occur over an extended period of time), improvement of water quality can be achieved by treating surface runoff prior to infiltration via the application of appropriate WSUD measures previously indicated in **Section 6**, as these will reduce the total nutrient load into the groundwater that originates from the development.

The reduction of nutrient load across the KAC area will be achieved by:

- Treating runoff in WSUD structures (discussed in **Section 6**).
- Street sweeping on a regular basis.
- Maintenance of WSUD features.
- Minimising fertiliser use to establish and maintain vegetation within POS, streetscape and landscaped areas (i.e. within verge, lot etc).
- Utilising drought tolerant plant species that require minimal water and nutrients.
- If utilised, turf species should be drought tolerant and require minimal water and nutrients WSUD features and Water Corporation Rundle Street Main Drain.
- Education of developers, lot owners, residents and tenants regarding fertiliser application and the use of nutrient absorbing vegetation.

The above measures will assist improving the quality of the surface water prior infiltrating into the underlying shallow groundwater (and eventual export to the Canning River) and will assist in achieving **Criteria GW2** and **GW3**.

7.3 Groundwater design criteria compliance

A summary of the proposed groundwater management criteria and how these will be addressed within the KAC Structure Plan area is provided in **Table 4**.

Table 4: Groundwater management criteria compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Provide 1.2 m clearance between habitable floor levels and MGL, the low permeability soil layer or subsoil drain inverts.	The utilisation of imported fill will be required to ensure adequate clearance to groundwater, impermeable soil layers and subsoil drains.
GW2	Groundwater quality beneath the site should be maintained or improved.	Treating runoff in WSUD features before infiltration of stormwater and/or conveyance to the Canning River.
GW3	Utilise best management practices to reduce the risk of nutrient loading to groundwater.	Street sweeping in accordance with operational requirements.
		Maintenance of WSUD features.

Table 4: Groundwater management criteria compliance summary (continued.)

Criteria number	Criteria description	Manner in which compliance will be achieved
GW3 (continued.)	Utilise best management practices to reduce the risk of nutrient loading to groundwater.	Minimising fertiliser use to establish and maintain vegetation within POS, streetscapes and landscaped areas (e.g. within verge, lot etc).
		Utilising drought tolerant plant species that require minimal water and nutrients.
		If utilised, turf species should be drought tolerant and require minimal water and nutrients.
		Education of developers, lot owners, residents and tenants regarding fertiliser application and the use of nutrient absorbing vegetation.
GW4	Where subsoil drains are adopted these are to have a free draining outlet.	Subsoils for the management of groundwater should have a free draining outlet within the existing stormwater network or at least 150 mm above the invert level of WSUD features to ensure free draining conditions.

8 Subdivision and Development Application

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of subdivision or development approval (DA). The development of any future UWMP or Stormwater Management Plan should follow the guidance provided in *UWMPs: Guidelines for Preparing Plans and for Complying with Subdivision Conditions s* (DoW 2008) and/or the requirements of the CoA.

Redevelopment of areas across the KAC Structure Plan area progressed under DA may not be required to prepare additional water management plans (i.e. UWMP) to support the application. In this case, detailed designs presented in DAs should be supported by sufficient justification that the criteria in this LWMS have been considered and adopted where possible. Proposals should be reviewed by the CoA in conjunction with the design criteria presented in this LWMS to ensure the appropriate elements of the water management strategy discussed herein are implemented.

While strategies have been provided within this LWMS that address planning for water management within the site, it is a logical progression that future redevelopment designs and the supportive UWMP (if required) will clarify details not provided within this LWMS. The main areas that will require further clarification include:

- Implementation of water conservation strategies
- Confirmation of irrigation sources and conceptual landscape design
- Imported fill strategy
- Modelling, design and configuration/retrofitting of WSUD features
- Lot drainage
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction period management strategy
- Monitoring and evaluation program.

These are further detailed in the following sections.

8.1 Implementation of water conservation strategies

A number of potential measures to conserve water have been presented within this LWMS (see **Section 5**). These water conservation strategies will be incorporated at the redevelopment stage and via the ongoing maintenance of all POS areas, streetscape areas and any other landscaped areas. Landscape design measures that will be incorporated into the water conservation strategy will be further detailed within the future UWMPs, DA applications or landscape designs.

It is expected that where any irrigation using groundwater is proposed, this will be covered by the existing license held by the CoA while adopting a contemporary water usage rates, or that an appropriate alternative approach is adopted.

The manner in which individual lot developers intend to promote water conservation measures discussed in this LWMS to future lot owners/tenants will also be discussed within the future UWMP, DA application or other supportive documentation.

8.2 Confirmation of irrigation sources and conceptual landscape design

POS areas, streetscape areas and other landscaped areas within the KAC area will need to either be irrigated by an appropriate fit-for-purpose water source (e.g. license held by the CoA) or be designed such that long term post-establishment irrigation is not required (e.g. 'dry parks' or low water use only required for establishment period). The existing approach to irrigating Fancote Park is expected to continue to be serviced by the current groundwater allocation.

All irrigation requirements for future POS area should be confirmed and detailed within future UWMPs, DA applications or landscape designs to be approved by the City.

8.3 Imported fill strategy

At the time of individual lot redevelopment, the fill approach and specifications will need to be refined based on localised conditions (e.g. underlain soils, clearance to groundwater, clearance to Canning River). This should be informed by site-specific geotechnical investigations and should consider how the site will connect (or not connect) to the surrounding drainage network.

8.4 Modelling, design and configuration/retrofitting of WSUD features

There has been no hydrological or hydraulic modelling undertaken at this stage as it is anticipated that the current existing drainage network alignment and catchment areas will be generally maintained/replaced at the time of the redevelopment, there is likely to be little increase in impervious area within the catchment. The adoption of at-source water quality approaches (where there currently are few) will likely reduce the peak flow rates discharged to the Canning River, and therefore it is not anticipated that peak flow rates will rise post-development. Notwithstanding, future investigations to determine the capacity of the existing network and to demonstrate that the 1% AEP peak flow rate being discharged from site does not increase should be undertaken to establish if any upgrades or onsite detention will be required.

Future lot redevelopment will confirm the exact location, type, configuration and size of proposed WSUD structures and/or the revitalised Water Corporation Rundle Street Main drain as a living stream. This detail should be specified and presented within future UWMPs, DA applications or other appropriate support documentation.

8.5 Lot drainage

The stormwater management strategy requires that residential and commercial lots will treat and/or manage the small rainfall within the lot boundary. The implementation of on-lot treatment is the responsibility of the lot owner/developer and should be designed in consideration of individual lot characteristics (e.g. soil types, groundwater levels and availability of surrounding drainage infrastructure). The design of lot drainage will need to be submitted to and approved by the CoA in the DA application, building licence or other appropriate support documentation prior to construction.

