Part 2

ROWE GROUP DESIGN

LOCAL STRUCTURE PLAN

PRECINCT 2A – PICTON INDUSTRIAL PARK SOUTHERN PRECINCT

OUR REF: 9013 17/01/2020

Figures

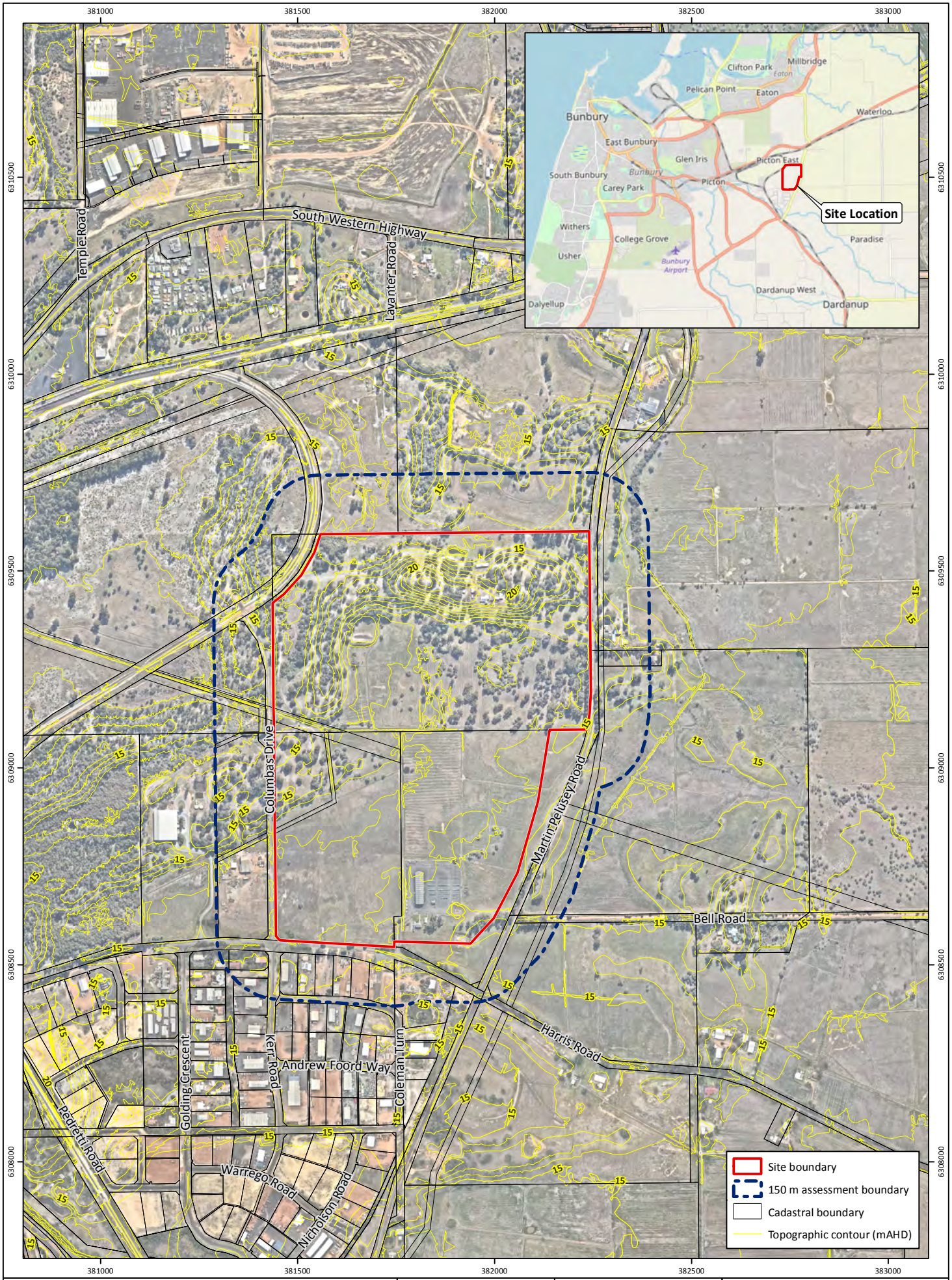

Figure 1: **Site Plan and Topographic Contours**

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(02)--F14

Drawn:	KNM
Date:	06/11/2019
Checked:	HPB
Approved:	KK
Date:	08/11/2019

N

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Metres

Scale: 1:12,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

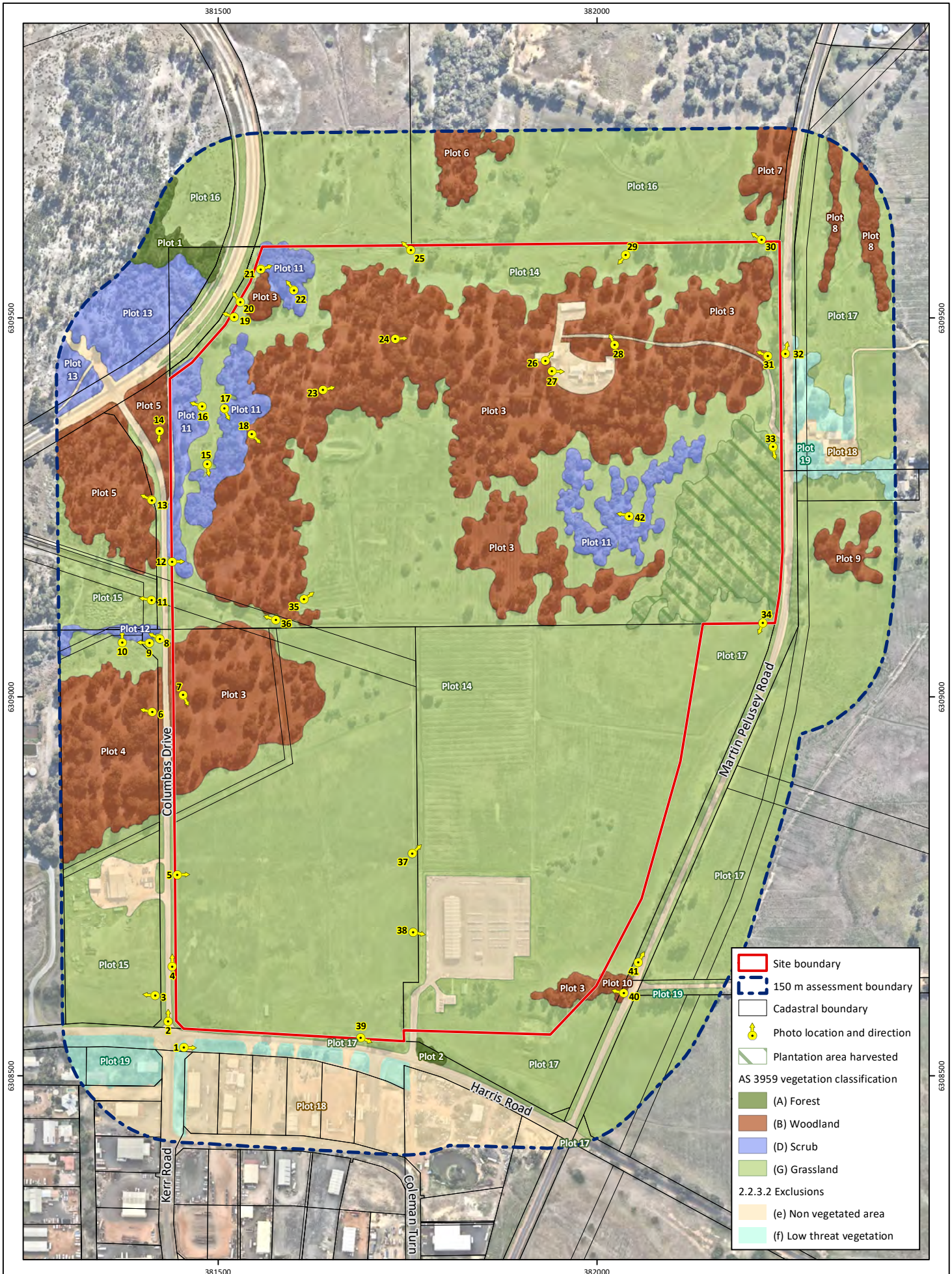

Figure 2: **Existing Site Conditions – AS 3959 Vegetation Classifications**

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(02)--F15

Drawn:	KNM
Date:	06/11/2019
Checked:	HPB
Approved:	KK
Date:	08/11/2019

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Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

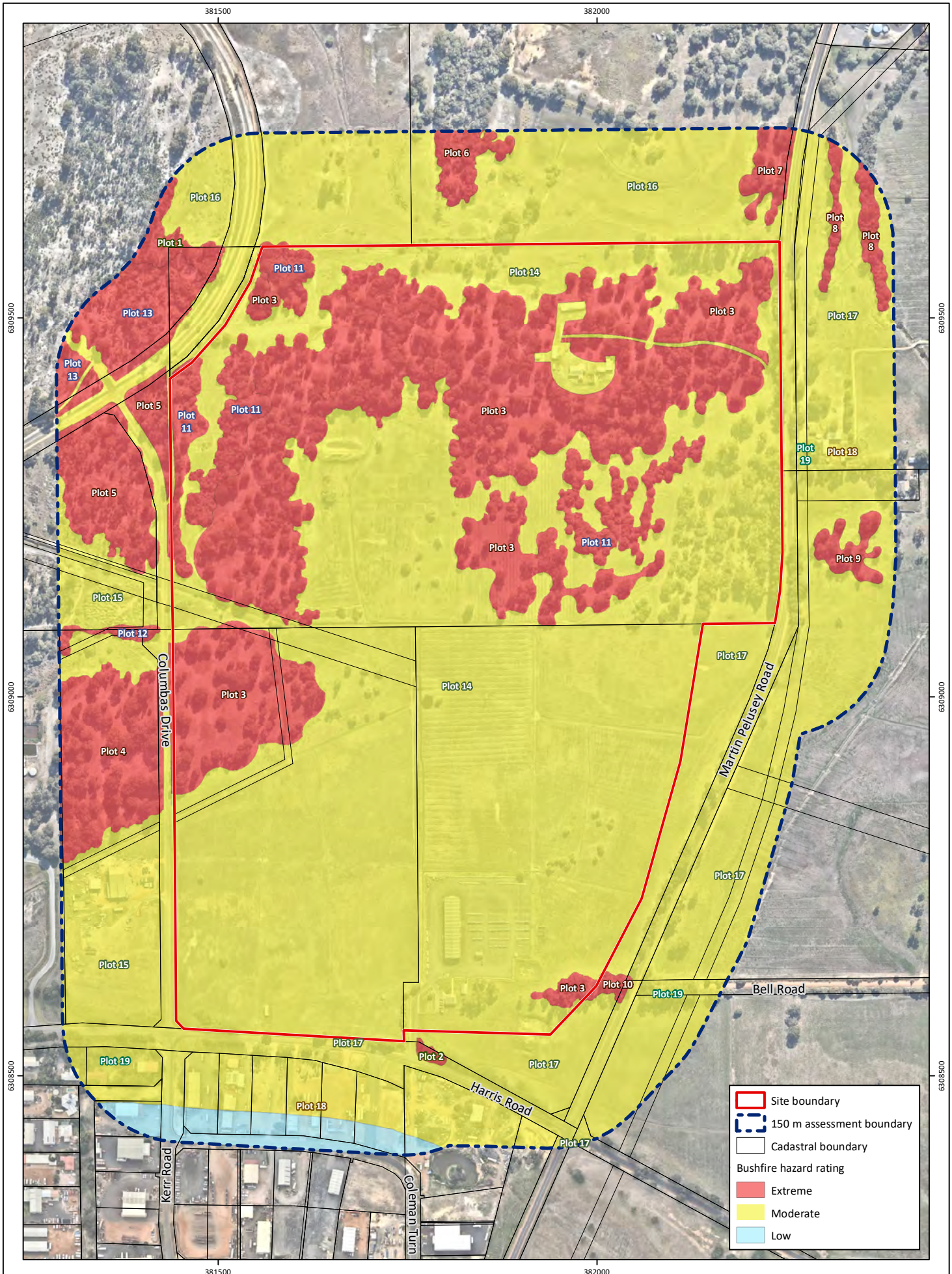

Figure 3: **Existing Site Conditions - Bushfire Hazard Rating**

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(02)--F16

Drawn:	KNM
Date:	07/11/2019
Checked:	HPB
Approved:	KK
Date:	08/11/2019

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

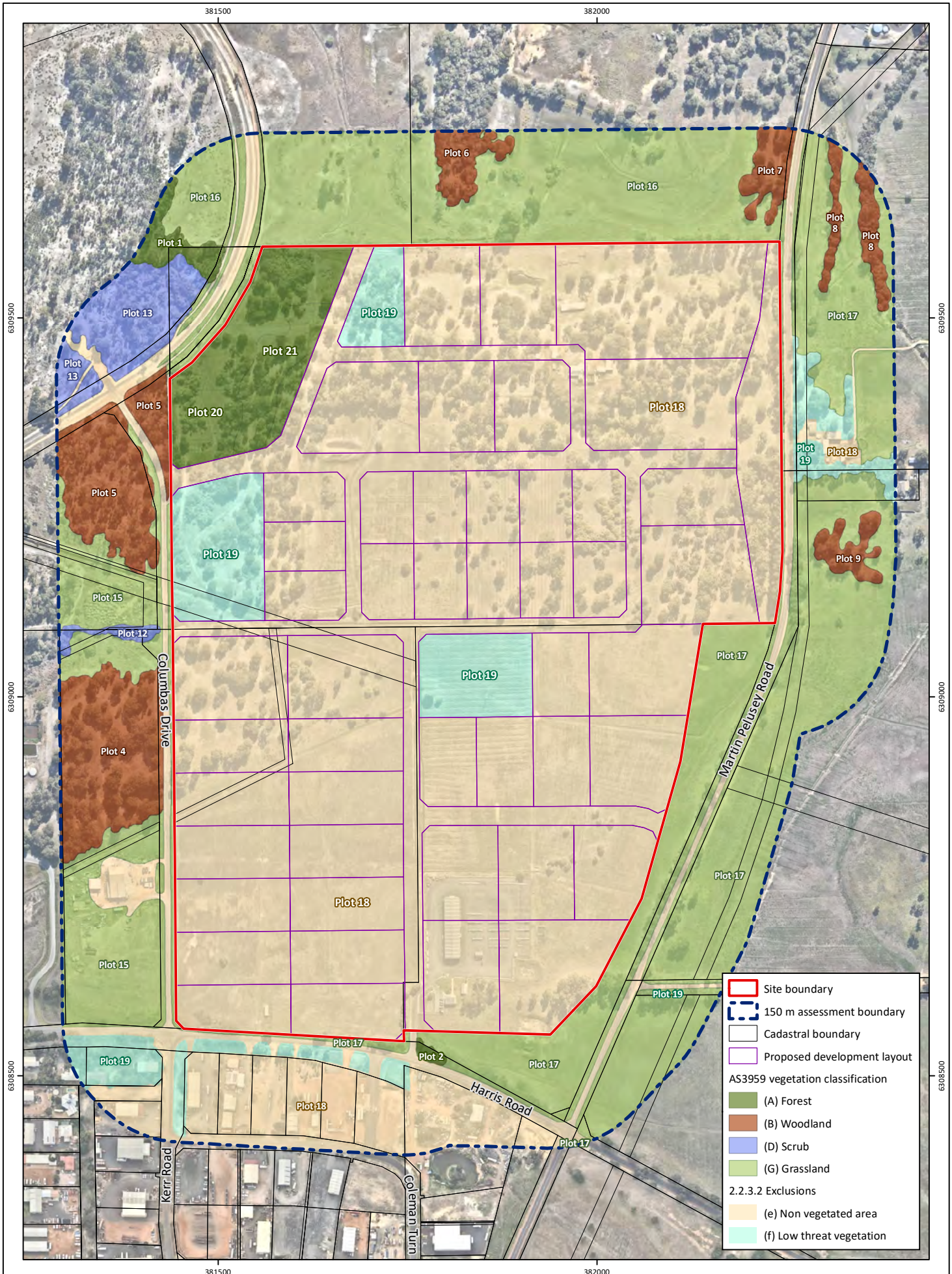

Figure 4: **Post Development Conditions – AS 3959 Vegetation Classifications**

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(02)--F17

Drawn:	KNM
Date:	07/11/2019
Checked:	HPB
Approved:	KK
Date:	08/11/2019

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

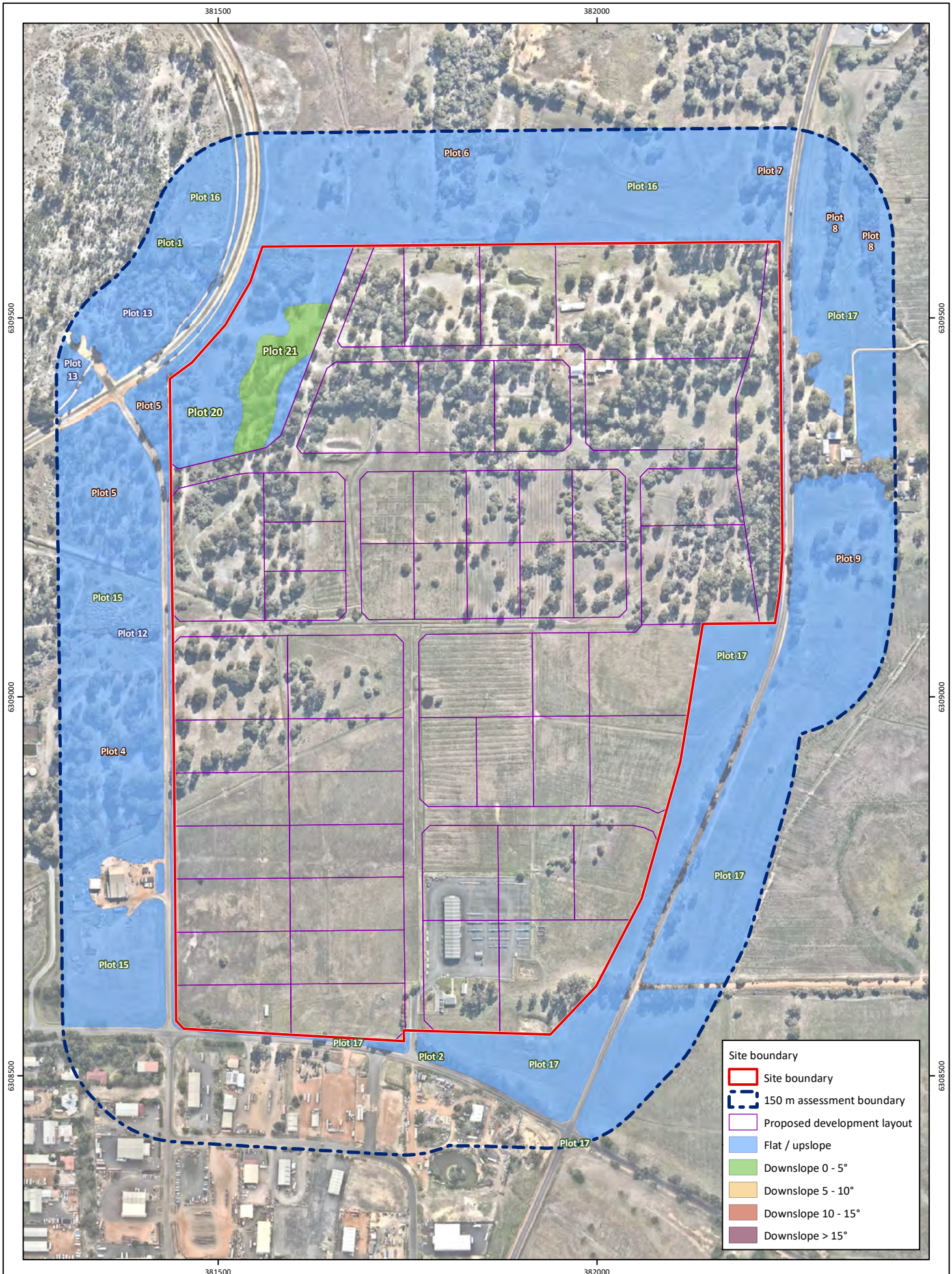

Figure 5: **Post Development Conditions – Effective Slope**

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(02)--F18

Drawn:	KNM
Date:	07/11/2019
Checked:	HPB
Approved:	KK
Date:	08/11/2019

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

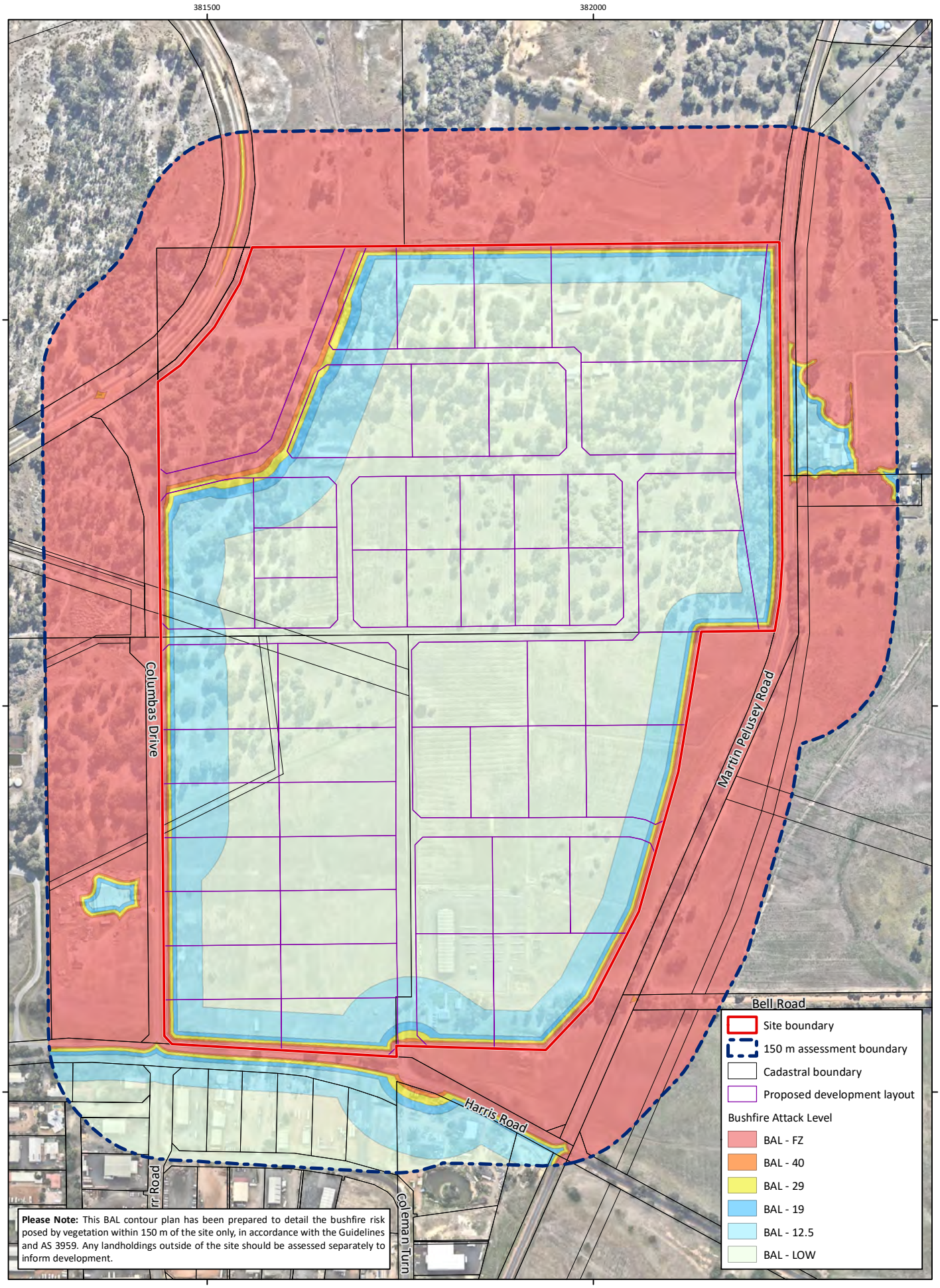

Figure 6: **Bushfire Attack Level Contours**

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(02)--F19

Drawn:	KNM
Date:	07/11/2019
Checked:	HPB
Approved:	KK
Date:	08/11/2019

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

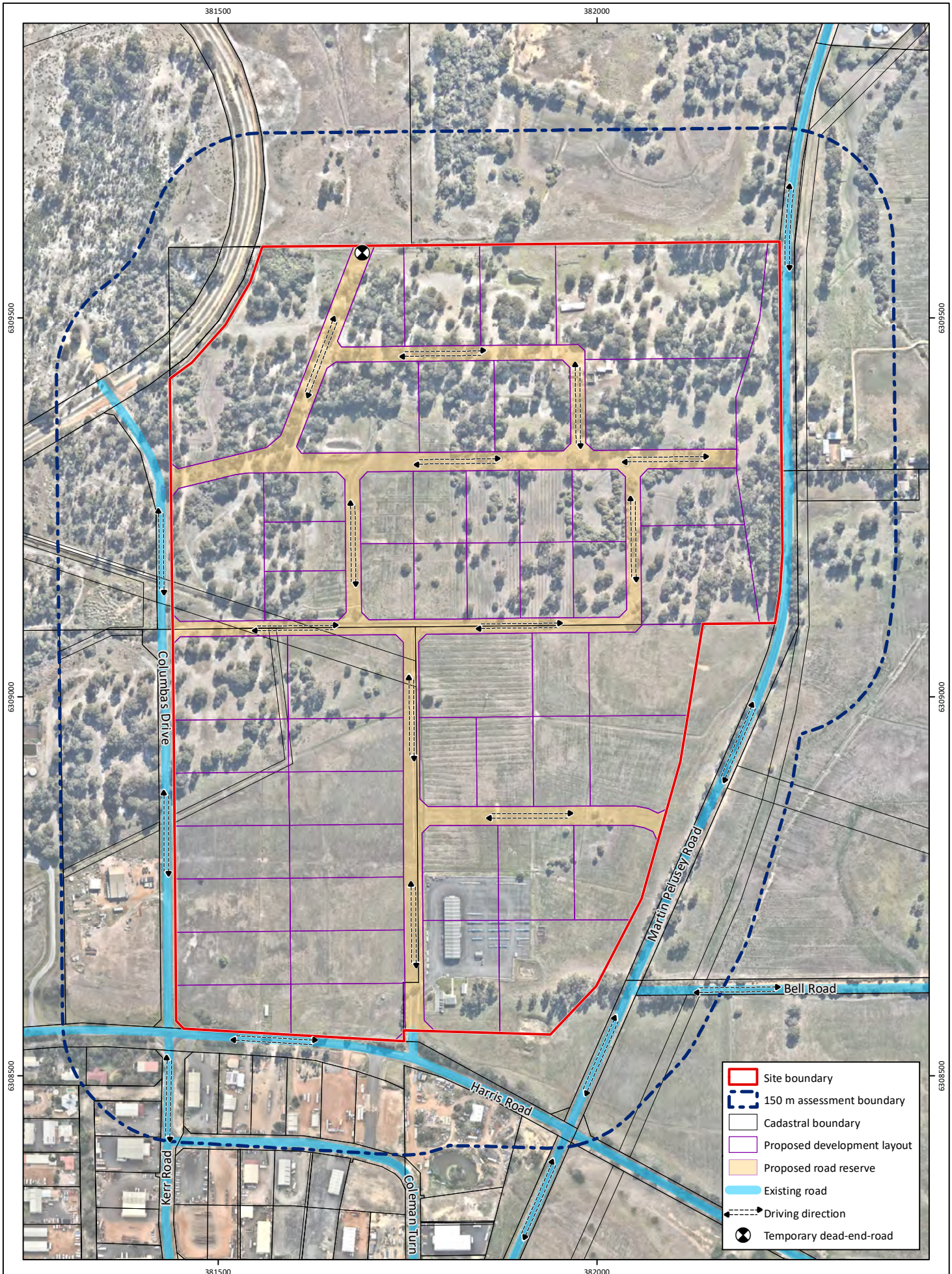

Figure 7: Vehicle Access Plan

Project: Bushfire Management Plan
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number:
EP12-039(02)--F20a

Drawn:	GAR
Date:	13/11/2019
Checked:	HPB
Approved:	KK
Date:	13/11/2019

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Metres

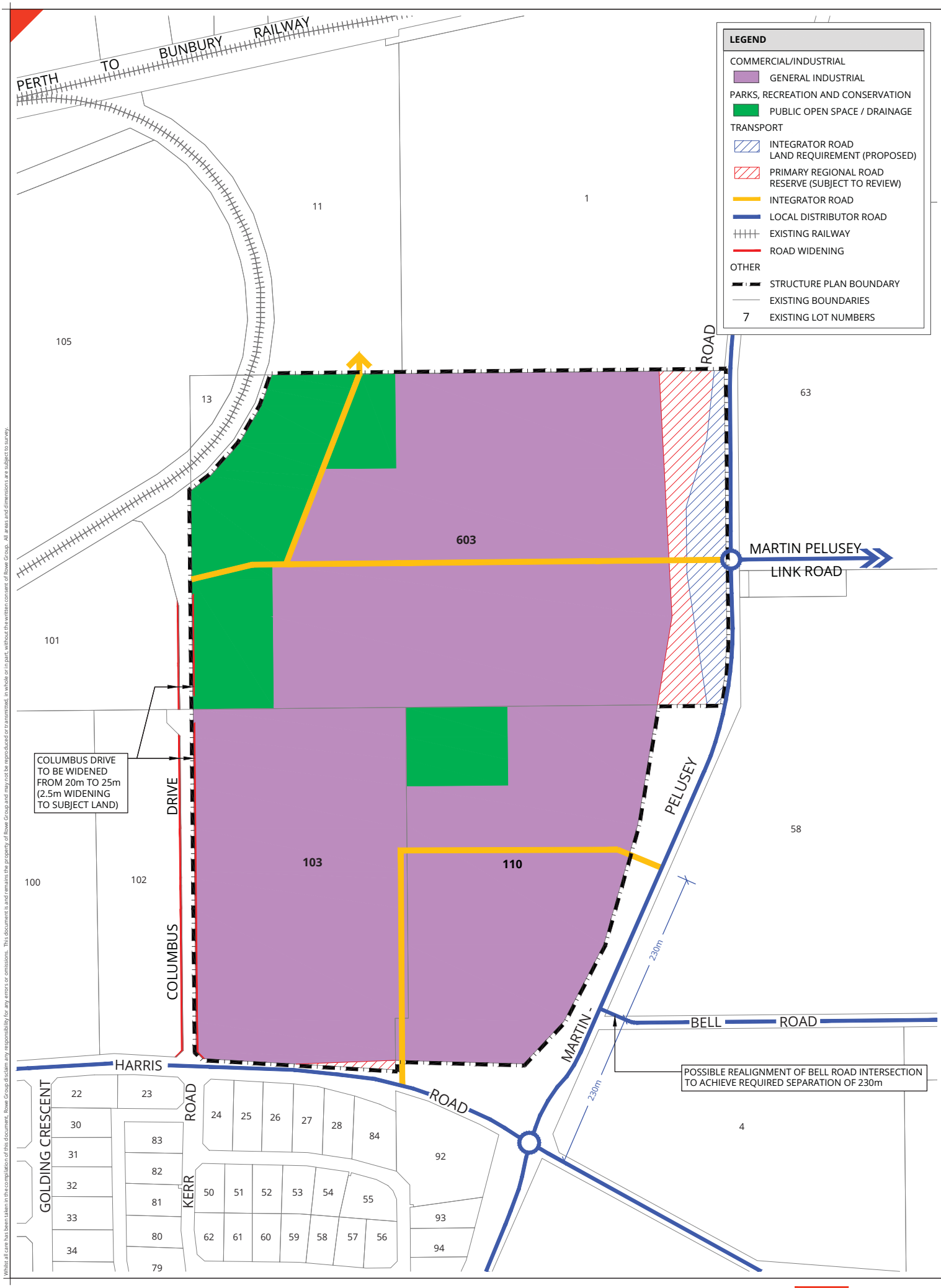
Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Proposed local structure plan (Rowe Group Design 2019)



LOCAL STRUCTURE PLAN

LOTS 103, 110 AND 603

PICTON EAST

NORTH

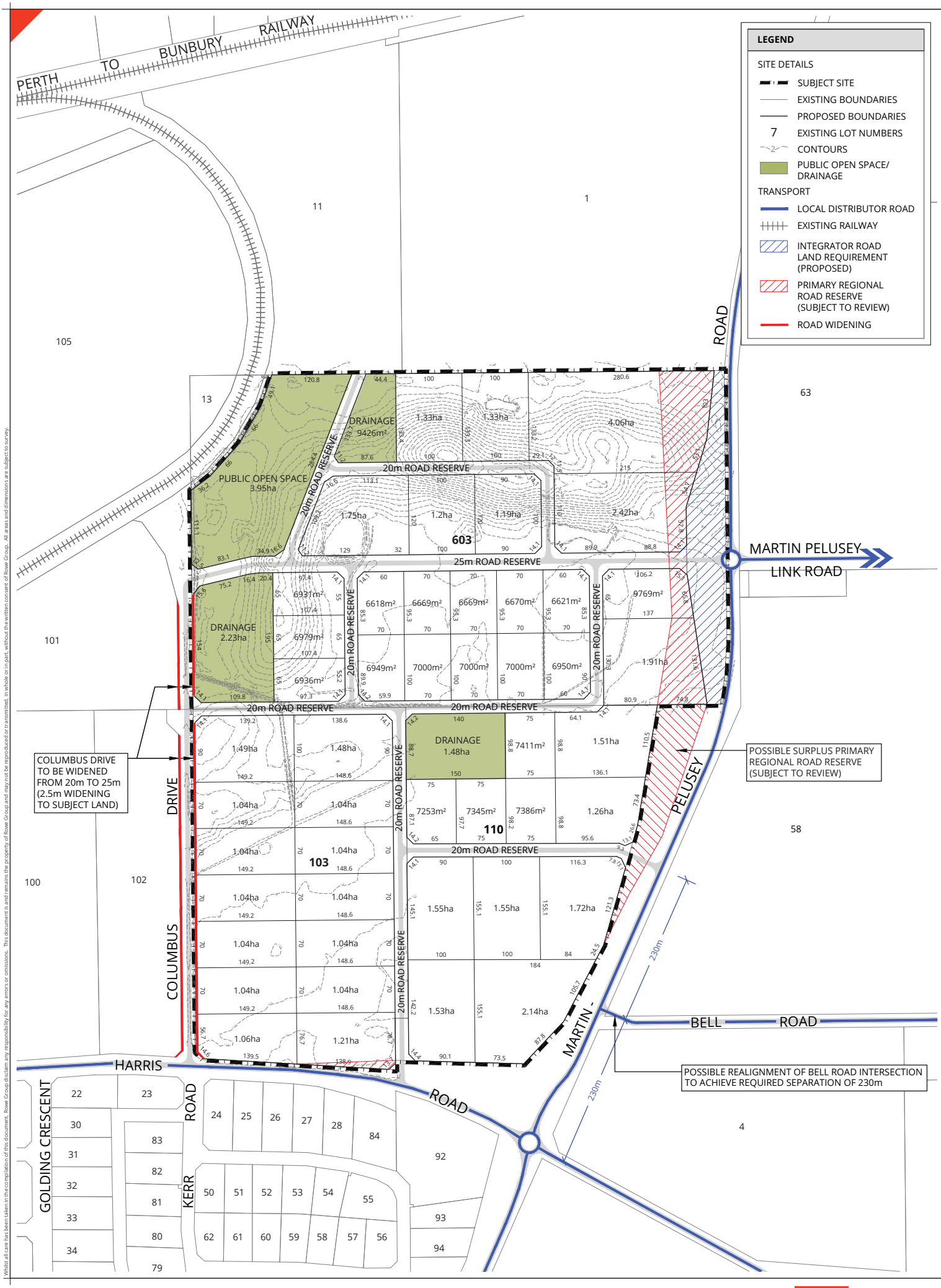
0 125 m

SCALE @ A3: 1:5000

9013-LSP-01-G

ROWE GROUP

9013_LSP01G_20191112 Picton East (LSP) | DRAWN: A. GLASKIN | DATE CREATED: 2019.11.12 | PROJECTION: MGA50 GDA94 | CADASTE: LANDGATE
N:\TOWN PLANNING\9000-9999\9013\GRAPHICS\CAD - WILLIAM CLEMENTS - 2019.11.12



CONCEPT PLAN

LOTS 103, 110 AND 603

PICTON EAST

9013-CON-01-E

ROWE GROUP

9013_CON01E_20191111 Picton East (Concept 1) DRAWN: A. GLASKIN DATE CREATED: 2019.11.11 PROJECTION: MGA50 GDA94 CADASTE: LANDGATE
N:\TOWN PLANNING\9000-9999\9013\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2019.11.12

Appendix B

Additional photographs

Table B1: Additional photo points organised by plot, as shown within Figure 2

Plot 3

AS 3959 classification (Figure 2): Woodland (Class B)

Photo location 24: woodland vegetation within the site, looking east.

Photo location 31: woodland vegetation within the northern portion of the site, looking west.

Plot 11

AS 3959 classification (Figure 2): Scrub (Class D)

Photo location 12: scrub vegetation along the western boundary of the site, looking east.

Photo location 16: scrub vegetation within the site, looking north-west.

Photo location 42: scrub vegetation within the central portion of the site, looking west.