8.6 Non-structural water quality improvement measures

Guidance for the implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007). CoA many also have or may develop their own specific measures which respond to local conditions or situations which arise from time to time. Some measures will be more appropriately implemented at a local government level, such as street sweeping. Many can be implemented relatively easily within the design and maintenance of the drainage network, including WSUD features. Others are more appropriately managed by individual lot owners (i.e. fertiliser application on landscaped areas).

It is expected that the future UWMP, DA application, stormwater management plan or other appropriate support documentation will provide a list of appropriate non-structural measures including timing and responsible parties for implementation.

8.7 Construction period management strategy

It is anticipated that the construction stage will require some management of various aspects (i.e. dust, surface runoff, noise, traffic etc.). The management measures undertaken for construction management will be addressed either in the future UWMP, DA application or a separate Construction Management Plan (CMP). As indicated, developments and construction activity should comply with City policy PLN2.5 Erosion Prevention and Sediment Control, and the manner in which this will be achieved should be captured within the CMP. Given that most of the redevelopment is proposed within the CoA jurisdiction, it is possible that road design and implementation will need to be undertaken directly by the CoA. In this case the appropriate construction measures and their implementation will be the responsibility of the CoA.

8.8 Monitoring and evaluation program

The management measures to be implemented to address surface water quality, such as the use of roadside bio-retention areas, swales will require ongoing maintenance. It is therefore expected that future UWMPs and/or DA application will provide detailed management and maintenance plans that will set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions). Given that approval from the CoA, DWER, Water Corporation and other relevant stakeholders will be sought for the proposed measures, it is anticipated that close consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

It will be necessary to confirm that the management measures that are implemented are able to fulfill their intended management purpose, and are in a satisfactory condition at a point of management handover to the CoA. A post-development monitoring program will be developed to provide this confirmation, and it will include details of objectives of monitoring, relevant issues and information, proposed methodology, monitoring frequency and reporting obligations.

The maintenance and monitoring requirements for the Water Corporation Rundle Street Main Drain (if upgraded as living stream) will likely require additional consideration between CoA, the Water

Corporation and other stakeholders. These monitoring programs are discussed in **Section 9** of this LWMS and will be further detailed at the UWMP or DA stage.

9 Monitoring and Maintenance

The post-development monitoring and maintenance for the KAC area will focus on the condition of newly constructed WSUD structures and Water Corporation Rundle Street Main Drain (assuming that this is retrofitted as a living stream), as well as surface water quality. Water quality being discharged to the Canning River should aim to achieve the Swan Canning Water Quality Improvement Plan targets. It is unlikely that a coordinated surface water quality monitoring program will be implemented until practical completion of the entire KAC redevelopment. However, it may be appropriate to undertaken monitoring of key measures (e.g. WSUD measures within the road network, or the Water Corporation Rundle Street Main Drain living stream). This should be confirmed with the CoA and Water Corporation during the design and construction of any WSUD structures.

9.1 Post-development monitoring

9.1.1 Condition monitoring

The overall conditioning of WSUD features across the KAC area and the revitalised Water Corporation Rundle Street Main Drain should be monitored on a bi-annual basis from completion of the civil and landscaping works. This should begin following completion of the civil and landscaping works, and continue for a period of two years to ensure that the functionality is maintained.

A visual assessment should be undertaken to monitor the overall condition of the redeveloped areas, with the aim to inform maintenance activities (which will be detailed in the UWMP as described in **Section 8**) and ensure that these are achieving the overall management objectives. The parameters that will be monitored and possible remedial actions that may be implemented are detailed in **Table 5**.

Table 5: Condition monitoring parameters and remedial actions

Parameter	Trigger for remedial action	Remedial action
Gross pollutants	If present	Remove gross pollutants and dispose of at approved facility
Excessive accumulation of sediment	If present	Manual removal of sediments
Terrestrial weeds	Excessive weed growth	Manually remove weeds
		Apply herbicide at manufacturer's recommended rate
Irrigation	Evidence of damage to irrigation system (if any)	Repair irrigation system (if any)
Vegetation density	If significant number of plant deaths/thefts occur	Remove dead plants
		Conduct infill planting to maintain species densities
Paths, benches, walkways, play equipment and other proposed infrastructure	Damage to, theft or vandalism of infrastructure adjacent to WSUD structures	Repair or replace damaged infrastructure

9.1.2 Surface water monitoring

After the completion of any WSUD features and/or the revitalised Water Corporation Rundle Main Drain, monitoring of surface water quality should ideally occur at the existing discharge locations (refer to **Figure 8**). Monitoring should be conducted quarterly for a period of two years from practical completion. As indicated in the *Swan Canning Water Quality Improvement Plan* (SRT 2009), the surface water quality concentration that the KAC area should aim to achieve are detailed in **Table 6.**

Table 6: Surface water quality target values (SRT 2009)

Analyte	Long-term groundwater quality guideline values
TN as N	1 (mg/L)
TP as P	0.1 (mg/L)

10 Implementation

The LWMS is a key supportive document for the KAC Structure Plan. The development of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of future UWMPs, DA applications or other appropriate support documentation to support individual lot development.

10.1 Roles and responsibility

The LWMS provides a framework that the CoA can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations and which are consistent with relevant State and Local Government policies.

The responsibility for working within the framework established within the LWMS rests with a number of agencies including CoA (where they are the proponent, and will need to upgrade any of the roads and construct associated drainage infrastructure), PTA (for railway drainage and carparks), Main Roads WA (for Albany Highway drainage), Water Corporation (for Water Corporation Assets), future subdivision/lot developers, lot owners and tenants. The roles are summarised in **Table 7**. Responsibilities related to non-structural measures will be detailed in future UWMPs, DA applications or other appropriate support documentation, as indicated in **Section 8.5.**

Table 7: Roles and responsibility

Role	Responsibility
Implement and maintain lot drainage strategy	Lot owner/lot developer and/or tenants.
Provision of lot drainage connection points	Lot developer (where subdivision occurs in a coordinated manner) or CoA (i.e. where the CoA choose to redevelop car park areas, streetscaped areas, landscaped areas or other POS areas.
Construct and maintain WSUD structures	
Maintain existing and future drainage assets	CoA, PTA, Water Corporation, Main Roads WA.

10.2 Funding

Funding for lot drainage infrastructure will be the responsibility of the lot owner/lot developer.

It is anticipated that KAC Structure Plan area is more likely to progress through DAs for individual lots, with road upgrades and the redevelopment of some POS areas likely to be progressed by the CoA or other applicable agency. Funding for works within individual lots will be the responsibility of the lot owner/developer. Funding for other civil infrastructure upgrades will likely rest with the owner/management authority of the infrastructure. The construction and maintenance of any drainage infrastructure within CoA managed public road reserves and/or existing reserves will be the responsibility of the CoA. Similarly, upgrades/development of infrastructure by other authorities within the KAC (e.g. PTA, Main Roads WA, Water Corporation) should be implemented by and be the responsibility of that authority.

10.3 Review

It is not anticipated that this LWMS will be reviewed, unless additional land parcels/lots are added to the KAC Structure Plan area prior to redevelopment, or the Structure Plan undergoes significant change post-lodgment of the LWMS. If additional areas are required to be covered by the LWMS it is most likely that an addendum to cover these areas could be prepared.

11 References

11.1 General references

The references listed below have been considered as part of preparing this document.

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11.2 Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 11.1**, with access date information provided in **Table R 1**.

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
(BoM 2022)	27 April 2022	Bureau of Meteorology – Climate Data Online
(DBCA 2021)	27 April 2022	Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)
(DWER 2017a)	27 April 2022	Acid Sulfate Soil, Swan Coastal Plain (DWER-055)
(DWER 2018)	27 April 2022	Hydrography Linear (DWER-031)
(DWER 2019)	27 April 2022	Gnangara Jandakot Water Table Elevation (DWER-100)
(DWER 2020a)	27 April 2022	Water Information Reporting Tool
(DWER 2020b)	27 April 2022	Water Register
(DWER 2021)	27 April 2022	Contaminated Sites Database
(DWER 2022a)	4 May 2022	FPM Flood Plain Area (DWER-020)
(DWER 2022b)	4 May 2022	Groundwater Map
(WALIA 2022)	27 April 2022	Landgate Map Viewer
(Water Corporation 2022)	27 April 2022	Drainage Gravity Pipe (WCORP-080)

Figures

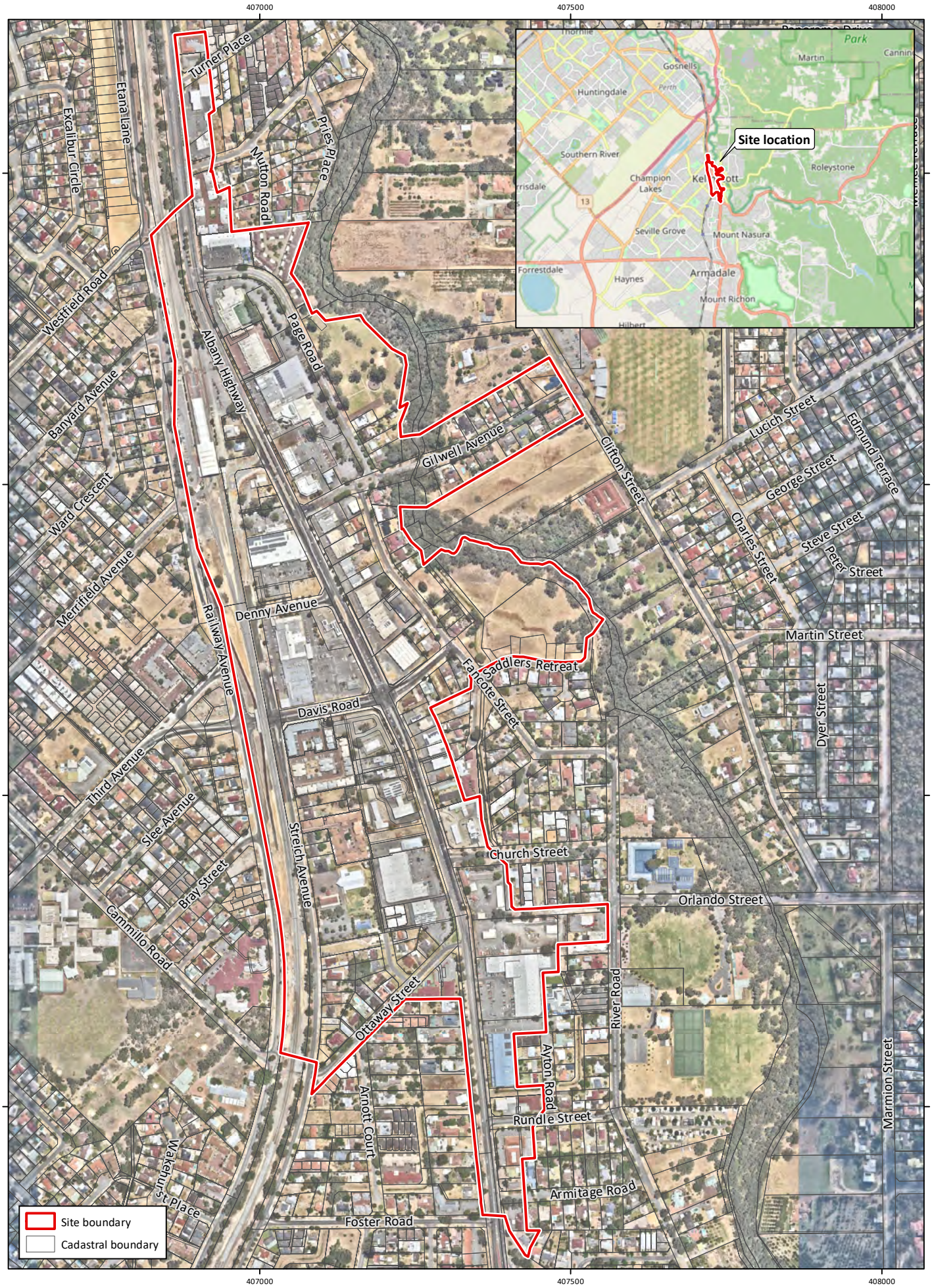

Figure 1: Location Plan

Project:	Local Water Management Strategy Kelmscott Activity Centre Plan DSP Support
Client:	TBB