Table B1: Additional photo points organised by plot, as shown within Figure 2 (continued)

Plot 15-17	
AS 3959 classification (Figure 2): Grassland (Class G)	
 *Photo location 25: grassland vegetation to the north of the site, looking north-west.*	 *Photo location 30: grassland vegetation within landholdings to the north of the site, looking north-west.*
 *Photo location 33: grassland vegetation within Martin Pelusey Road, with scattered trees.*	 *Photo location 39: grassland within Harris Road reserve with some Melaleuca sp. Present.*
 *Photo location 41: grassland vegetation along Martin-Pelusey Road, looking north.*	

Table B1: Additional photo points organised by plot, as shown within Figure 2 (continued)

Plot 18	
AS 3959 classification (Figure 2): Non-vegetated (e)	
 *Photo location 26: exisiting water tanks and sheds within the site, looking north-east.*	 *Photo location 32: Martin-Pelusey Road adjacent to the eastern boundary of the site, looking north.*

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APPENDIX 5

LOCAL WATER MANAGEMENT STRATEGY

ROWE GROUP DESIGN

Local Water Management Strategy

Local Structure Plan, Lots 103, 110 and 603, Picton East

Project No: EP12-039(01)

Prepared for Harris Road Pty Ltd
November 2019

Document Control

Doc name:	**Local Water Management Strategy Local Structure Plan, Lots 103, 110 and 603, Picton East**				
Doc no.:	**EP12-039(01)--002E KT**				
Version	**Date**	**Author**		**Reviewer**	
1	February 2014	Aisha Chalmers	ASC	David Coremans	DPC
	For review by project team				
A	March 2014	Aisha Chalmers	ASC	David Coremans	DPC
	For submission to SoD and DoW				
B	May 2014	Aisha Chalmers	ASC	David Coremans	DPC
	For submission to SoD and DoW				
C	May 2014	Aisha Chalmers	ASC	David Coremans	DPC
	For submission to SoD and DoW				
D	November 2019	Aisha Chalmers	ASC	David Coremans	DPC
	For project team review				
E	November 2019	Aisha Chalmers	ASC	David Coremans	DPC
	To accompany local structure plan submission				

Executive Summary

Harris Road Pty Ltd (the 'proponent') proposes to develop a portion of the Picton Industrial Park Southern Precinct within the Shire of Dardanup (SoD) for industrial purposes. Specifically Lots 103, 110 and 603 (referred to herein as 'the site'), which have existing frontages to Columbus Drive, Harris Road and Martin Pelusey Road, respectively.

The site covers appropriately 73 hectares (ha). The full range of land uses permissible under the SoD *Town Planning Scheme No. 3* (DPLH 2019b) 'General Industry' zone will be accommodated. The site is anticipated to include lots ranging in size from approximately 0.65 ha to 4.6 ha, with an overall yield of 47 lots. In addition to industrial lots, the development will include three 25 m wide integrator road reserves, 3.9 ha of regional open space (ROS), approximately 4.7 ha of drainage reserves, and local access roads.

This local water management strategy (LWMS) has been prepared to support the local structure plan and has been developed in accordance with *Better Urban Water Management* (WAPC 2008b) and other relevant policies and guidelines.

Water will be managed using an integrated water cycle management approach. The first step in applying integrated water cycle management is to understand the existing environment. In summary, the environmental investigations conducted to date indicate that:

- The site receives 726 mm of average annual rainfall with the majority of rainfall received in June to August.
- Topography of the site ranges from 12 m Australian height datum (AHD) to 23 m AHD, with lower areas generally consistent with existing drains and farm dams. The higher elevations are located along the western and northern boundaries of the site.
- The site is underlain by fine to medium grained sands with clayey sands of the Guildford Formation at depth. Yellow Bassendean sands are located in the areas of higher elevation.
- The site is in an area of moderate to low risk of acid sulfate soils (ASS) occurring within three metres of the natural surface. No potential for ASS was found within the site by a preliminary ASS investigation.
- Most of the site is listed as multiple use wetland.
- Small farm drains and dams occur across the site and ultimately contribute to a major drain that is currently managed by the Water Corporation. These drains ultimately discharge into the Ferguson River before entering the Preston River.
- Pre-development surface runoff modelling determined that the majority of the site is located within a catchment that discharges beneath the railway to the west of the site at a rate of 0.96 m^3/s in the 1% average exceedance probability (AEP) rainfall event. A small portion of the site discharges north into a trapped low point.
- Depth to maximum groundwater level ranged from 0.05 m to 0.9 m below natural surface.
- Total nitrogen and total phosphorus concentrations within groundwater beneath the site exceeded available guideline values.
- The site has historically been used for agricultural purposes and general industry.

The LWMS design objectives seek to deliver best practice outcomes using a water sensitive urban design approach, including detailed management approaches for:

- Water and wastewater servicing
- Water conservation
- Stormwater quantity and quality management
- Groundwater level and quality management.

The overall approach to water supply is a reticulated network for potable uses with groundwater available for non-potable uses within the lots. No ongoing water use is proposed for the estate itself and water efficiency measures (e.g. waterwise gardening (WWG)) will be promoted to lot owners to reduce water requirements. All lots will install a secondary treatment system (i.e. an aerobic treatment unit (ATU)) for the management of waste from buildings/site offices and any wastewater produced from industrial processes will be required to be treated appropriately on lot.

Stormwater management focuses on treating runoff from the small rainfall event as close to source as possible within lots and road reserves to mimic the existing hydrological regime. Detention structures are also required to maintain pre-development peak flow rates for minor and major events.

Groundwater management focuses on creating controlled groundwater levels (CGL) through a combination of maintaining existing inverts, creating roadside swales and subsoil drains. The inverts of these will maintain CGLs across the site, which will be set in accordance with *Water resource considerations when controlling groundwater levels in urban development* (DoW 2013). Required clearances to the CGL will be achieved by utilising imported fill. Non-structural measures (e.g. education) have been proposed to ensure both stormwater and groundwater quality outcomes are met.

The proposed design criteria and the manner in which they are proposed to be achieved are presented in **Table E 1**. 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 at the site have actually been achieved.

This LWMS demonstrates that the site is capable of being developed by following the recommendations detailed in the report.

Table E 1 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 supply, conservation and wastewater servicing	WC1	Ensure the efficient use of all water resources.	Lots will be provided with potable water through a reticulated network.	Developer	Detailed design and implementation
			Promotion of rainwater tanks, water efficient appliances and WWG principles for use within lots.	Developer	At point of sale
			Use of water efficient fittings and toilets within lots.	Lot owner	Lot construction
			No ongoing water use is proposed for the ROS, drainage reserves or verges (including swales).	Developer	Landscape design and implementation
	WC2	Ensure appropriate treatment of wastewater from lots is provided in consideration of ultimate lot use.	General building wastewater be serviced by ATUs until such time that reticulated sewer network is constructed throughout the region.	Lot owner	Lot construction
			Wastewater from any industrial processes will be treated appropriately within the lot.	Lot owner	Lot construction
Stormwater management	SW1	Treat the small rainfall event as close to source as practicably possible.	Lots are required to provide 2 m^3 of storage for each 65 m^2 of impervious area through a combination of rainwater tanks, detention within carparks or hardstand, infiltration in landscaped areas, subsurface storage/soakwells and/or lot detention areas (LDAs).	Lot owner	Lot construction
			Swales within road verges will treat small event rainfall from the adjacent road bitumen.	Developer	Detailed design and implementation
	SW2	Maintain allowable peak flow rates and volumes up to the major rainfall event discharging from the development.	Lots are required to provide 2 m^3 of storage for each 65 m^2 of impervious area through a combination of rainwater tanks, detention within carparks or hardstand, infiltration in landscaped areas, subsurface storage/soakwells and/or LDAs.	Lot owner	Lot construction
			Swales and detention areas will detain the minor and major rainfall event runoff from road reserves to maintain allowable peak flow rates and volumes.	Developer	Detailed design and implementation

Table E 1 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	SW3	Provide conveyance of upstream flows through the development.	Roadside swales and the existing swale along the railway line and Columbas Drive will convey upstream flows through the site towards the ultimate discharge location.	Developer	Detailed design and implementation
	SW4	Minor roads remain passable in the minor rainfall event (i.e. 10% AEP).	Minor roads remain passable in the minor rainfall event (i.e. 10% AEP).	Developer	Detailed design and implementation
	SW5	Finished floor levels should have a clearance from the major rainfall event top water level within detention areas of 300 mm.	Sand fill may be required to ensure finished flood levels of habitable buildings meet the required clearances.	Developer	Detailed design and implementation
	SW6	Apply appropriate non-structural measures to reduce pollutant loads.	Street sweeping on a regular basis.	Developer and then SoD	Post-construction
			No ongoing fertiliser use is proposed within the ROS, drainage reserves and swales, as these are not proposed to require ongoing irrigation.	Developer and then SoD	Post-construction
			Education of lot owners regarding fertiliser application and the use of nutrient absorbing vegetation within LDAs and landscaped areas.	Developer	At point of sale
Groundwater management	GW1	Swales and/or subsoil drains used to control groundwater will have inverts (i.e. the CGL) set in relation to existing drain inverts and have free draining outlets.	Existing inverts at the ultimate discharge location and within the existing swale located along the western boundary of the site will be maintained. Roadside swales and subsoil drains will have free draining outlets and minimum grades of 1:750 and 1:500, respectively. This will determine the inverts of swales and subsoil drains and therefore the CGL across the site.	Developer	Detailed design and implementation
	GW2	Detention areas will be designed to dry out between rainfall events and will have inverts no lower than CGL or an existing drain invert.	Detention areas will have a low flow outlet to ensure these dry out between rainfall events.	Developer	Detailed design and implementation

Table E 1 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	GW2	Detention areas will be designed to dry out between rainfall events and will have inverts no lower than CGL or an existing drain invert.	Detention Area 1 is assumed to have an invert set at CGL (i.e. 13 mAHD). Detention Area 2 and 3 are assumed to have an invert set at the existing drain invert (i.e. 12.05 mAHD and 12.5 m AHD, respectively).	Developer	Detailed design and implementation
	GW3	Finished floor levels of habitable buildings should have a clearance from CGL of 500 mm.	Finished floor levels will be set at least 500 mm above the CGL. Fill will be used to meet this clearance where necessary.	Lot owner	Lot construction
	GW4	Maintain or improve groundwater quality onsite.	Education of lot owners regarding fertiliser use and nutrient absorbing vegetation species appropriate for use within lots.	Developer	At point of sale
			No ongoing fertiliser use is proposed within the ROS, drainage reserves and swales, as these are not proposed to require ongoing irrigation.	Developer	Landscape design and implementation
			Use of ATUs for the management of waste from buildings/site offices in accordance with relevant guidelines.	Lot owner	Lot construction
			Appropriate treatment and/or the capture and removal of wastewater from industrial processes from the lot.	Lot owner	Lot construction
			Utilising water sensitive urban design measures within each lot as is appropriate to the final industrial land use.	Lot owner	Lot construction
			Use of high phosphorous retention index soils (or similar) beneath LDAs and roadside swales, and surrounding subsoil drains.	Lot owner and developer	Lot construction and detailed design and implementation
			Directing infiltrated stormwater and groundwater captured by subsoil drains into a vegetated roadside swale.	Developer	Detailed design and implementation

Table E 1 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	GW4	Maintain or improve groundwater quality onsite.	Stormwater and groundwater captured in the primary subsoil system will be discharged into bio-retention areas.	Developer	Detailed drainage design and implementation
			Fertiliser use will not be required on ROS, conservation lots, drainage reserves or road verges.	Developer	Post-construction
			Lot owners will be educated regarding fertiliser use and nutrient absorbing vegetation species appropriate for use within lots.	Developer	At point of sale

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BoM	Bureau of Meteorology
DBCA	Department of Biodiversity, Conservation and Attractions
DoH	Department of Health
DoP	Department of Planning (now DPLH)
DoW	Department of Water (now DWER)
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
IPWEA	Institute of Public Works Engineering Australasia
MRWA	Main Road Western Australia
NWRC	National Water Reform Committee
WAPC	Western Australian Planning Commission
WGE	Wood & Grieve Engineers, now part of Stantec
WQPSC	Water Quality Policy Sub Committee

Table A2: Abbreviations – General terms

General terms	
AEP	Annual exceedance probability
AHD	Australian height datum
ASS	Acid sulfate soil
ATU	Aerobic treatment units
BUWM	Better urban water management
CAP	Contingency action plan
CGL	Controlled groundwater level
DA	Development application
DSP	District structure plan
DWMS	District water management strategy
EC	Electrical conductivity

Table A2: Abbreviations – General terms (continued)

General terms	
GPT	Gross pollutant trap
LDA	Lot detention area
LSP	Local structure plan
LWMS	Local water management strategy
MGL	Maximum groundwater level
MUW	Multiple use wetland
NO_2	Nitrite
NO_3	Nitrate
NO_X	Nitrate and nitrite
PRI	Phosphorous retention index
ROS	Regional open space
TKN	Total Kjeldahl Nitrogen
TN	Total nitrogen
TP	Total phosphorous
TPS	Town planning scheme
TWL	Top water level
UWMP	Urban water management plan
WA	Western Australia
WQIP	Water quality improvement plan
WSUD	Water sensitive urban design
WWG	Waterwise gardening

Table A3: Abbreviations – Units of measurement

General terms	
cm	Centimetre
m^3	Cubic metre
m^3/ha	Cubic metres per hectare
m^3/s	Cubic metres per second
$m^3/s/ha$	Cubic metres per second per hectare
ha	Hectare
kL	Kilolitres

Table A3: Abbreviations – Units of measurement (continued)

General terms	
km	Kilometres
m	Metre
m AHD	Metres in relation to the Australian height datum
m/day	Metres per day
mg/L	Miligrams per litre
mm	Millimetre
%	Percentage
m^2	Square metre

1 Introduction

1.1 Background

Harris Road Pty Ltd (the proponent) proposes to develop a portion of the *Picton Industrial Park Southern Precinct - District Structure Plan* (DSP) (DPLH 2018) within the Shire of Dardanup (SoD) for industrial purposes. Specifically Lots 103, 110 and 603 (referred to herein as 'the site'), which have existing frontages to Columbus Drive, Harris Road and Martin Pelusey Road, respectively. The location, aerial photography illustrating the current condition, and cadastral boundaries of the site are shown in **Figure 1**.

1.2 Town planning context

The site is currently zoned 'Industrial Deferred' under the *Greater Bunbury Region Scheme* (DPLH 2019a). Lots 103 and 603 are zoned 'General Farming' and Lot 110 is zoned 'Restricted Use 10' (for timber sales and storage) under SoD *Town Planning Scheme No. 3* (TPS 3) (DPLH 2019b).

1.3 Purpose of this report

The proponent has prepared a local structure plan (LSP) to support and guide future development within the site. The LSP is provided in **Appendix A**. This Local Water Management Strategy (LWMS) details the water management approach to support the LSP, and has been developed in consideration of the policies listed in **Section 1.4** and the existing environment described in **Section 3**.

1.4 Policy framework

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

- *State Water Strategy* (Government of WA 2003b)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *State Water Plan* (Government of WA 2007)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Liveable Neighbourhoods* (WAPC 2009a)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (ASS) (WAPC 2009b).

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 urbanised developments should aim to achieve. These are key inputs that relate either directly or indirectly to the site and include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000; WQPSC & NWRC 2018)
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Stormwater Management Manual for WA* (DoW 2007b)
- *Better Urban Water Management* (BUWM) (WAPC 2008b)

- *Interim: Development a LWMS* (DoW 2008a)
- *Leschenault Estuary Water Quality Improvement Plan (WQIP)* (DoW 2012)
- *Water resource considerations when controlling groundwater levels in urban developments* (DoW 2013)
- *Specification: Separation distances for groundwater controlled urban development* (IPWEA 2016)
- *Australian Rainfall and Runoff* (Ball J *et al.* 2019)
- *Decision Process for Stormwater Management in WA* (DWER 2017)
- *Policy No CP095 – Local Biodiversity* (SoD 2018b)
- *Policy No CP060 – Storm Water Discharge from Buildings* (SoD 2018a).

1.5 Previous studies

The District Water Management Strategy (DWMS) was prepared by Calibre (2017). The key water management strategies proposed in the DWMS are consistent with integrated water cycle management principles outlined in the reference documents described previously. Those of relevance to the site are:

- Drainage management
  - On lot and off lot detention systems, combined with treatment systems such as bioretention gardens will capture and treat stormwater flows. All flows leaving the site up to the 1% annual exceedance probability (AEP) event are generally to match the pre-development rate.
  - Lots will have a direct connection to the road network stormwater system, after storage is exceeded on the lot.
  - On lot storage is to be in accordance with the local authority guidelines.
  - All finished flood levels will be designed to maintain a clear separation of 300 mm between the habitable floor levels and the 1% AEP flood level, generated on site.
- Groundwater and ASS management strategy
  - Inflows to groundwater are to be treated through bioretention media and plants within the basins and swales, to improve the quality of water prior to it entering the groundwater.
  - A subsoil drainage system, interconnected with the swale network, will be used to control groundwater levels around buildings and roads.
  - All groundwater level management is to focus on fill minimisation.
  - Subsoil drainage systems are to incorporate amended filter media around them to treat groundwater prior to it entering the subsoil pipe.
  - All groundwater discharged from subsoil drains will be further treated through vegetation within the receiving drainage system.
  - An ASS investigation is required within each LSP area. ASS will be handled in accordance with an ASS management plan at subdivision stage.
- Sustainable water servicing
  - Industrial buildings are to be encouraged to incorporate rainwater storage devices where practical. These are to be plumbed to provide a source of internal and external non potable water.
  - All lots are to be connected to a potable reticulated water main to provide security of supply.

  - Lots to be connected to mains sewerage unless detailed planning shows a portion is suitable to dry industry or onsite effluent management, using alternative treatment units (ATUs).
  - Non-potable water may come from a variety of sources including some stormwater harvesting and treated wastewater.
  - Provision of awareness raising material on water saving measures to business developers.
  - Landscaping on private lots to be in accordance with waterwise landscaping principles as directed by the local authority.
- Water dependent ecosystem management
  - New waterway habitat will be created within upgraded and new swales.
  - Bioretention systems and detention basins will provide riparian wetland habitat.
  - The water sensitive urban design (WSUD) elements used on site will treat stormwater and groundwater, improving the water quality prior to it entering downstream ecosystems.
- Fill management
  - Fill minimisation is to be a key consideration in all developments within the DSP area.
  - Utilisation of techniques such as a close network of subsoil drains and swales are to be investigated to minimise groundwater mounding and control groundwater rise.
  - Infrastructure that can be built within and on top of minimal fill are to be preferentially used to reduce fill requirements.

1.6 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in *Better Urban Water Management* (WAPC 2008a) and the overarching DWMS (**Section 1.5**). It is intended to support the LSP, and is further based on the following major objectives:

- Provide a broad level water management framework to support future industrial development.
- Recognise and convey runoff form upstream catchments.
- Consider all potential water sources and all uses in water supply planning.
- Incorporate appropriate WSUD measures into the drainage systems that address the environmental and stormwater management issues identified.
- Manage risks to the underlying groundwater source appropriately.
- Minimise development construction costs.
- Minimise ongoing operation and maintenance costs for the land owners and SoD.
- Gain support from the DWER, SoD and Water Corporation for the proposed method to manage water within the site and to mitigate potential impacts on downstream areas.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 Proposed Development

The site is proposed to be developed for industrial uses. The full range of land uses permissible under the SoD TPS 3 (DPLH 2019b) 'General Industry' zone will be accommodated. The site is anticipated to include lots ranging in size from approximately 0.65 ha to 4.6 ha, with an overall yield of roughly 47 lots. In addition to industrial lots, the development will include three 25 m wide integrator road reserves, 3.9 ha of regional open space (ROS), approximately 4.7 ha of drainage reserves, and a number of 20 m wide local access roads (which are not required to be shown on the statutory LSP).

The ROS is located where the greatest conservation protection values will be achieved. Drainage reserves are provided to integrate stormwater treatment and storage requirements into the development. Drainage reserves have been located based on post-development catchments identified within the site and the requirement for flows to be directed towards existing discharge points.

Small farm drains and dams occur across the site and runoff from the site ultimately contributes to a major drain that is currently managed by the Water Corporation. The site either discharges directly into East Picton Main Drain 711 or into a tributary (East Picton Sub-Section D 709 and East Picton Sub-Section E 710). Runoff from within the site will be maintained to pre-development conditions at these locations through the use of on lot treatment and detention, roadside swales and drainage reserves.