Plan Number:
EP21-032(01)--F09

Drawn:	WJC
Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

N

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

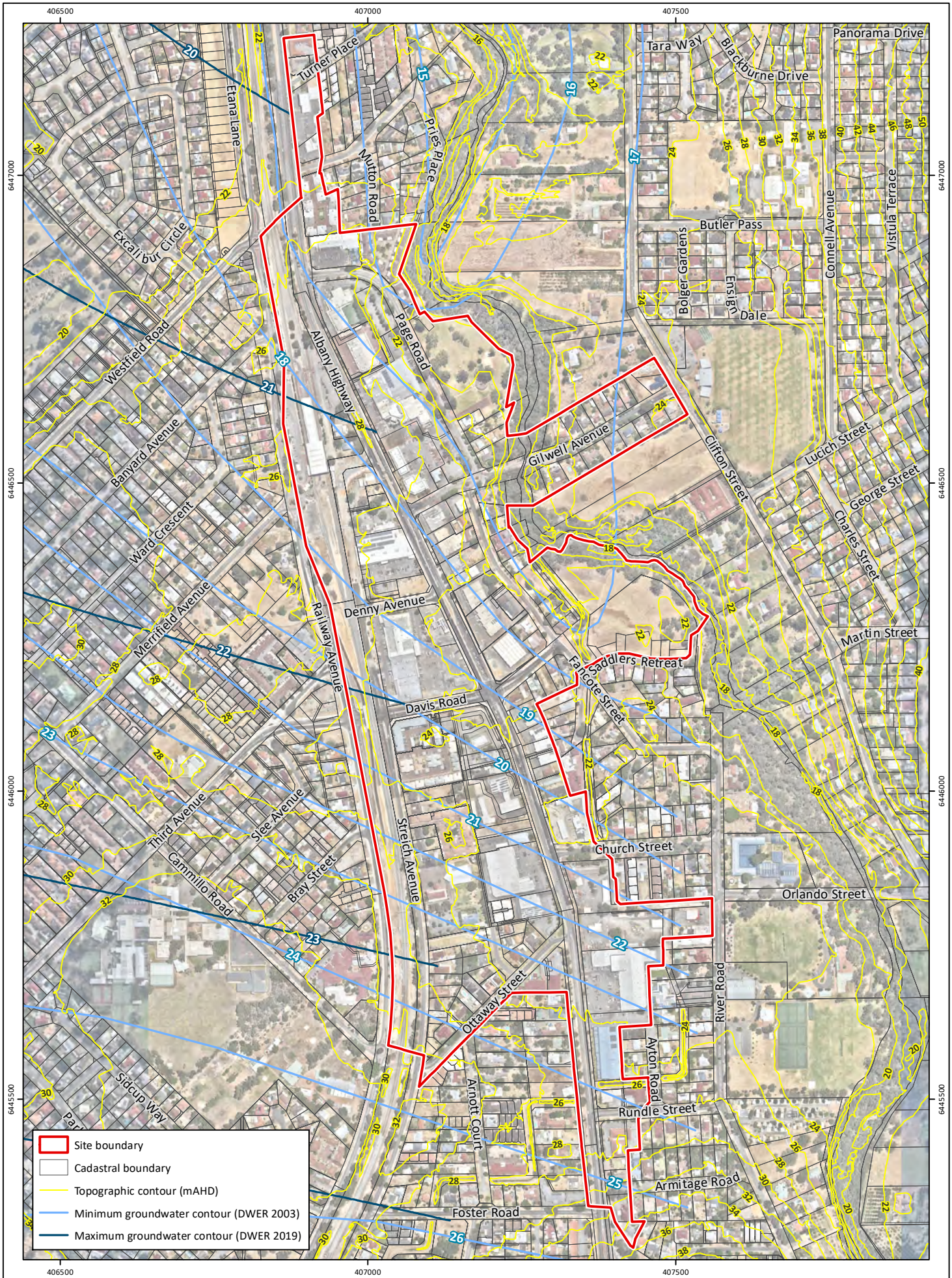

Figure 2: Topographic Contours and Groundwater Levels

Project: Local Water Management Strategy
Kelmscott Activity Centre Plan DSP Support

Client: TBB

Plan Number:
EP21-032(01)--F10

Drawn:	WJC
Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

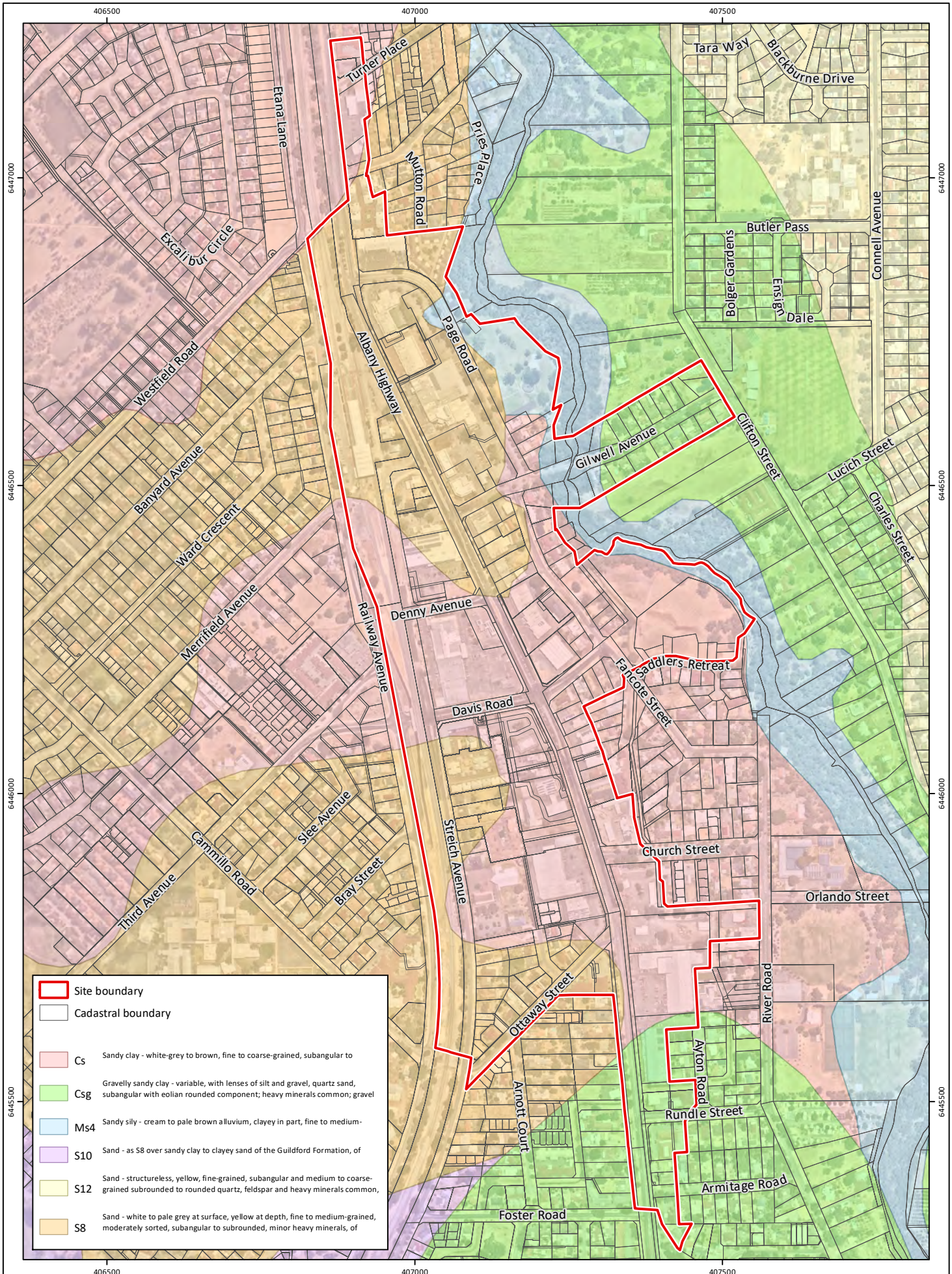

Figure 3: Environmental Geology

Project: Local Water Management Strategy
Kelmscott Activity Centre Plan DSP Support