The LSP and a concept plan, as a guide to the site's development potential, are included in **Appendix A**.

3 Pre-development Environment

3.1 Sources of information

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

- *South West Rural Drainage, Run-off Map, 50098-1-2* (Public Works Department 1977)
- Geological mapping (Gozzard 1981)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000; WQPSC & NWRC 2018)
- *Picton Industrial Park Southern Precinct - District Structure Plan* (DPLH 2018)
- *Weather and Climate Statistics Data: Bunbury* (BoM 2019)
- *Geomorphic Wetlands on the Swan Coastal Plain* dataset (DBCA 2019)
- ASS mapping (DWER 2019a)
- *Hydrography linear* dataset (DWER 2019b)
- *Water Register* (DWER 2019c).

In addition to the above information, site-specific investigations have been conducted. These have aimed at providing more detail to the existing regional information. The site-specific investigations include:

- Survey of Lots 103 and 603 Martin Pelusey Rd, Picton East in 2010
- *Groundwater Levels & Quality Monitoring Report: Lot 103 Harris Road & 96 Martin Pelusey Road* (TME 2012)
- *Preliminary Acid Sulphate Soil Investigation: Picton East, Shire of Dardanup, WA* (Strategen 2010)
- *LSP, Lots 103, 110 and 603, Picton East Bushfire Management Plan* (Emerge Assocates 2019).

3.2 Climate

The site experiences a dry Mediterranean climate of hot dry summers and cool wet winters. Long term climatic averages at the Bunbury station (Site No 009965) indicate that the site is located in an area of moderate rainfall, receiving 726 mm on average annually (BoM 2019) with the majority of rainfall received in June to August. The region experiences rainfall for 85 days annually (on average).

3.3 Geotechnical conditions

3.3.1 Topography

The site ranges from 12.0 m Australian Height Datum (AHD) to 23.0 m AHD. The higher elevations and steeper slopes are located along the western and northern boundaries of the site. The lowest areas are generally consistent with the existing drainage channels and farm dams (which are detailed in **Section 3.4.2**). Topographic contours across the site are shown in **Figure 2**.

3.3.2 Soils and geology

The surface geology is dominated by undifferentiated consolidated Cainozoic sedimentary rocks; sandstone, limestone, conglomerate and siltstone. The site is underlain by the Guildford formation, consisting of clay, silt, sand and gravels, with some Bassendean Sand outcrops. Geological mapping (Gozzard 1981) in **Figure 3** illustrates the following types:

- Qpa – Guildford formation: mainly alluvial sandy clay
- QPb – Bassendean Sand: low rounded dunes
- Qpb/Qpa – thin bassendean sand over Guildford formation.

Soils observed across low-lying areas of the site within boreholes installed by Strategen (2010) were light brown or yellow brown to grey brown in colour, consisting of fine to medium grained sands, with clayey sands below depths of 1 m. A borehole installed along the northern ridge (BH4) was observed to have yellow sand to the maximum installation depth of 2.25 m (Strategen 2010). The location of these boreholes is provided in **Figure 3** and the preliminary ASS report is provided in **Appendix B**.

3.3.3 Acid sulfate soils

The site is in an area of moderate to low risk of ASS occurring within three metres of the natural surface (DWER 2019a). Strategen (2010) completed a preliminary ASS investigation in May 2010. The investigation found there was a potential for ASS in the vicinity of Lot 11 Martin Pelusey Road (BH2), Lot 102 Harris Road (BH8) and Lot 104 Columbas Drive (BH5). However, these are located beyond the site and no potential for ASS was found in BH4 or BH9. The preliminary ASS report is provided in **Appendix B**.

3.4 Surface water

3.4.1 Wetlands

A review of the *Geomorphic Wetlands on the Swan Coastal Plain* dataset (DBCA 2019) indicates that there are a number of geomorphic wetlands on site. The geomorphic wetlands are shown in **Figure 4**.

Most of the site is listed as a Multiple Use Wetland (MUW) (UFI #14329). There is another small MUW wetland within the site (UFI #1554). There is a further MUW (UFI #1555) that interests the western boundary of the site.

3.4.2 Existing hydrological features

Small farm drains and dams occur across the site. Runoff form the site ultimately contributes to a major drain that is currently managed by the Water Corporation. Indicative mapping of these features from the *Hydrography linear* dataset (DWER 2019b) are shown in **Figure 5**. This dataset does not capture all of the existing farm drains or dams located across the site.

The site either discharges directly into East Picton Sub Drain C, or into a tributary (East Picton Sub-Section D and East Picton Sub-Section E). The site then ultimately discharges to the East Picton Main Drain and then the Ferguson River before entering the Preston River.

The main drains were originally installed by the Public Works Department to drain paddocks and prevent surface ponding over long periods of time, not for flood management purposes. The site is within an area where rural drains were sized to cater for 7.5 m^3/s per 1,000 ha, but ultimately discharge into drains sized for 5 m^3/s per 1,000 ha (Public Works Department 1977). The limited capacity of these drains must be considered when modifying the site from a rural to urban landscape.

3.4.2.1 Pre-development modelling

Pre-development surface runoff modelling for the broader Picton Industrial Park Southern Precinct was completed as part of the overarching DWMS (Calibre Consulting 2017).

The pre-development catchments (see **Appendix C**) show most of the site is located within Catchment G, which discharges towards the East Picton Main Drain in Catchment F at a prorata rate of 0.96 m^3/s in the 1% AEP rainfall event. However, the approved *Lot 105 Columbas Drive, Picton East Preliminary Servicing Strategies* (DVN 2009) report proposed a water management strategy that controls flows into Catchment F (i.e. beneath the railway) to 1.16 m^3/s in the 1% AEP rainfall event. As noted in the DWMS, this rate is slightly higher than the prorata rate determined by surface runoff modelling. A copy of the Lot 105 report is provided in **Appendix D** and allowable discharge rates from the site are discussed further in **Section 6.1**.

A small portion of the site is located within Catchment E (see **Appendix C**) and currently discharges north into an existing trapped low point (see **Figure 2**).

3.4.3 Surface water quality

There has been no surface water quality monitoring undertaken at the site. The site is located within the Leschenault Estuary Catchment, which is included within the *Leschenault Estuary WQIP* (DoW 2012). Monitoring within the Ferguson River Catchment measured an average concentration of 1.5 mg/L for total nitrogen (TN) and 0.1 mg/L for total phosphorous (TP). Target concentrations specified in the WQIP are 1 mg/L for TN and 0.1 mg/L for TP.

Results from groundwater level and quality monitoring are provided in **Section 3.5**. Groundwater is generally close to the surface and consequently, groundwater quality is a reasonable indicator of likely surface water quality.

3.5 Groundwater

3.5.1 Groundwater resources

Information on the regional groundwater resources obtained from the *Water Register* (DWER 2019c) indicates that the site is underlain by a multi-layered aquifer system comprised of the Perth – Superficial Swan, Perth – Leederville and Perth – Yarragadee South resources. All of these resources have available allocation within the Bunbury management area.

A resource allocation report received by DWER on 21 August 2019 listed the following available volumes:

- Perth – Superficial Swan: 227,650 kL
- Perth – Leederville: 22,300 kL
- Perth – Yarragadee South: 107,000 kL.

There are no existing private bores within the site. A number of lots adjacent to the site (i.e. to the west of Columbas Drive, south of Harris Road and east of Martin-Pelusey Road) have existing licences for the Perth – Leederville aquifer and drawpoints mapped on the *Water Register* (DWER 2019c).

The site is not located within a public drinking water source area nor are there any wellhead protection zones in the vicinity of the site (DWER 2019d).

3.5.2 Groundwater levels

There are three DWER bores within a 3 km radius that have sufficient groundwater level data (WIN ID 1583, 1584 and 1585) to be utilised as reference bores. However, this data is not relevant to monitoring within the superficial aquifer, as they are drilled into the Yarragadee or Leederville aquifer. There are no DWER bores close to the site that have sufficient and relevant data to be utilised as reference bores. Consequently, maximum groundwater levels (MGL) across the site have been defined by the monitoring undertaken on site.

Groundwater level monitoring was carried out by TME between October 2010 and December 2012 at nine monitoring bores (shown in **Figure 2**) installed within Lot 103 and Lot 603. This monitoring program captured two winter peaks and one summer low (see **Plate 1** and data provided in **Appendix E**). The monitoring indicated that groundwater generally flowed from the south-east to the north-west corner of the site (TME 2012).

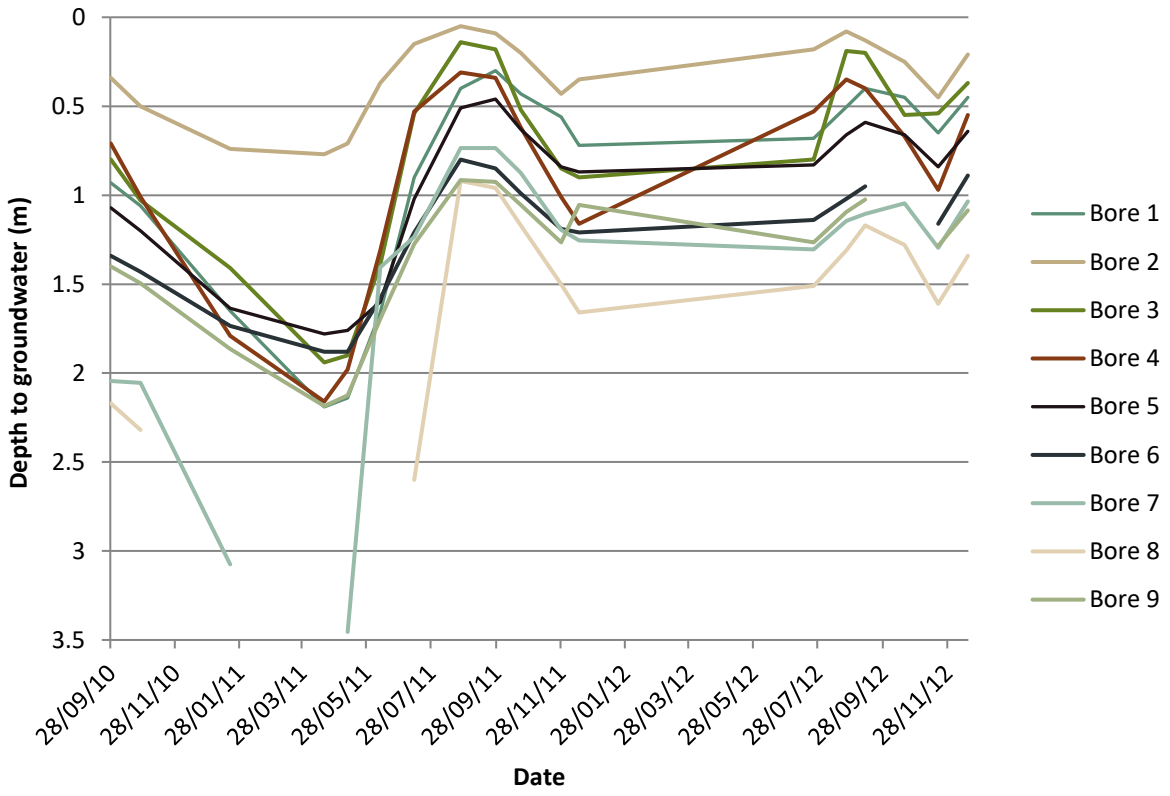

Plate 1: Depth to groundwater from natural surface (TME 2012)

Plate 1 shows that depth to groundwater from the natural surface over 2011 and 2012 ranged from 0.05 m to 3.4 m, with the seasonal fluctuation across the bores ranging from 0.25 m to 2.7 m. Measured maximum groundwater level (MGL) occurred on the 25/08/2011 in seven bores and on the 27/09/2011 in two bores. Depth to MGL at each bore ranged from 0.05 m to 0.9 m below natural surface. MGL contours across the site are shown on **Figure 2**. The 2012 peak occurred in either August (three bores), September (four bores), or December (two bores).

Given the date of the pre-development monitoring program. Groundwater levels within the bores was measured again on 22/08/2019 (see data provided in **Appendix E**). While Bore 8 was destroyed, depth to groundwater at the other bores ranged from 0.06 to 1.1 m below natural surface. These are generally consistent with winter groundwater levels measured in 2011 and 2012, but are still lower than the MGL measured in 2011. Therefore, the MGL contours derived from data collected in 2011-2012 are still valid and are shown in **Figure 2**.

3.5.3 Groundwater quality

Groundwater monitoring of the nine bores by TME included sampling of physio-chemical parameters in situ and laboratory analysis of nutrient, metal and salinity concentrations. Measured groundwater quality is summarised in **Table 1**, which details the parameters significant to, and managed within, this LWMS (i.e. physio-chemical parameters and nutrient concentrations). Groundwater quality monitoring results are provided in more detail in **Appendix E**.

The analysis of groundwater found that TN and TP levels beneath Lot 103 and Lot 603 exceeded ANZECC and ARMCANZ (2000) default trigger values for slightly disturbed ecosystems in the south-west coast as well as the target concentrations for the Ferguson River (DoW 2012). The pH levels measured across all bores were generally low (slightly acidic), between 5.01 and 6.71, which is somewhat below the ANZECC and ARMCANZ (2000) trigger value for surface waters in 'lowland rivers' (i.e. 6.5). These results were not unexpected given past agricultural land uses in the region (TME 2012).

Table 1: Groundwater quality monitoring summary

Analytes	Bore 1	Bore 2	Bore 3	Bore 4	Bore 5	Bore 6	Bore 7	Bore 8	Bore 9
pH	5.82 (0.28)	6.33 (0.33)	6.28 (0.27)	6.25 (0.28)	5.95 (0.17)	6.05 (0.52)	5.90 (0.39)	5.45 (0.43)	5.49 (0.58)
Electrical conductivity (EC) (mS/cm)	1.72 0.87	0.78 (0.56)	2.61 (0.77)	2.35 (0.49)	0.57 (0.05)	0.75 (0.24)	2.60 (2.10)	1.18 (1.68)	1.32 (0.40)
Nitrite (NO_2) (mg/L, LOR = 0.01)	<0.01 (0)	<0.01 (0)	0.02 (0.02)	<0.01 (0)	<0.01 (0)	0.01 (0)	<0.01 (0)	<0.01 (0)	<0.01 (0)
Nitrate (NO_3) (mg/L, LOR = 0.01)	0.02 (0.02)	0.02 (0.01)	0.21 (0.27)	0.06 (0.07)	0.04 (0.02)	0.92 (1.26)	0.05 (0.06)	0.02 (0.01)	0.023 (0.015)
NOx (mg/L, LOR = 0.01)	0.02 (0.02)	0.02 (0.01)	0.22 (0.28)	0.06 (0.07)	0.04 (0.02)	0.93 (1.26)	0.05 (0.06)	0.02 (0.01)	0.023 (0.015)
Total Kjeldahl nitrogen (TKN) (mg/L, LOR = 0.1)	4.1 (3.2)	3.3 (1.3)	4.3 (1.4)	1.6 (1.5)	3.1 (2.0)	4.5 (3.4)	4.4 (2.7)	3.8 (2.3)	12.3 (12.1)
TN (mg/L, LOR = 0.1)	4.1 (3.2)	3.3 (1.3)	4.5 (1.6)	1.7 (1.5)	3.2 (2.0)	5.5 (3.2)	4.5 (2.6)	3.8 (2.3)	12.3 (12.1)
Reactive phosphorous (mg/L, LOR = 0.01)	0.01 (0)	<0.01 (0)	0.01 (0)	0.01 (0)	<0.01 (0)	0.43 (0.81)	0.01 (0)	0.015 (0.01)	<0.01 (0)
TP (mg/L, LOR = 0.01)	0.26 (0.20)	0.21 (0.08)	0.37 (0.12)	0.18 (0.15)	0.21 (0.08)	2.27 (1.64)	0.49 (0.28)	0.59 (0.35)	1.33 (1.01)

Values given are average and standard deviation. Derived from TME (2012) groundwater monitoring data.

3.6 Current and historical land uses

The site has established rural land on its northern, western and eastern boundaries, with an industrial estate to the south. The land within this site is predominately used for rural purposes, with Lot 110 used for general industry.

3.7 Summary of existing environment

In summary, the environmental investigations conducted to date indicate that:

- The site receives 726 mm of average annual rainfall with the majority of rainfall received in June to August.
- Topography of the site ranges from 12 m AHD to 23 m AHD, with lower areas generally consistent with existing drains and farm dams. The higher elevations are located along the western and northern boundaries of the site.
- The site is underlain by fine to medium grained sands with clayey sands of the Guildford Formation at depth. Yellow Bassendean sands are located in the areas of higher elevation.
- The site is in an area of moderate to low risk of ASS occurring within three metres of the natural surface. No potential for ASS was found within the site by a preliminary ASS investigation.
- Most of the site is listed as MUW.
- Small farm drains and dams occur across the site and ultimately contribute to a major drain that is currently managed by the Water Corporation. These drains ultimately discharge into the Ferguson River before entering the Preston River.
- Pre-development surface runoff modelling determined that the majority of the site is located within a catchment that discharges beneath the railway to the west of the site at a rate of 0.96 m^3/s in the 1% AEP rainfall event. A small portion of the site discharges north into a trapped low point.
- Depth to MGL ranged from 0.05 m to 0.9 m below natural surface.
- TN and TP concentrations within groundwater beneath the site exceeded available guideline values.
- The site has historically been used for agricultural purposes and general industry.

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this LWMS and future Urban Water Management Plans (UWMP) must achieve. The water management strategy covers water supply, water consumption, wastewater servicing, stormwater management, and groundwater management.

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003a) and *Better Urban Water Management* (WAPC 2008a) endorse the promotion of integrated water cycle management and application of WSUD principles to provide improvements in the management of stormwater, 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, stormwater 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 of 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. Management design objectives should therefore seek to deliver best practice outcomes in terms of:

- Water supply, water consumption and wastewater servicing
- Flood mitigation
- Stormwater quality 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** of this document. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines and site specific studies undertaken in and around the site. These were detailed in **Sections 1.4** and **3.1.**

The overall objective for preparing integrated water cycle management plans for proposed industrial developments is to minimise pollution and maintain an appropriate water balance. This objective is central to the water management approach for the LSP.

4.2 Water supply, conservation and wastewater servicing

Water supply, conservation and wastewater servicing design criteria are proposed which are consistent with the guidelines presented in *Better Urban Water Management* (WAPC 2008a) and consultation with key stakeholders. This LWMS proposes the following criteria:

Criteria WC1 Ensure the efficient use of all water resources.

Criteria WC2 Ensure appropriate treatment of wastewater from lots is provided in consideration of ultimate lot use.

The manner in which these objectives will be achieved is further detailed in **Section 5**.

4.3 Stormwater management

The principle behind stormwater management at the site is to mimic the pre-development hydrological conditions. This principle and the guidance documents discussed in **Section 1.4** and **1.5** have guided the stormwater management criteria. This LWMS proposes the following stormwater quantity design criteria:

Criteria SW1 Treat the small rainfall event as close to source as practicably possible.

Criteria SW2 Maintain allowable peak flow rates and volumes up to the major rainfall event discharging from the development.

Criteria SW3 Provide conveyance of upstream flows through the development.