Client: TBB

Plan Number:
EP21-032(01)--F11

Drawn:	WJC
Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

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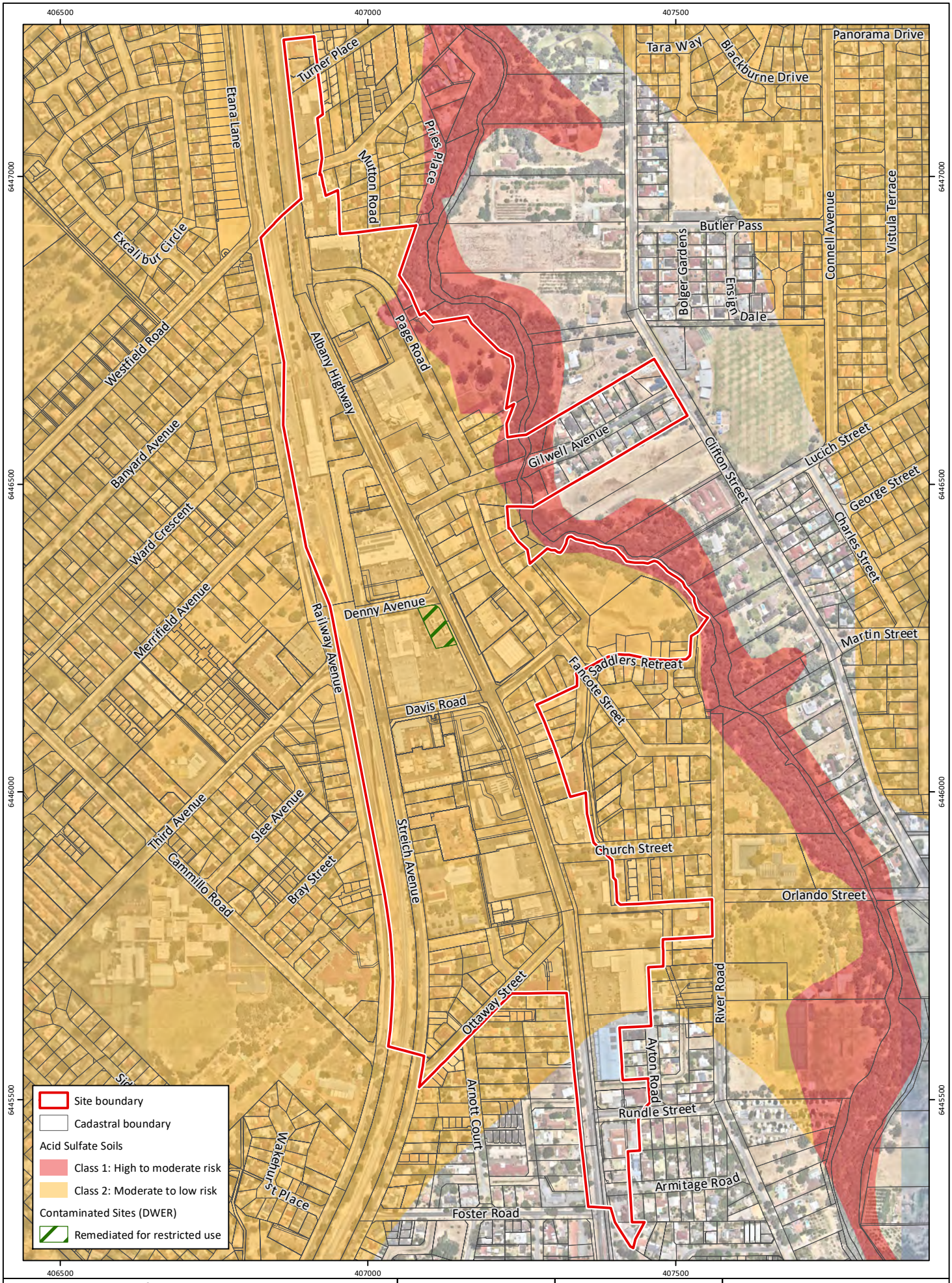

Figure 4: Acid Sulfate Soils and Contaminated Sites

Project: Local Water Management Strategy
Kelmscott Activity Centre Plan DSP Support

Client: TBB

Plan Number: EP21-032(01)--F12

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Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

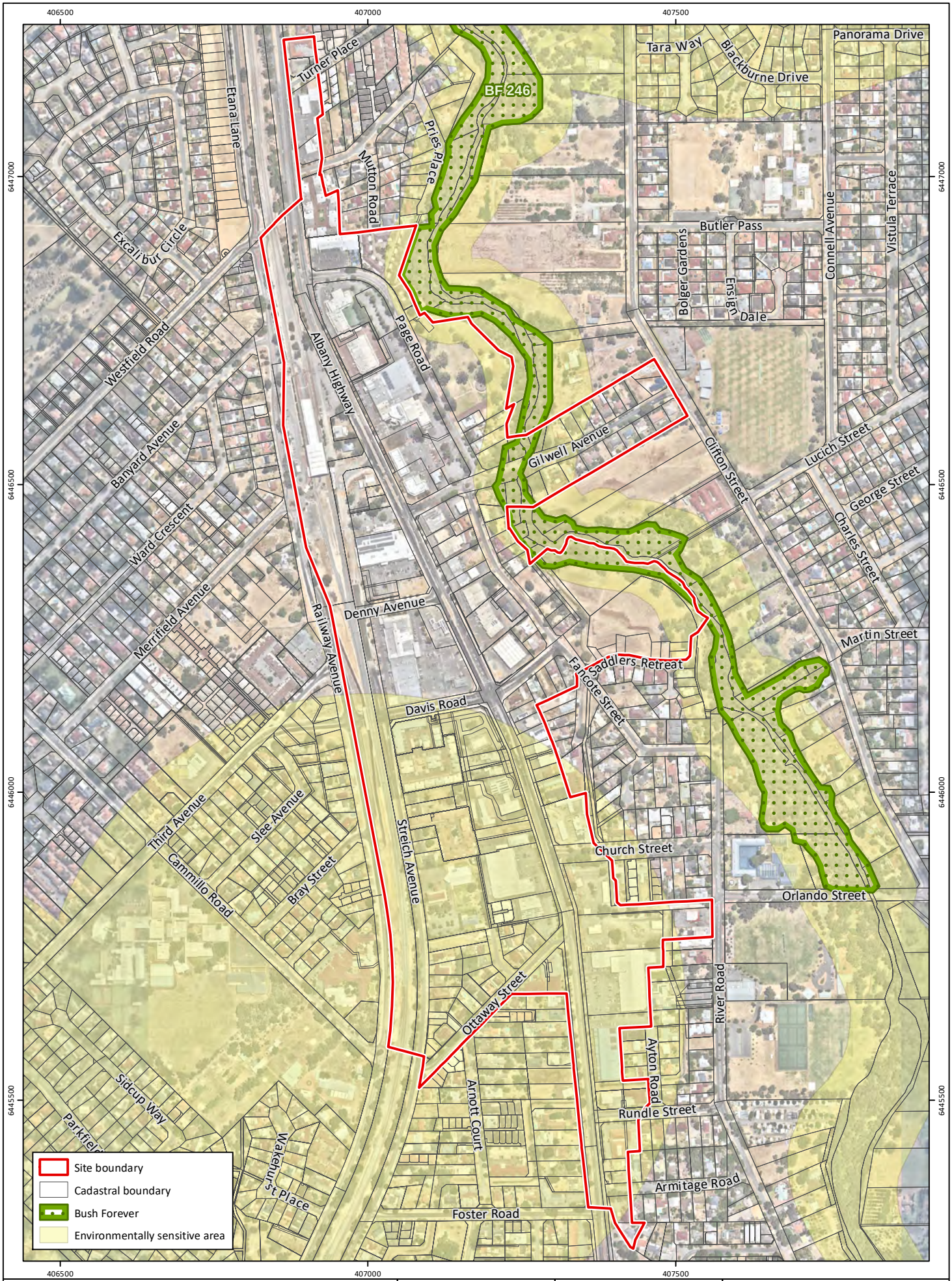

Figure 5: **Environmental Sensitive Areas and Bush Forever Sites**

Project: Local Water Management Strategy
Kelmscott Activity Centre Plan DSP Support

Client: TBB

Plan Number: EP21-032(01)--F13

Drawn:	WJC
Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

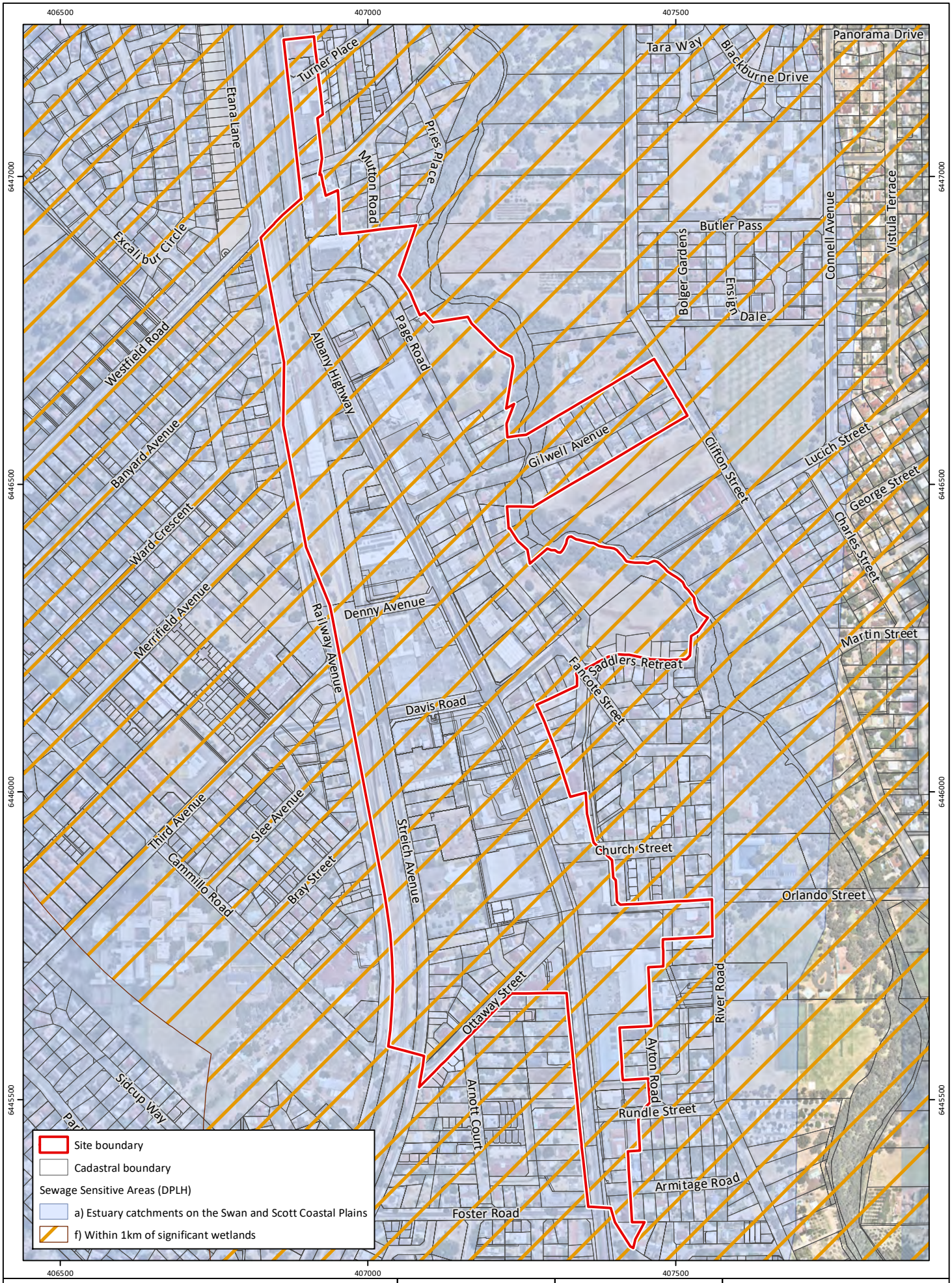

Figure 6: Sewage Sensitive Areas

Project: Local Water Management Strategy
Kelmscott Activity Centre Plan DSP Support