Criteria SW4 Minor roads remain passable in the minor rainfall event (i.e. 10% AEP).

Criteria SW5 Finished floor levels should have a clearance from the major rainfall event top water level (TWL) within detention areas of 300 mm.

Criteria SW6 Apply appropriate non-structural measures to reduce pollutant loads.

The manner in which these objectives will be achieved is further detailed in **Section 6**.

4.4 Groundwater management

The principle behind the groundwater management strategy is to maintain the existing groundwater levels and quality. This LWMS proposes the following groundwater management criteria:

Criteria GW1 Swales and/or subsoil drains used to control groundwater will have inverts (i.e. the controlled groundwater level (CGL)) set in relation to existing drain inverts and have free draining outlets.

Criteria GW2 Detention areas will be designed to dry out between rainfall events and will have inverts no lower than CGL or an existing drain invert.

Criteria GW3 Finished floor levels of habitable buildings should have a clearance from CGL of 500 mm.

Criteria GW4 Maintain or improve groundwater quality onsite.

The manner in which these objectives will be achieved is further detailed in **Section 7**.

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

5.1 Water supply

5.1.1 Potable water

The site is located within an area operated by Aqwest and there is an existing 300 mm diameter water main within Harris Road along the southern boundary of the site. This existing water main has the capacity to service the site and will need to be extended east towards the intersection with Martin Pelusey Road. Extension of the reticulated network will also be required to service lots within the site and will require approval from Aquest (WGE 2019).

5.1.2 Non-potable water

As discussed in **Section 3.5.1**, groundwater is available from all three aquifers beneath the site, with 227,650 kL/year available from the Perth-Superficial Swan aquifer.

5.2 Lot scale water use

Water efficient fittings and toilets are mandated through the building licence process. In order to ensure that water is used efficiently, lot owners will be encouraged to utilise rainwater tanks, water efficient appliances and employ waterwise gardening (WWG) principles across any landscaped areas within the lot. The following WWG measures will be used within the development:

- Improve soil with conditioner certified to Australian Standard AS4454 to a minimum depth of 300 mm for garden beds.
- Design and install any irrigation system according to best water efficient practices.
  - Control systems must be able to irrigate different zones with different irrigation rates.
  - Emitters must disperse coarse droplets or be subterranean.
  - Utilise subsoil irrigation where appropriate.
- Landscape with native, preferably endemic, species.
- Mulch garden beds to 100 mm with a product certified to Australian Standard AS4454.
- Minimise use of slow fertilisers and these are only to be utilised on initial planting.

Groundwater may be used on lots for irrigation of landscaping or other appropriate non-potable water uses. It is the lot owners responsibility to obtain a groundwater licence appropriate to the proposed use where necessary.

Given the large lot industrial uses the water savings achieved by the above measures are likely to be nominal.

5.3 Estate scale water use

No ongoing water use is proposed for the estate itself. The ROS does not require irrigation as it is a natural conservation area. Drainage reserves and verges (including swales) are to be designed not to be irrigated in the long term by the SoD (J Reilly [SoD] 2019, *pers. comm.* 23 August). Any ongoing irrigation of verges can be undertaken at the discretion of the adjacent lot owner. Species selected for drainage reserves and swales should not require ongoing irrigation once established (i.e. be waterwise). Temporary establishment irrigation will occur prior to handover of the drainage reserves and swales to the SoD.

5.4 Wastewater management

5.4.1 General building wastewater

No existing reticulated sewerage network is located in close proximity to the site. The Water Corporation has advised that the site is within two future wastewater pump station catchment areas, though neither are planned to be constructed within the next five years. As such, it is anticipated that reticulated sewer will not be available for the site in the near future (WGE 2019).

The site is located within a sewage sensitive area (specifically within the estuary catchments on the Swan and Scott Coastal Plains) (DPLH 2019c). Therefore, all lots will be required to install a secondary treatment system (i.e. an ATU) for the management of waste from buildings/site offices consistent with the *Government Sewerage Policy* (DPLH 2019) to ensure discharge is of sufficient quality to protect downstream environments.

It is assumed that wastewater requirements are consistent with general office uses (i.e. toilets, sinks, showers etc.) with wastewater loading rates consistent with those stipulated in Table 2 of the Department of Health WAs (DoH) *Supplement to Regulation 29 and Schedule 9 - Wastewater system loading rates* (DoH 2019a). DoH approved systems, as listed in the *Approved secondary treatment systems* (DoH 2019b) will be utilised and installation will be carried out in line with the *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units* (DoH 2015) or where larger systems are required designs will be assessed and approved by DoH on a case by case basis.

Design specifications of ATUs, including the location and discharge mechanisms (i.e. land application areas or discharge outlets), will need to be confirmed through a site and soil evaluation (DoH 2019; DPLH 2019). This will consider the specific site constraints present on the lot including the estimated hydraulic load, soil texture and category, location of WSUD strategies and subsoil drains, clearances to groundwater etc. Lot owners will be informed of these requirements prior to the purchase of lots.

5.4.2 Industrial process wastewater

Any wastewater produced on lots from industrial processes (additional to general building wastewater, discussed above) will be required to be treated appropriately on lot. Where appropriate treatment is not achievable on lot, either due to the volumes or contaminants contained therein, industrial process wastewater will be captured and removed from site to an appropriate treatment facility. This approach is consistent with industrial sites across WA, even where deep sewer connection is provided.

Any onsite industrial wastewater treatment plants associated with specific lot uses should be designed and constructed in accordance with *Water Quality Protection Note 51: Industrial wastewater management and disposal* (DoW 2009) with approvals sought from the DoH and SoD as part of the building approvals process.

5.5 Water conservation criteria compliance summary

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

Table 2: Water conservation compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
WC1	Ensure the efficient use of all water resources.	Lots will be provided with potable water through a reticulated network.
		Promotion of rainwater tanks, water efficient appliances and WWG principles for use within lots.
		Use of water efficient fittings and toilets within lots.
		No ongoing water use is proposed for the ROS, drainage reserves or verges (including swales).
WC2	Ensure appropriate treatment of wastewater from lots is provided in consideration of ultimate lot use.	General building wastewater be serviced by ATUs until such time that reticulated sewer network is constructed throughout the region.
		Wastewater from any industrial processes will be treated appropriately within the lot.

6 Stormwater Management Strategy

The principle behind the stormwater management strategy for the site is to maintain the existing hydrology by matching allowable peak flow rates and volumes leaving the site. The stormwater management strategy consists of two distinct components:

- Lot drainage
- Development drainage.

Each component has been designed to achieve the objectives and criteria stated in **Section 4.3**. The sizing of each component has been determined using XPSTORM hydrological and hydraulic software. The modelling assumptions report provided in **Appendix G** presents the detailed methods and assumptions used to develop the model.

6.1 Allowable peak flow rates and indicative storage volumes

As discussed in **Section 3.4.2.1**, the approved *Lot 105 Columbas Drive, Picton East Preliminary Servicing Strategies* (DVN 2009) proposed that this development would convey flows through Lot 105 via an arterial 1050 mm diameter pipe. Further, that inflows to this pipe beneath the railway line will need to be restricted to 1.16 m^3/s in the 1% AEP rainfall event. This was incorporated into the post-development surface runoff modelling completed in the overarching DWMS (Calibre Consulting 2017), which is provided in **Appendix C**.

The DWMS proposes that runoff from Catchments 3, 4 and 5 will achieve the allowable peak flow of 1.16 m^3/s in the 1% AEP rainfall event. More specifically, that this will be achieved on a prorata basis to ensure that the treatment and detention of runoff is applied across the Picton Industrial Park Southern Precinct area equitably. As shown in Table 5 of the DWMS (see **Appendix C**), this equates to combined allowable peak flow rates in the 1% and 10% AEP rainfall events from Catchment 3 and 4 of 0.0065 $m^3/s/ha$ and 0.0058 $m^3/s/ha$, respectively, and indicative combined storage volumes (in addition to detention provided within lots) in the 1% and 10% AEP rainfall events from Catchment 3 and 4 of 465 m^3/ha and 300 m^3/ha, respectively.

Table 3 summarises the allowable peak flow rates and indicative storage volumes from the two catchments within the site. Note that Catchment 2 is the ultimate discharge location for the whole site, which encompasses Catchment 1, Catchment 2 and both upstream catchments. The upstream catchment boundaries are consistent to those described as Catchment 3 and 4 in the DWMS.

Allowable peak flow rates and indicative required storage volumes (in addition to detention provided within lots) are based upon the allowable peak flow rates and indicative storage requirements above (i.e. determined through post-development surface runoff modelling presented in the DWMS) and the post-development catchments for the site shown in **Figure 6**.

Table 3: Allowable peak flow rates and indicative required storage volumes

Catchment	1% AEP allowable peak flow rate (m^3/s)	1% AEP indicative required storage volume (m^3)	10% AEP allowable peak flow rate (m^3/s)	10% AEP indicative required storage volume (m^3)
Catchment 1	0.07	4,980	0.06	3,290
Catchment 2	0.76	53,285	0.68	35,170

6.2 Lot drainage

All lots will be required to retain 2 m^3 of runoff for every 65 m^2 of hardstand or roof (i.e. impervious area) consistent with the SoD's *Policy No CP060 – Storm Water Discharge from Buildings* (SoD 2018a). Combining a number of WSUD strategies in a treatment train is the most effective manner in which to treat and retain catchment runoff, which may include:

- Rainwater tanks to retain runoff from roofs, which can be used for internal and external non-potable uses.
- Temporary inundation of car park or other hardstand areas to retain runoff prior to infiltration within another WSUD structure. A maximum flooding depth of 300 mm is recommended within car park areas.
- Waterwise landscaped areas to treat and infiltrate runoff.
- Subsurface soakage/soakwells to retain and infiltrate runoff.
- Vegetated lot detention areas (LDAs) to treat and infiltrate runoff. A layer of high phosphorus retention index (PRI) >10 soil or engineered media should be located beneath the invert of the LDA to provide treatment as runoff infiltrates (Payne et al. 2015).

The invert of subsurface soakage/soakwells must be at or above CGL or the low permeability layer. The invert of LDAs should be at or above CGL (discussed further in **Section 7.1**). For many lots across the site, runoff can be infiltrated into the existing sand and/or fill beneath the lot. It is understood that the site constraints within some lots (i.e. where there is a thin layer of sand over low permeability soil and/or shallow groundwater) may make infiltration difficult. A low flow discharge or subsoil connection point may be required to ensure that LDAs dry out due to shallow groundwater.

To represent these lot drainage requirements, the post-development surface runoff model (see **Appendix G**) has assumed that lots are 90% impervious and 10% pervious, and will utilise LDAs with a capacity of 2 m^3 for every 65 m^2 of impervious area. The LDAs are nominally modelled to have 1:6 side slopes, maximum depth of 1 m, and a low infiltration rate of 2 m/day. When represented in this manner, the LDAs are approximately 5% of the total lot area.

Other WSUD strategies, which are industry specific, may also need to be installed within each lot to treat runoff prior to it discharging from the lot. These are discussed in following sections.

The selection and design of lot WSUD strategies are the responsibility of the lot owner and should be selected to suit individual site characteristics and the intended development of the lot. The design of lot drainage will be submitted to the SoD within a development application (DA).

6.2.1 Gross pollutant traps

Stormwater runoff can transport nutrients and gross pollutants to downstream water bodies. A gross pollutant trap (GPT) is considered a primary level treatment system, removing a proportion of these large pollutants and, in some cases, the smaller particles such as sediments and hydrocarbons. The pollutants captured in the GPT must be regularly removed to ensure the efficiency of the device.

GPTs are best suited to land uses with high gross pollutants such as commercial development, or for collecting gross pollutants during the construction phase of the development. These may be applicable to some lots within the site depending on the industrial use.

6.2.2 Trash racks

Trash racks are usually permanent structures which intercept trash and other debris to protect the quality of water. Trash racks are generally constructed upstream of LDAs and require regular maintenance to remove debris and silt and ensure their ongoing efficiency. Trash racks may also be incorporated in the design of GPTs.

6.2.3 Grease and sediment traps

Certain industrial land uses can produce sediments and hydrocarbons to a level that cannot be treated by GPTs. Grease and sediment traps can be used as a secondary level treatment system to remove these smaller particles. Grease and sediment traps must be regularly maintained to ensure the efficiency of the device. These are more likely to be required where there is either a high vehicle/traffic load, or where vehicle servicing/maintenance is to be carried out onsite.

6.2.4 Oil-water separators

Oil-water separators can be used to provide water quality treatment at a lot scale, particularly for small industrial or commercial lots where larger WSUD strategies are not feasible due to site constraints. There are a range of systems available which incorporate some combination of filtration media, hydrodynamic sediment removal, oil and grease removal, or screening to remove pollutants from stormwater.

Oil-water separators are best used in commercial, industrial and transportation type land uses i.e. areas that are expected to receive high sediment and hydrocarbon loadings, such as car parks and service stations.

6.3 Development drainage

The development is required to treat the small rainfall event, detain major event runoff to ensure that the post-development peak flows discharging from the development beneath Columbas Drive are consistent with the allowable peak flow rates outlined in **Section 6.1**, and convey runoff from catchment catchments. This will be achieved through the use of roadside swales and detention areas as discussed in the following sections.

6.3.1 Roadside swales

Treatment of stormwater runoff from road reserves will occur at source. Swales will be located within road verges to infiltrate and treat small event (first 15 mm) runoff from the adjacent road pavement as close to source as possible in order to mimic the pre-development hydrological regime.

Swales are proposed along the downstream side of the road located immediately adjacent to road pavement. The post-development surface runoff model has nominally assumed that swales will have 1:4 side slopes, a 1 m wide base, be 500 mm deep, and have an infiltration rate of 2 m/day (plus a 50% clogging factor). It is also assumed that 20% of the swale length shown in **Figure 6** will be required for cross-overs and therefore will not provide any treatment capacity.

Swales will be vegetated with reeds and rushes suitable for removing nutrients (Payne *et al.* 2015). A layer of high PRI >10 soil or engineered media should be located beneath the invert of the swale to provide treatment as runoff infiltrates towards the underlying lower permeability layer (Payne *et al.* 2015).

Table 4 provides the volume that will be treated with the swale profile, and demonstrates that the required volume can be treated within swales located along a section of the road reserve. **Table 4** also provides the swale depths in frequent, minor and major runoff events. **Figure 7** illustrates the areas inundated by the small rainfall event.

Table 4: Treatment of small event runoff and detention of minor and major event runoff within swales

Rainfall event	Attribute	Catchment 1	Catchment 2
	Length of swale (m)	790	2,535
Small rainfall event (first 15 mm)	Volume (m^3)	85	660
	Water depth (m)	0.08	0.16
Minor rainfall event (10% AEP)	Volume (m^3)	755	2,065
	Water depth (m)	0.38	0.34
Major rainfall event (1% AEP)	Volume (m^3)	860	2,810
	Water depth (m)	0.41	0.42

The swale profiles can be revised in the future to meet localised site and servicing requirements, provided that the treatment and detention volumes specified in this LWMS are achieved. Further storage could also be forced within the swales by introducing minor weir structures.

6.3.2 Detention areas

Surface runoff from road reserves and lots will be conveyed towards detention areas shown in **Figure 6** via the swales and overland flow. These detention areas are only required to detain infrequent and major event runoff, and are not intended to be inundated in response to small and frequent rainfall events. It is assumed that the capacities of swales (as provided in **Table 4**) are fully utilised prior to runoff entering downstream detention areas. Detention areas will be utilised to ensure that post-development peak flow rates discharging beneath Columbas Drive are consistent with the allowable peak flow rates outlined in **Section 6.1**.

The invert of detention areas can be set at CGL, on the underlying lower permeability layer or consistent with any existing invert (where relevant). Given these inverts, the surface runoff model has conservatively assumed that no infiltration will occur within detention areas.

At this stage, is it broadly assumed the CGL will be set close to MGL where an existing invert is not proposed to be maintained (this is discussed further in **Section 7.1**). Therefore, Detention Area 1 is assumed to have an invert of approximately 13 mAHD. The invert of Detention Area 2 will be set at 12.05 mAHD, which is the invert of the existing culverts beneath Columbas Drive. Similarly, Detention Area 3 can be set at the invert of existing drains in this area, being 12.5 mAHD.

Depth of these detention areas must consider existing topographic contours within the proposed ROS area (i.e. proposed to be located to the west and downstream of the detention area) and along Columbas Drive. Therefore, Detention Areas 1, 2 and 3 are assumed to have a maximum water depth of 500 mm, 950 mm and 500 mm, respectively. All detention areas are nominally assumed to have 1:6 side slopes.

Discharge from detention areas can be controlled via a number of outlet options such as v-notch weir, low flow pipe and weir combinations etc. Detention Area 1 will discharge beneath the proposed road reserve towards an existing drain located along the eastern boundary of the existing railway and Columbas Drive (discussed further below in **Section 6.3.3**). It is assumed that the existing culverts beneath Columbas Drive will need to be realigned and/or upgraded to direct runoff from this existing swale and Detention Area 2 towards Picton Sub Drain C. Finally, runoff from Detention Area 3 will also be directed towards the ultimate discharge location. This can be achieved through a number of methods, which should be determined when an earthworks plan is being developed, and may include:

- Overland flow onto the adjacent road reserve
- Discharge into an adjacent roadside swale via culvert and/or overland flow
- Installation of an arterial pipe network that connects Detention Area 3 to the discharge location.

The design of detention areas and finished lot levels will be such that habitable floor levels will be at least 300 mm above the TWL to ensure protection from flooding during extreme rainfall events.

The required detention volumes provided in **Table 5** can be revised in the future, provided that the allowable peak flows discharging from the site (shown in **Figure 6**) are maintained. The inundated areas for the minor and major rainfall events are shown in **Figure 8** and **Figure 9**, respectively.

Table 5: Detention of minor and major event runoff within detention areas

Detention area	Minor rainfall event (10% AEP)			Major rainfall event (1% AEP)		
	Volume (m^3)	Max water depth (m)	Surface area (m^2)	Volume (m^3)	Max water depth (m)	Surface area (m^2)
1	850	0.14	6,175	3,215	0.50	6,870
2	7,135	0.42	17,835	17,135	0.95	19,590
3	2,580	0.21	12,305	6,200	0.50	13,075

6.3.3 Existing swale

The existing swale located along the western boundary of the site from the north western corner adjacent to the railway and the proposed ROS area to the ultimate discharge location beneath Columbas Drive is proposed to be retained. This swale will be utilised to convey runoff from the detention area within Catchment 1 towards the detention area within Catchment 2. It will also be utilised to convey runoff from future industrial development to the north of the site (i.e. from Catchment 3 US) through the site towards the ultimate discharge location.

6.4 Drainage design assessment

The post-development catchments, proposed WSUD strategies and the site's ultimate discharge location beneath Columbas Drive are shown in **Figure 6**. As detailed previously, the stormwater management strategy aims to match allowable peak flows leaving the site and required storage volumes in a minor and major rainfall event. **Table 6** compares the post-development peak flow rates from each catchment and the storage volumes provided within each catchment in a minor and major rainfall event to the allowable rates and volumes discussed in **Section 6.1** (and which were determined in the DWMS). Modelling assumptions are discussed in **Appendix G**.

Table 6: Allowable peak flow rates, indicative required storage volumes and post-development comparison

Catchment	Scenario	1% AEP peak flow rate (m^3/s)	1% AEP storage volume (m^3)	10% AEP peak flow rate (m^3/s)	10% AEP storage volume (m^3)
Catchment 1	Allowable	0.07	4,980	0.06	3,290
	Post-development	0.07	4,075*	0.05	1,605*
Catchment 2	Allowable	0.76	53,285	0.68	35,170
	Post-development	0.77	55,600**	0.58	24,167**

** Encompasses the volume provided by swales in Catchment 1 and Detention Area 1.*

*** Encompasses the volume provided by swales and detention areas across the site, and estimated detention volumes required for upstream catchments. Estimated detention volumes to be required within upstream catchments are shown in **Figure 6**.*

6.5 Non-structural water quality measures

The structural measures proposed within the site provide both a storage and treatment function to stormwater runoff. A number of non-structural measures will also be implemented across the site to help reduce nutrient loads within stormwater that discharges from the development. These measures include:

- Education of lot owners regarding fertiliser use and nutrient absorbing vegetation species appropriate for use within lots.
- No ongoing fertiliser use is proposed within the ROS, drainage reserves and swales, as these are not proposed to require ongoing irrigation.
- Utilising WSUD measures within each lot as is appropriate to the final industrial land use.
- Directing first flush stormwater to vegetated LDAs or roadside swales.

- Use of high PRI soils (or similar) beneath LDAs and roadside swales, and surrounding subsoil drains.
- Directing infiltrated stormwater and groundwater captured by subsoil drains into vegetated roadside swales.
- Directing all stormwater and groundwater captured by the proposed stormwater and groundwater management strategy into vegetated detention areas prior to discharge from site.

6.6 Stormwater criteria compliance summary

A summary of the proposed stormwater design criteria and how these are addressed is given within **Table 7**.

Table 7: Stormwater management criteria compliance

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Treat the small rainfall event as close to source as practicably possible.	Lots are required to provide 2 m^3 of storage for each 65 m^2 of impervious area through a combination of rainwater tanks, detention within carparks or hardstand, infiltration in landscaped areas, subsurface storage/soakwells and/or LDAs.
		Swales within road verges will treat small event rainfall from the adjacent road bitumen.
SW2	Maintain allowable peak flow rates and volumes up to the major rainfall event discharging from the development.	Lots are required to provide 2 m^3 of storage for each 65 m^2 of impervious area through a combination of rainwater tanks, detention within carparks or hardstand, infiltration in landscaped areas, subsurface storage/soakwells and/or LDAs.
		Swales and detention areas will detain the minor and major rainfall event runoff from road reserves to maintain allowable peak flow rates and volumes.
SW3	Provide conveyance of upstream flows through the development.	Roadside swales and the existing swale along the railway line and Columbas Drive will convey upstream flows through the site towards the ultimate discharge location.
SW4	Minor roads remain passable in the minor rainfall event (i.e. 10% AEP).	Minor roads remain passable in the minor rainfall event (i.e. 10% AEP).
SW5	Finished floor levels should have a clearance from the major rainfall event TWL within detention areas of 300 mm.	Sand fill may be required to ensure finished flood levels of habitable buildings meet the required clearances.
SW6	Apply appropriate non-structural measures to reduce pollutant loads.	Street sweeping on a regular basis.
		No ongoing fertiliser use is proposed within the ROS, drainage reserves and swales, as these are not proposed to require ongoing irrigation.
		Education of lot owners regarding fertiliser application and the use of nutrient absorbing vegetation within LDAs and landscaped areas.

7 Groundwater Management Strategy

The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.4**. The principle behind the groundwater management strategy for the site is to maintain the existing groundwater regime while achieving adequate separation from infrastructure.

7.1 Groundwater level management

The management of groundwater levels within lots is the responsibility of the lot owner and is specific to the uses proposed within the lot. As specified by **Criteria GW3**, habitable floor levels of buildings will be required to have a minimum clearance of 500 mm from CGL. As specified in the *Government Sewerage Policy* (DPLH 2019), the discharge point of all ATUs within a sewerage sensitive area is required to achieve a clearance to CGL of 1.5 m.

Groundwater beneath road reserves may need to be controlled and/or additional design measures implemented to ensure the appropriate level of serviceability is achieved. As specified by **Criteria GW2**, detention areas will be designed to dry out between rainfall events. Otherwise, the swales and ROS are not required to achieve a separation to the MGL or CGL.

Consistent with Criteria GW1, CGLs across the site should be set in accordance with the *Water resource considerations when controlling groundwater levels in urban development* (DoW 2013). CGL across the site can be set below MGL given there are no significant natural environments (e.g. conservation category or resource enhancement category wetlands, or the Ferguson River) within the vicinity of the site. The extent to which this can occur will be controlled by the retention of the existing inverts at the ultimate discharge location (i.e. beneath Columbas Drive) and within the existing swale located along the western boundary of the site. Consequently, the CGL at any point within the site will be set based on the existing discharge invert, plus minimum grades for swales and subsoil drains.

The above requirements will be achieved through a combination of the following measures:

- Maintain existing invert at the ultimate discharge location beneath Columbas Drive. As discussed in **Section 6.3.2**, it is proposed that the existing culvert invert be maintained (though realignment of these culverts is anticipated).
- The two detention areas will have inverts set at CGL or slightly above the existing drain invert. Both detention areas will have a low flow outlet to ensure these dry out between rainfall events.
- Maintain inverts of the existing swale located along the western boundary of the site (i.e. adjacent to Columbas Drive and the ROS).
- Roadside swales will convey runoff from road reserves towards the detention areas (see **Section 6.3.1**) and these will have free draining outlets (150 mm above the invert of the discharge point) and grades that do not result in scour or conversely, in extended ponding. Grades of swales should be determined by flow velocity, vegetation and proposed maintenance regime, infiltration and landform. It is generally recommended that swales be no flatter than 1:750 to provide sufficient detention, while minimising scour and extended ponding.

- Use of subsoil drains along lot boundaries and grading of any underlying clayey sand layer to the subsoil drain. These subsoil drains should also have free draining outlets (i.e. they should outlet into the roadside swale at least 150 mm above the swale invert). Generally, subsoil drains should be no flatter than 1:500, though subsoils with grades of 1:800 where the land is very flat have demonstrated to be successful (R Martin [WGE] 2019, *pers. comm.*, 7 November).
- Use of sand fill to ensure the required clearances and serviceability are achieved.

7.2 Groundwater quality management

The main objective for the management of groundwater quality is to maintain or improve the existing groundwater quality. This can be achieved by treating surface runoff and any captured stormwater or groundwater in subsoils prior to infiltration. Treating this water via appropriate WSUD measures will reduce the total nutrient load that infiltrates from the development.

The reduction of nutrient load to the groundwater will be achieved by:

- Education of lot owners regarding fertiliser use and nutrient absorbing vegetation species appropriate for use within lots.
- No ongoing fertiliser use is proposed within the ROS, drainage reserves and swales, as these are not proposed to require ongoing irrigation.
- Use of ATUs for the management of waste from buildings/site offices in accordance with relevant guidelines.
- Appropriate treatment and/or the capture and removal of wastewater from industrial processes from the lot.
- Utilising WSUD measures within each lot as is appropriate to the final industrial land use.
- Use of high PRI soils (or similar) beneath LDAs and roadside swales, and surrounding subsoil drains.
- Directing infiltrated stormwater and groundwater captured by subsoil drains into a vegetated roadside swale.

7.3 Groundwater criteria compliance summary

A summary of the proposed groundwater quantity design criteria and how these are addressed within the Picton East LSP area is provided in **Table 8**.

Table 8: Groundwater criteria compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Swales and/or subsoil drains used to control groundwater will have inverts (i.e. the CGL) set in relation to existing drain inverts and have free draining outlets.	Existing inverts at the ultimate discharge location and within the existing swale located along the western boundary of the site will be maintained. Roadside swales and subsoil drains will have free draining outlets and minimum grades of 1:750 and 1:500, respectively. This will determine the inverts of swales and subsoil drains and therefore the CGL across the site.

Table 8: Groundwater criteria compliance summary (continued)

Criteria number	Criteria description	Manner in which compliance will be achieved
GW2	Detention areas will be designed to dry out between rainfall events and will have inverts no lower than CGL or an existing drain invert.	Detention areas will have a low flow outlet to ensure these dry out between rainfall events.
		Detention Area 1 is assumed to have an invert set at CGL (i.e. 13 mAHD). Detention Area 2 and 3 are assumed to have an invert set at the existing drain invert (i.e. 12.05 mAHD and 12.5 m AHD, respectively).
GW3	Finished floor levels of habitable buildings should have a clearance from CGL of 500 mm.	Finished floor levels will be set at least 500 mm above the CGL. Fill will be used to meet this clearance where necessary.
GW4	Maintain or improve groundwater quality onsite.	Education of lot owners regarding fertiliser use and nutrient absorbing vegetation species appropriate for use within lots.
		No ongoing fertiliser use is proposed within the ROS, drainage reserves and swales, as these are not proposed to require ongoing irrigation.
		Use of ATUs for the management of waste from buildings/site offices in accordance with relevant guidelines.
		Appropriate treatment and/or the capture and removal of wastewater from industrial processes from the lot.
		Utilising WSUD measures within each lot as is appropriate to the final industrial land use.
		Use of high PRI soils (or similar) beneath LDAs and roadside swales, and surrounding subsoil drains.
		Directing infiltrated stormwater and groundwater captured by subsoil drains into a vegetated roadside swale.

8 Future Subdivision and Urban Water Management Plans

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of subdivision. The development of any future UWMP should follow the guidance provided in *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008b).

While strategies have been provided within this LWMS that address planning for water management within the site, future development stages will need to clarify details not provided within this LWMS. The main areas that will require further clarification include:

- Geotechnical investigation
- Modelling of local road drainage network
- Stormwater storage and subsoil drainage within lots
- Roadside swale and detention area configurations
- Implementation of water conservation strategies
- Non-structural water quality improvement measures
- Management and maintenance requirements
- ASS management plan
- Construction period management strategy
- Monitoring and evaluation program.

These are further detailed in the following sections.

8.1 Geotechnical investigation

All future UWMP(s) will need to be supported by a detailed geotechnical investigation, as this informs both the stormwater and groundwater management strategies (e.g. revising infiltration rates, determining CGLs and earthworks).

8.2 Modelling of local road drainage network

The design of the drainage system to date has been undertaken at an appropriate level for local structure planning and runoff-routing computer modelling of the stormwater drainage system will be reviewed once the subdivision plan has been determined and detailed drainage design has commenced for the area. It is anticipated that this will occur during the subdivision design process and detailed within the future UWMPs.

Land ownership within the LSP area is somewhat fragmented and consequently it is difficult to determine when each landholding will be developed. Portions of the LSP can be developed as shown in the LWMS without development of the ultimate drainage system by use of temporary structures.

The exception to the requirement to revise the surface runoff modelling is if the catchment details (including layout of the 20 m access road reserves as shown on the concept plan in **Appendix A**), and designs are consistent with the assumptions made in this LWMS. If this were the case it would be acceptable to provide design calculations for the drainage network and WSUD strategies to demonstrate compliance with the LWMS.

8.3 Stormwater storage and subsoil drainage within lots

The stormwater management strategy assumes that all lots will retain 2 m^3 of runoff for every 65 m^2 of hardstand or roof (i.e. impervious area). Other WSUD strategies, which are industry specific, may also need to be installed within each lot to treat runoff prior to it discharging from the lot. It is the lot owners' responsibility to ensure that the appropriate storage is provided and appropriate WSUD strategies used within the lot.

Lot designs, including stormwater drainage, are to be approved by SoD at building approval stage prior to construction, and therefore will not be available for inclusion in the UWMP. However, the UWMP should clearly identify the roles and responsibilities for implementing lot-scale storage and treatment structures.

8.4 Roadside swale and detention area configurations

The exact location, size and shape of the roadside swales and detention areas will still need to be specified and presented within the future UWMPs.

In order to review the final configurations, the hydrological model that has been developed to support this LWMS may need to be refined in light of stakeholder feedback or to accommodate other design considerations. It is expected that the civil drainage designs will be progressed to a level that provides detailed cross-sections, sizes of storage areas, pipe sizes, inverts, etc. The ultimate aim of revising the hydrological model will be to confirm that the drainage designs are able to meet the performance criteria proposed in **Section 4** of this LWMS.

8.5 Implementation of water conservation strategies

A number of potential measures to conserve water have been presented within this LWMS. These water conservation strategies will be incorporated into the subdivision design and will be further detailed within the future UWMPs produced for the development. The manner in which the proponent intends to promote water conservation measures discussed in this LWMS to future lot owners will also be discussed within the future UWMP.

8.6 Non-structural water quality improvement measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007a). Some measures will be more appropriately implemented at a local government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the subdivision and the drainage reserves. It is expected that the future UWMPs will provide a schedule of management and maintenance actions including timing and responsible parties.

8.7 Management and maintenance requirements

The management measures to be implemented to address surface water quality, such as the use of vegetation within swales and detention areas will require ongoing maintenance. It is therefore expected that the future UWMPs will set out maintenance actions (e.g. gross pollutant removal), timing (i.e. how often it will occur), locations (i.e. exactly where it will occur) and responsibilities (i.e. who will be responsible for carrying out the actions). Given that approval from the SoD and DWER will be sought for the proposed measures, it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

8.8 ASS management plan

An ASS management plan will be required in this moderate to low risk ASS area (DWER 2019a) if the CGL is confirmed to be set below MGL in future UWMPs, as proposed by the groundwater management strategy (see **Section 7.1**). The ASS management plan should include more detailed on-site investigations (potentially as part of future geotechnical investigations described in **Section 8.1**) than the investigation provided in **Appendix B**.

8.9 Construction period management strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. dust, surface runoff, noise, traffic etc.). The management measures undertaken for construction management will be addressed either in the future UWMPs or a separate Construction Management Plan.

8.10 Monitoring and evaluation program

It will be necessary to confirm that the management measures that are implemented are able to fulfil their intended management purpose, and are in a satisfactory condition at a point of management hand-over to the SoD. 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. These monitoring programs are discussed in **Section 9** of this LWMS and will be further detailed at the UWMP stage.

9 Monitoring and Maintenance

9.1 Management and maintenance

It is proposed that the overall condition of the development will be monitored on a bi-annual basis. This monitoring will be implemented after the completion of the civil and landscaping works and will continue for a period of two years until handover of drainage reserves to the SoD.

A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities are achieving the overall management objectives for the development. The parameters that will be monitored include:

- Nutrients and water quality
- Gross pollutants
- Terrestrial weeds
- Drainage infrastructure.

The management and maintenance objectives will be detailed within future UWMPs along with details of the corresponding monitoring program.

9.2 Water quality monitoring

Post-development monitoring will be carried out to ensure that the proposed storage and treatment measures, detailed in **Section 6** and **7**, are working efficiently. An upstream-downstream comparison for surface water and groundwater is proposed to confirm that the water treatment infrastructure is performing as intended.

9.2.1 Recommended program for UWMP

Surface water and groundwater monitoring locations will be selected to provide an indication of the effects of the development on water quality leaving the site. Indicative monitoring locations are provided in **Figure 6**. These upstream/downstream locations will be finalised in the UWMP.

Surface water quality monitoring will be conducted on a fortnightly basis during winter (typically July to September). Groundwater quality monitoring will be conducted on a quarterly basis. A summary of the post-development monitoring program is shown in **Table 9**. The post-development monitoring will be conducted for two years post construction of the development.

Table 9: Monitoring program summary

Monitoring type	Locations	Frequency	Parameters
Surface water	Inflow to existing swale and discharge from site	Fortnightly (typically Jul, Aug, Sept)	In situ pH, EC, temperature. Sample TSS, TN, TKN, NO_X, NO_2, NO_3, NH_3, TP, reactive phosphorous.
Groundwater	Bores upstream and downstream of the site	Quarterly (typically Jan, April, July, Oct)	In situ pH, EC, temperature. Sample TN, TKN, NO_X, NO_2, NO_3, NH_3, TP, reactive phosphorous.

9.2.2 Post-development trigger values

Groundwater water quality targets have been derived from background levels measured during monitoring prior to development, provided in **Table 1**. Trigger values have been determined through consideration of the pre-development monitoring concentrations, the ANZECC and ARMCANZ (2000) trigger value for lowland river aquatic ecosystems in South-west Australia and target concentrations specified in the *Leschenault Estuary WQIP* (DoW 2012). The trigger criteria proposed are shown in **Table 10**.

Table 10: Water quality trigger values

Analyte	pH	EC (mg/L)	TN (mg/L)	TKN (mg/L)	NO_X (mg/L)	TP (mg/L)	Reactive phosphorous (mg/L)
Surface water	6.5 - 8	0.12 - 0.3	1	NA	0.15	0.1	NA
Groundwater	6 - 8	0.17 - 5	11	11	2.77	4.6	1.64

While trigger values have been defined in **Table 10**, the water quality data over the site is varied. It is therefore proposed that the post-development trigger values provided in **Table 10** are dynamic values, and should be assessed in the context of an upstream/downstream comparison. The secondary trigger to implement a contingency action (see **Section 9.3**) will be if the downstream concentration of the above parameters is greater than 20% higher than the upstream concentration.

9.3 Contingency action plan

A Contingency Action Plan (CAP) will be detailed and implemented as a part of each UWMP. The CAP is effectively a plan of steps that will be undertaken should certain water quality criteria be reached.

9.3.1 Trigger criteria

As indicated, the trigger values proposed in **Table 10** have been derived from water quality levels measured during pre-development monitoring and relevant guidelines. These values should be reviewed for each UWMP to include additional data gained from any additional monitoring.

9.3.2 Contingency actions

If the results from the initial monitoring occasion indicate that nutrient concentrations exceed the nominated trigger values, a number of contingency measures may be employed.

The first action that should be undertaken if trigger criteria are exceeded is to repeat the monitoring to remove the potential for sampling error. If the repeat monitoring still shows results which breach the trigger value, the next action will be to compare the upstream (incoming) nutrient concentrations with the downstream (outgoing) nutrient concentrations. Comparison should also be made between groundwater and surface water quality concentrations, when these are sampled on the same monitoring event.

If the downstream nutrient concentrations are >20% higher than the upstream nutrient concentrations, the following actions should be undertaken:

- Review nutrient application practices to identify source of possible.
- Conduct surveillance of site to determine any potential and obvious nutrient inputs, including within lot treatment structures/verge maintenance practices.
- Remove source if possible (e.g. fertiliser input, etc.).

If the downstream nutrient concentrations are found to be generally consistent with the upstream concentrations the next action will be to conduct a site-specific comparison of background data collected within the site prior to development. There is some amount of variability (both spatially and temporally) in nutrient concentrations experienced across the site and the trigger values may need to be modified following additional monitoring. This information should then be used as a management tool in consultation with DWER and SoD to determine if the trigger values should be revised.

Following the implementation of the above contingency measures the water quality will be re-sampled. If the results are consistent with the previous monitoring events, DWER and SoD will be informed of the results, and the proponent will work with DWER and SoD to determine if the results are representative of a broader catchment management issue, and whether any additional contingency actions need to be implemented onsite.

9.4 Reporting

A post-development monitoring report will be prepared on conclusion of the two year monitoring period, and will be provided to the SoD and the DWER. Interim results (spreadsheet) can be provided to either SoD or DWER on request during the monitoring program.

10 Implementation

The LWMS is a key supportive document for the LSP. 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 the future UWMPs.