Client: TBB

Plan Number: EP21-032(01)--F14

Drawn:	WJC
Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

N

0 100 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

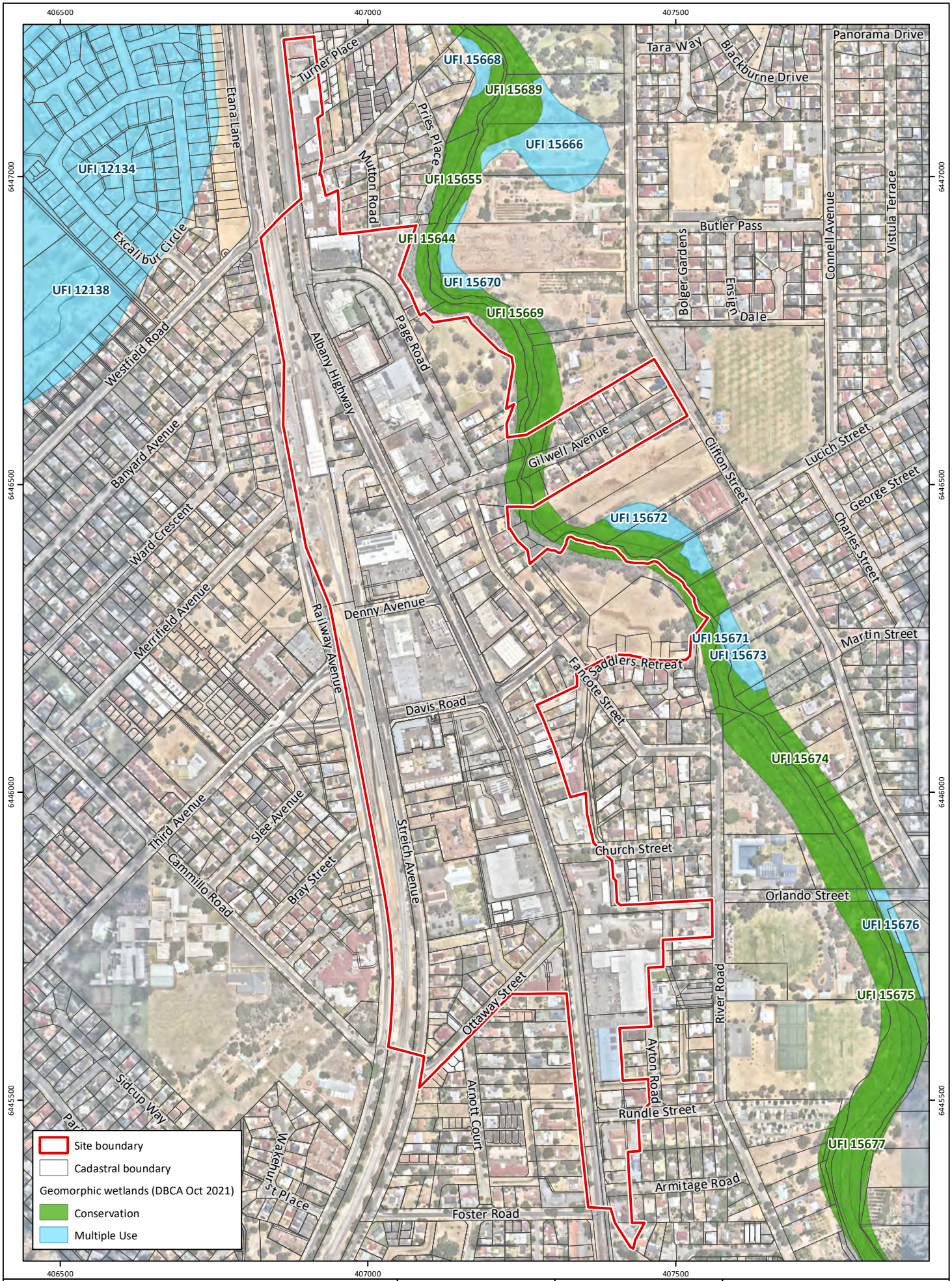

Figure 7: Geomorphic Wetlands

Project: Local Water Management Strategy
Kelmscott Activity Centre Plan DSP Support

Client: TBB

Plan Number: EP21-032(01)--F15

Drawn:	WJC
Date:	28/04/2022
Checked:	FMH
Approved:	DPC
Date:	06/05/2022

N

0 100 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

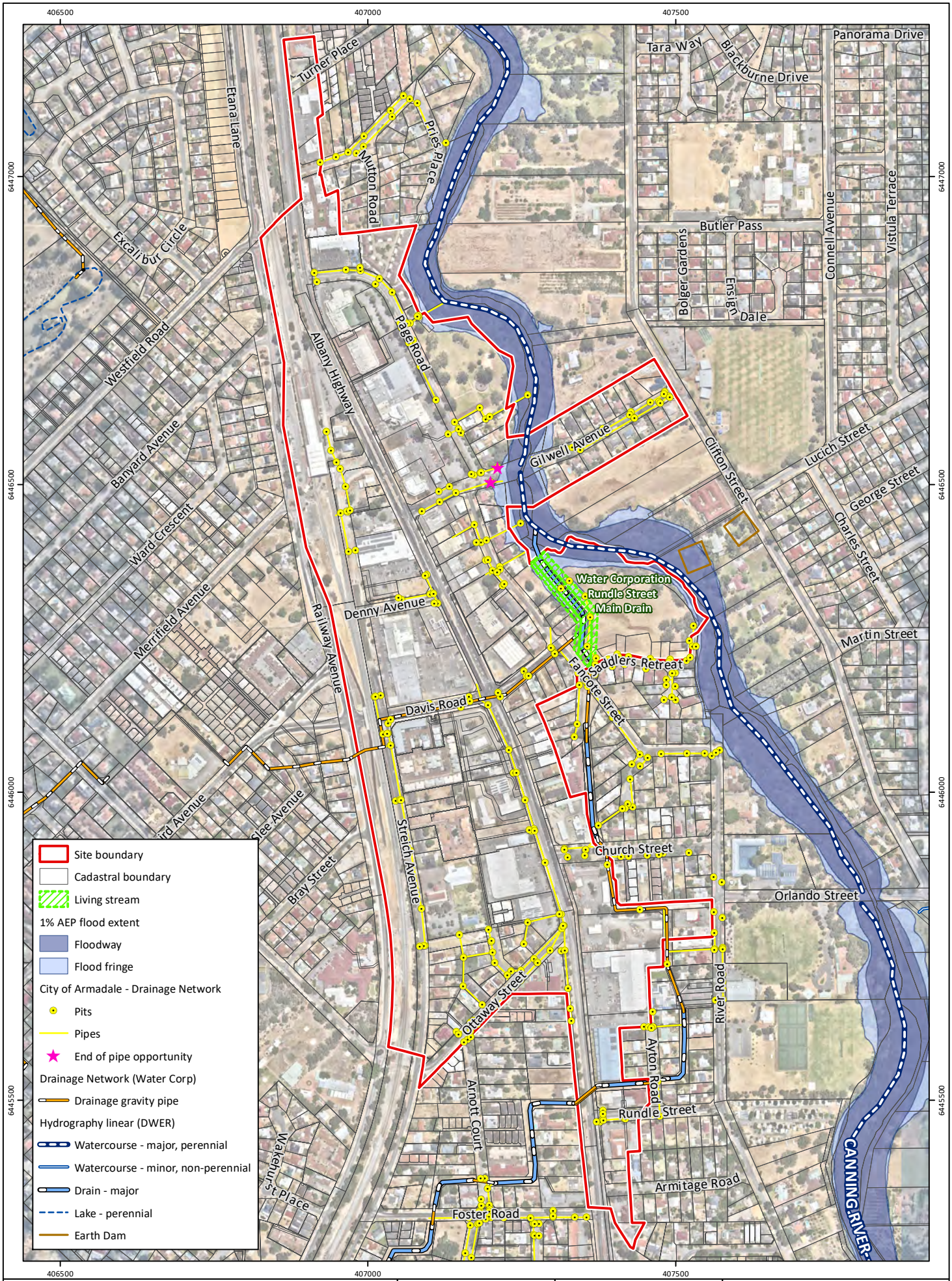

Figure 8: Hydrological Features

Project:	Local Water Management Strategy Kelmscott Activity Centre Plan DSP Support
Client:	TBB