10.1 Roles and responsibility

The LWMS provides a framework that the proponent can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations, are consistent with relevant State and Local Government policies, and have been endorsed by the SoD. The responsibility for working within the framework established within the LWMS rests with the landholder, although it is anticipated that future UWMPs will be developed in consultation with the SoD and DWER and in consideration of other relevant policies and documents.

The responsibility to implement and maintain within lot water quality treatment measures that are appropriate to the land use will be with the lot owner/lot developer. The sizing and design of LDAs for detention of runoff within lot will be the responsibility of the lot owner/lot developer.

Main Roads WA (MRWA) will be responsible for the design and construction of the Martin-Pelusey Road upgrade and associated drainage infrastructure.

10.2 Funding

Funding for within-lot drainage and groundwater management infrastructure will be the responsibility of the lot owner. The site includes multiple landholdings that are anticipated to be developed sporadically over the long term. Therefore, estate scale drainage infrastructure will be funded by each landholder. The upgrade of Martin-Pelusey Road and associate drainage infrastructure will be funded by MRWA.

10.3 Review

It is not anticipated that this LWMS will be reviewed, unless additional land parcels/lots are added to the LSP area prior to subdivision, or the LSP 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. Surface runoff modelling undertaken for this LWMS will need to be reviewed and the criteria proposed revised to ensure that all are still appropriate if the LSP is substantially modified.

The next stages of water management are anticipated to be lot planning through subdivision. Subdivision approvals will be supported by a UWMP. The UWMP is largely an extension of the LWMS, as it should provide detail to the designs proposed within this LWMS, and will demonstrate compliance with the criteria proposed in **Section 4**.

In addition to the issues detailed in **Section 8**, the UWMP will address:

- Compliance with design objectives within the LWMS
- Detailed stormwater and groundwater management design
- Specific structural and non-structural methods to be implemented and their manner of implementation
- Details of proposed roles and responsibilities for the above measures.

The next stage of development following the UWMP is single lot development. It is recognised that certain elements of the LWMS and the UWMP will not be implemented until this late stage, and that there is little or no statutory control that can be applied to ensure the implementation of any remaining measures. While the remaining measures are unlikely to be enforced at this stage, their implementation will be encouraged by the SoD through policy (or modification of these where necessary), building licence or awareness programs (such as the Water Corporation Waterwise program).

11 References

11.1 General references

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Figures

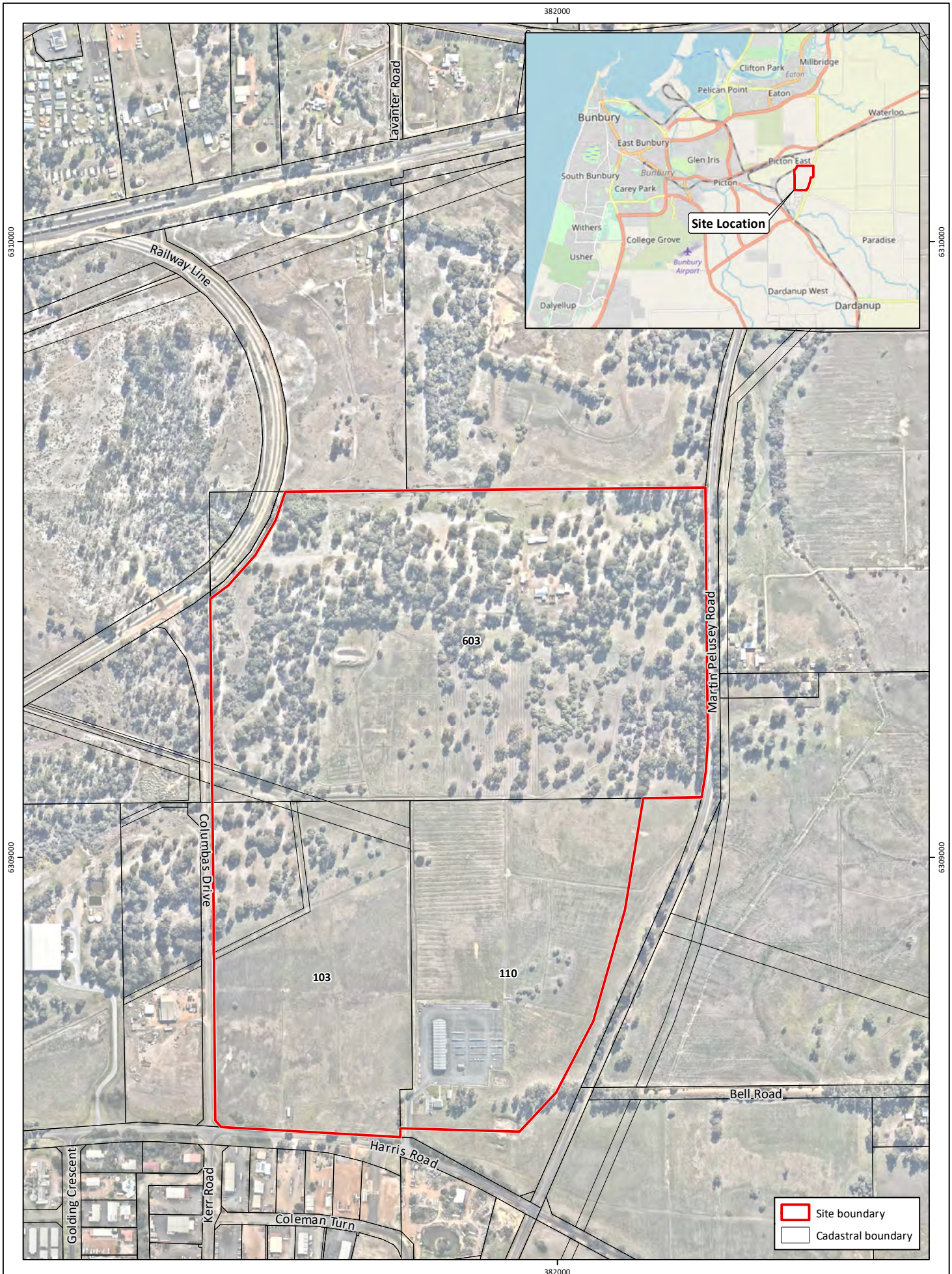

Figure 1: **Site Boundary**

Project:	Local Water Management Strategy Local Structure Plan, Lots 103, 110 and 603, Picton East
Client:	Harris Road Pty Ltd

Plan Number:
EP12-039(01)--F23

Drawn:	GAR
Date:	12/09/2019
Checked:	ASC
Approved:	DPC
Date:	08/11/2019

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

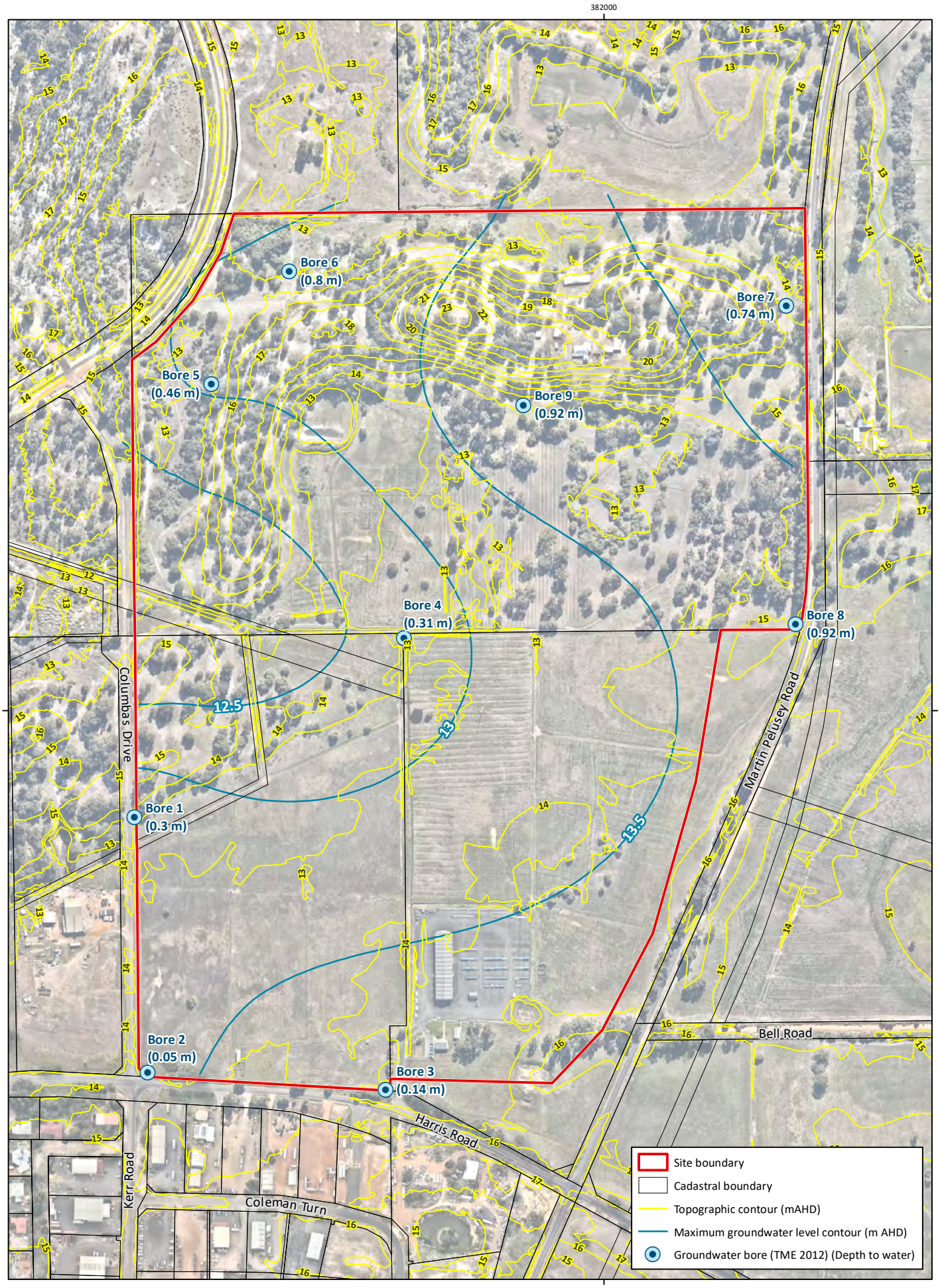

Figure 2: **Topographic and Maximum Groundwater Contours**

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(01)--F24

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Checked:	ASC
Approved:	DPC
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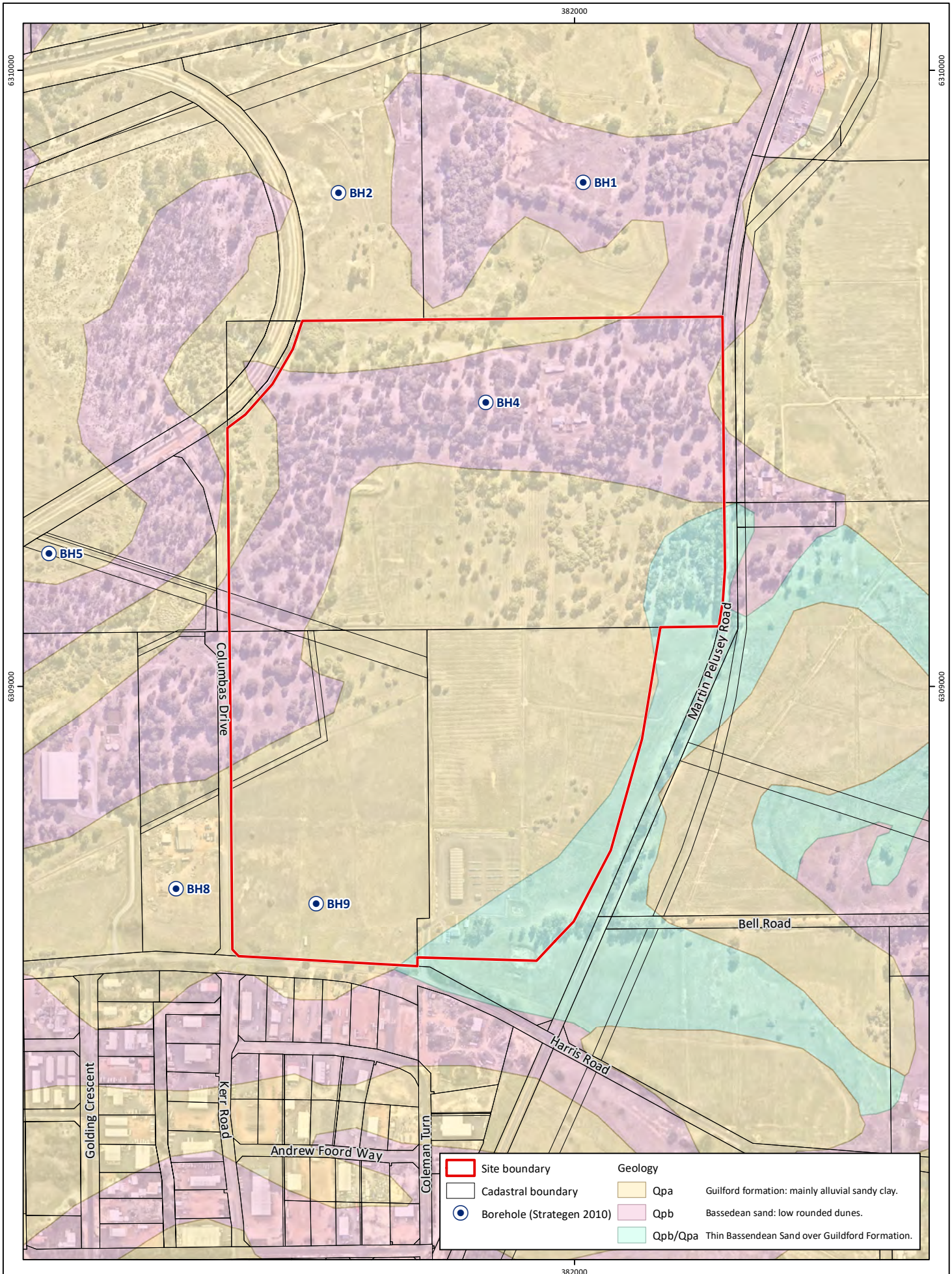

Figure 3: Geological Mapping

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number:
EP12-039(01)--F25

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Checked:	ASC
Approved:	DPC
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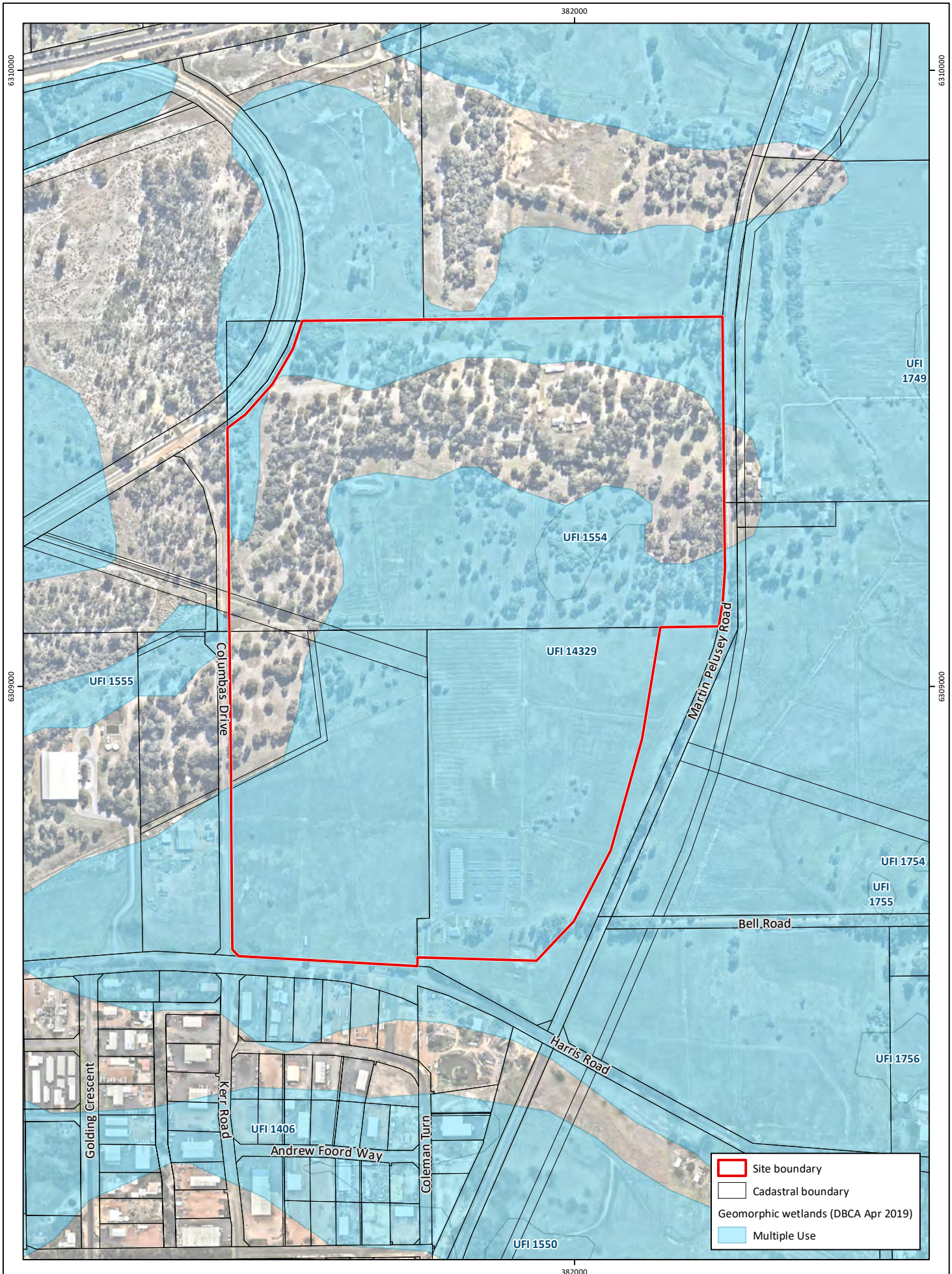

Figure 4: Geomorphic Wetlands

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number:
EP12-039(01)--F26

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Checked:	ASC
Approved:	DPC
Date:	08/11/2019