Plan Number:
EP21-032(01)--F16a

Drawn:	GAR
Date:	29/07/2022
Checked:	FMH
Approved:	DPC
Date:	29/07/2022

N

0 100 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

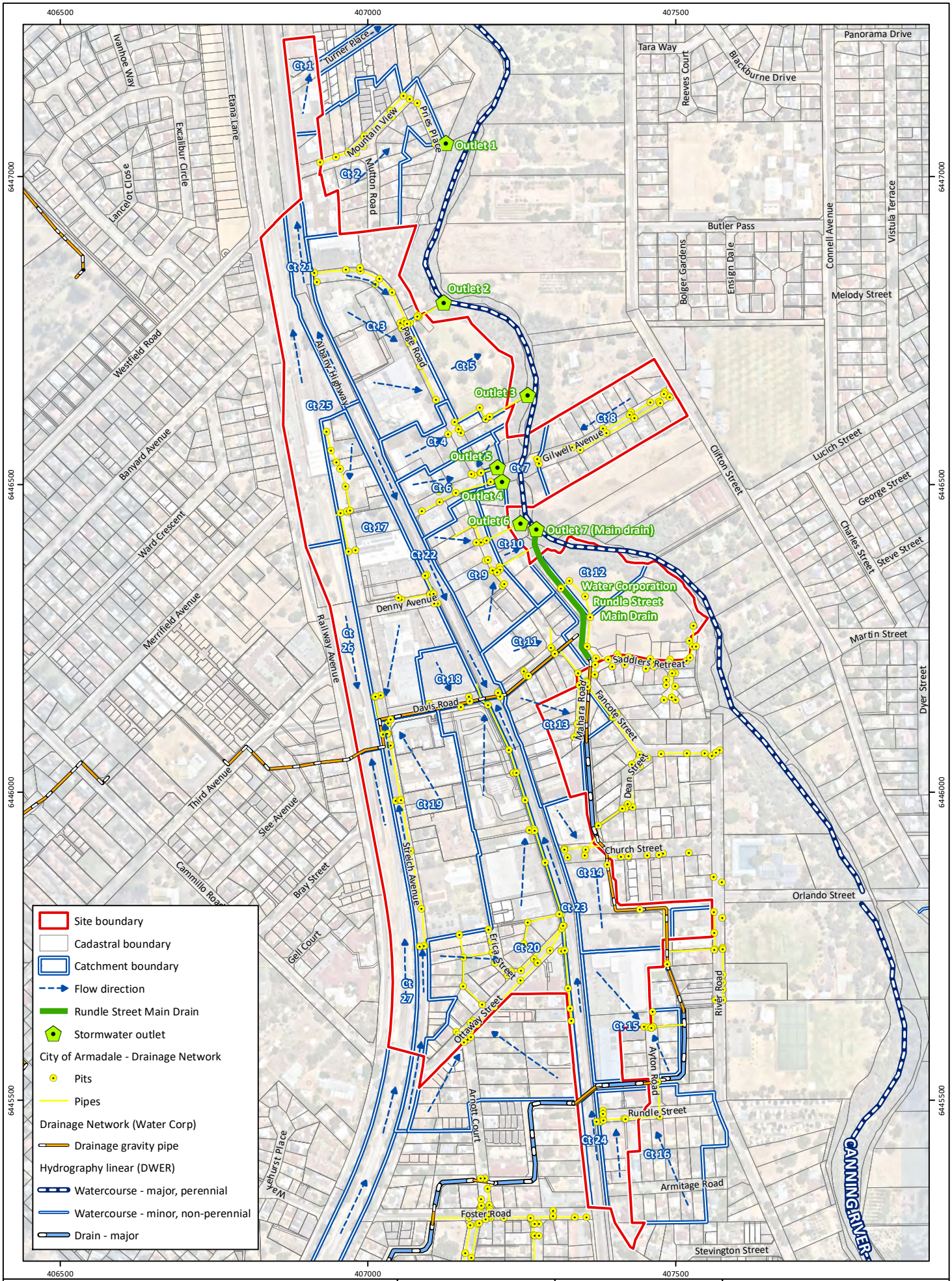

Figure 9: Stormwater Catchments

Project:	Local Water Management Strategy Kelmscott Activity Centre Plan DSP Support
Client:	TBB

Plan Number: EP21-032(01)--F18a

Drawn:	GAR
Date:	29/07/2022
Checked:	FMH
Approved:	DPC
Date:	29/07/2022

N

0 100 200
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Kelmscott Activity Centre Precinct Plan

Taylor Burrell Barnett (2022)

Legend

Kelmscott Activity Centre Precinct boundary

Land Use + Built Form

- Mixed Use Residential - 9 Storey max.
- Mixed Use Residential - 6 Storey max.
- Mixed Use Residential - 4 Storey max.
- Mixed Use Residential - 3 Storey max.

Ground Floor Land Use Activation (Mixed Use)

- Type 1 – Small-Frontage Retail / F & B
- Type 2 – Commercial / Retail
- Type 3 – Primarily Residential

- Residential - 3 Storey max.(R60)
- Special Residential - 2 Storey max.(R5)
- Commercial
- Building setbacks to enable tree planting only (no parking within front setback)
- Trees on Public Reserves - Future Retention
- Landscaped parking within front setback
- Pedestrian shopping street
- Setback controls to ensure bushfire, flooding and other environmental mitigation adressed
- Landmark building: High built form amenity (4 storey minimum)
- Landmark Building: High built form amenity (2 storey minimum)
- Building with local heritage significance
- Activation of Station Master's House and Plaza
- Church and other community uses likely to remain
- Existing Building Footprint

Public Realm

- Urban Space
- Green Space
- Shared Space Street
- Slow Speed Town Centre Street
- Park Café / Food & Beverage Opportunity
- Recreational Activity Node
- Tree Preservation Order

Movement

- Key Urban Pedestrian Connection
- Key Pedestrian/Cyclist Connection
- Existing & Future Key Cyclist Connection
- Possible future investigation of river pedestrian crossing
- Signalised Pedestrian Crossing
- Signalised School Crossing

Other

- Canning River

Draft Precinct Plan

KELMSCOTT ACTIVITY CENTRE PRECINCT

A City of Armadale Project

scale: 1:6000@A3 | 1:3000@A1

0 60 120m

plan: 20/053/016G

date: 21/03/2022

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