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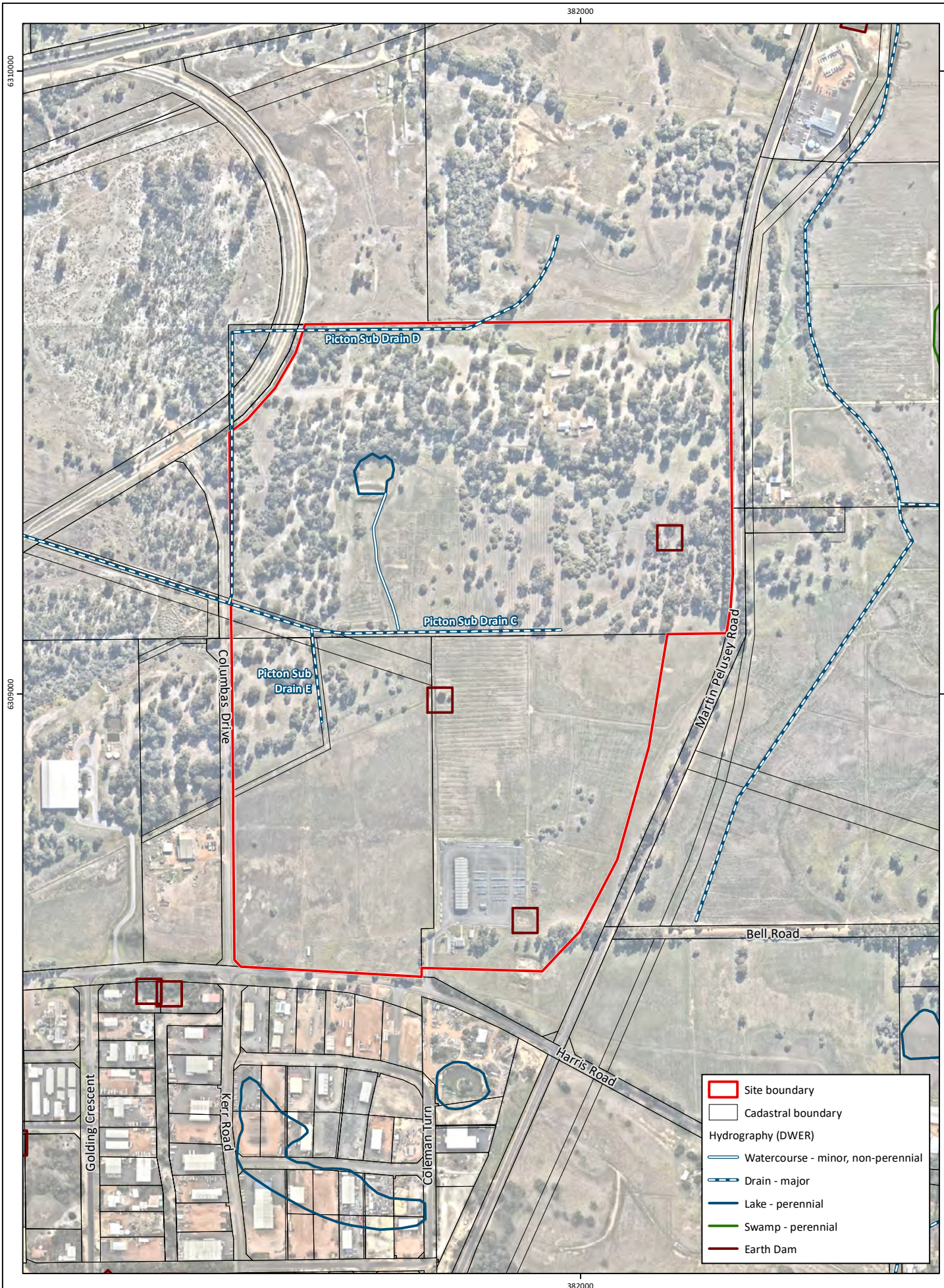

Figure 5: Hydrological Features

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number:
EP12-039(01)--F27

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Date:	12/09/2019
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Approved:	DPC
Date:	08/11/2019

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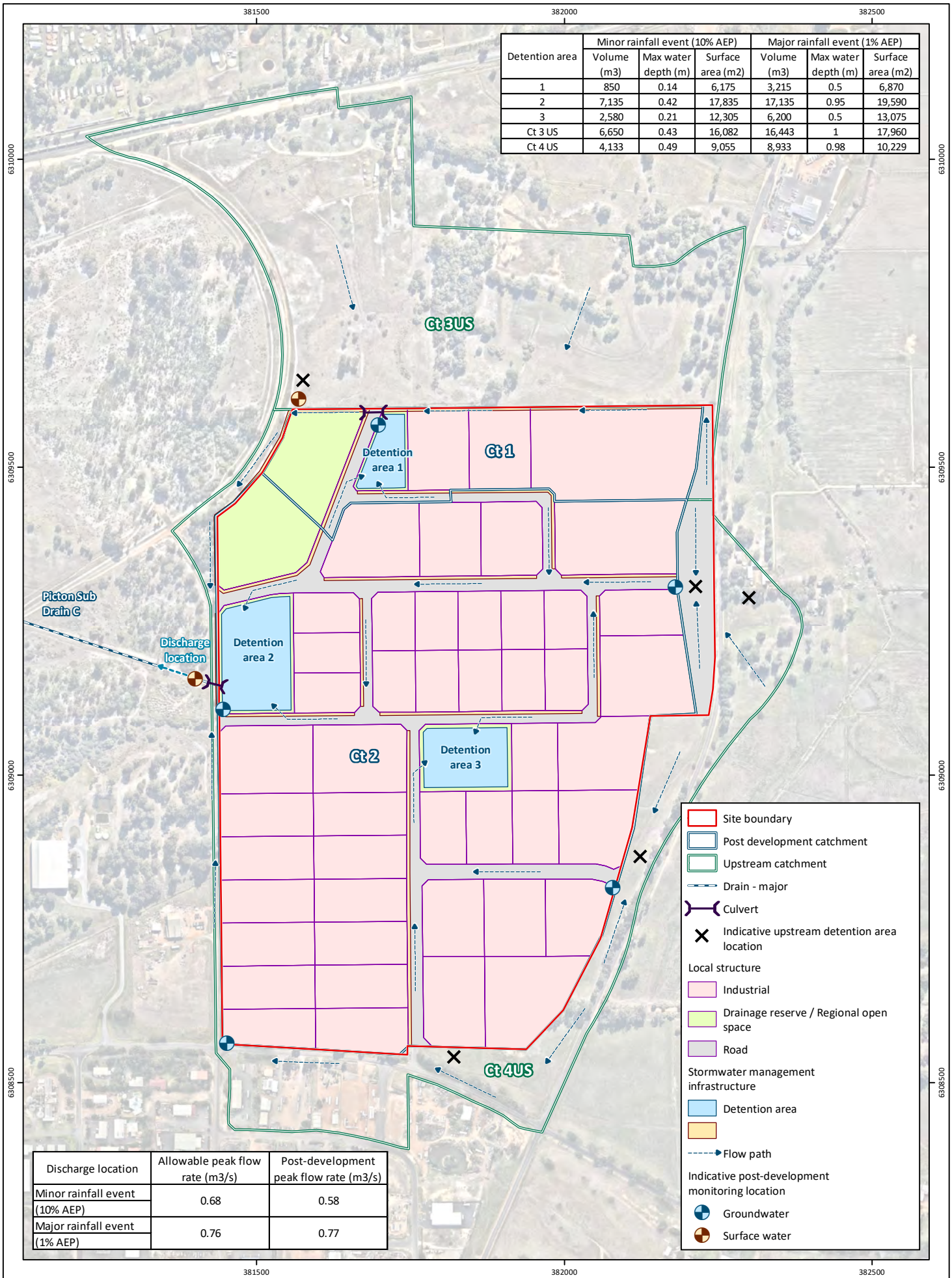

Detention area	Minor rainfall event (10% AEP)			Major rainfall event (1% AEP)		
	Volume (m3)	Max water depth (m)	Surface area (m2)	Volume (m3)	Max water depth (m)	Surface area (m2)
1	850	0.14	6,175	3,215	0.5	6,870
2	7,135	0.42	17,835	17,135	0.95	19,590
3	2,580	0.21	12,305	6,200	0.5	13,075
Ct 3 US	6,650	0.43	16,082	16,443	1	17,960
Ct 4 US	4,133	0.49	9,055	8,933	0.98	10,229

Discharge location	Allowable peak flow rate (m3/s)	Post-development peak flow rate (m3/s)
Minor rainfall event (10% AEP)	0.68	0.58
Major rainfall event (1% AEP)	0.76	0.77

Figure 6: Stormwater Management Plan

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(01)--F35

Drawn:	GAR	
Date:	07/11/2019	
Checked:	ASC	
Approved:	DPC	
Date:	07/11/2019	

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Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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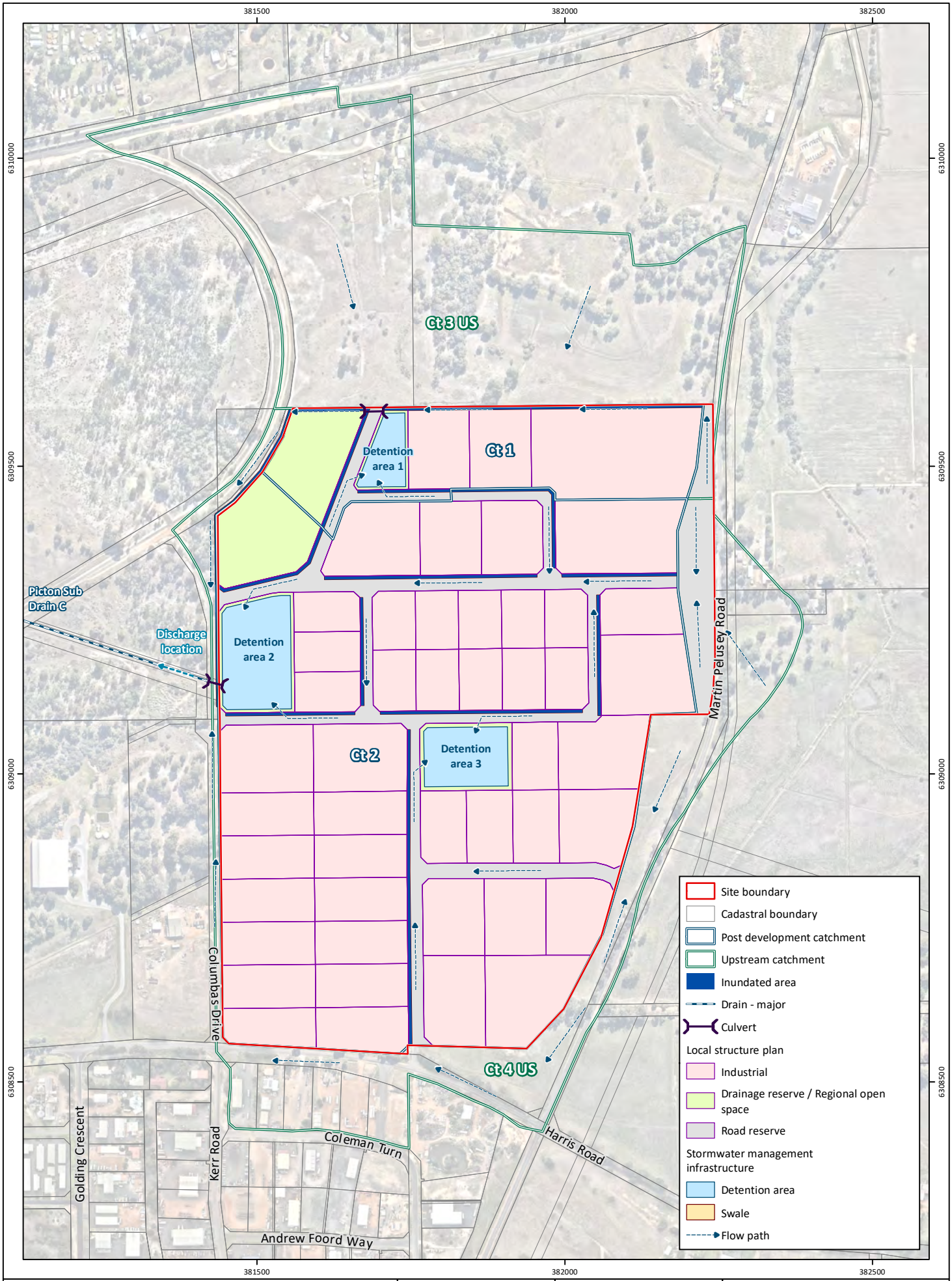

Figure 7: **Small Rainfall Event Inundation Mapping**

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(01)--F36

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Checked:	ASC	
Approved:	DPC	
Date:	07/11/2019	

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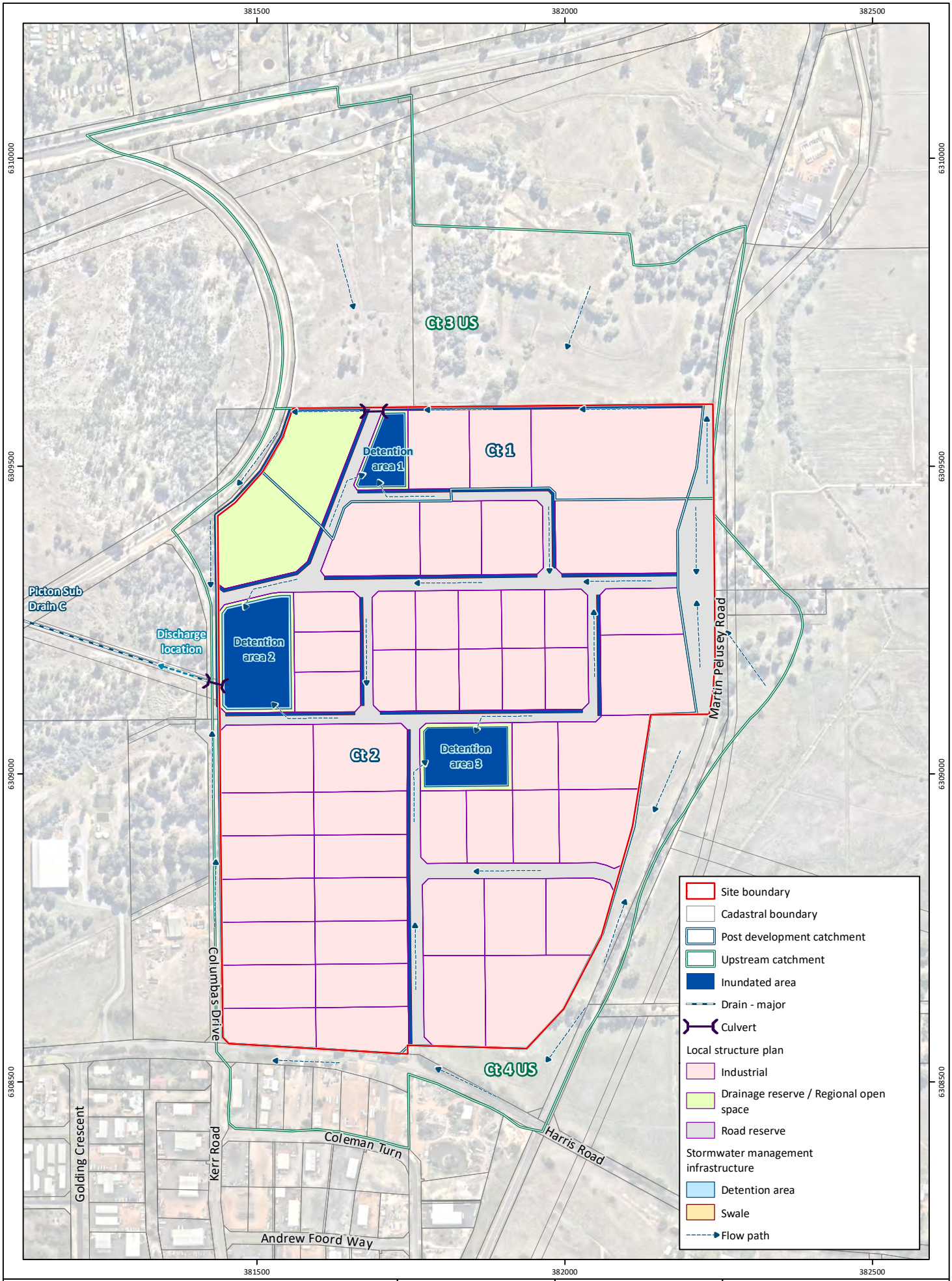

Figure 8: **Minor Rainfall Event Inundation Mapping**

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(01)--F37

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

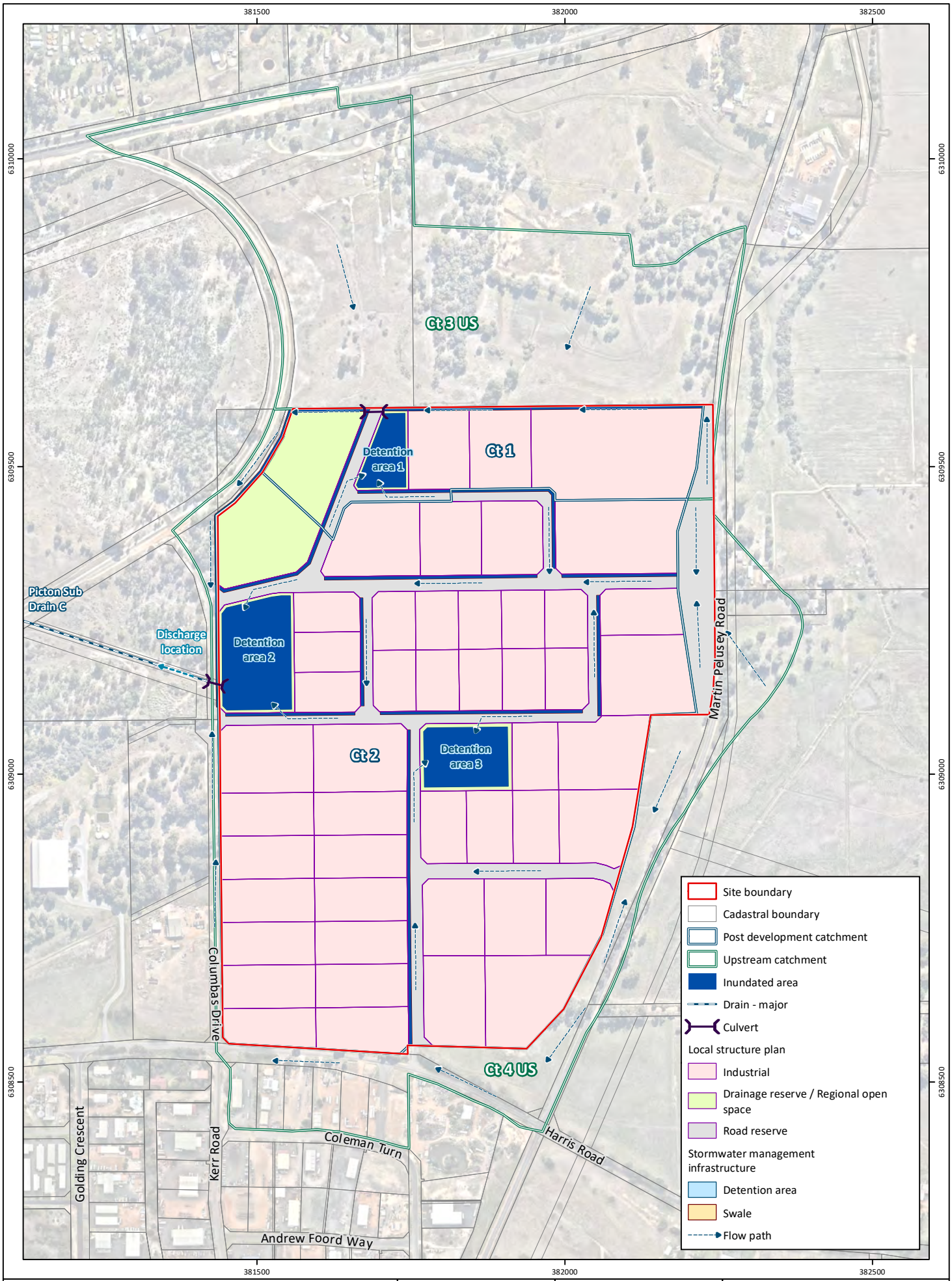

Figure 9: **Major Rainfall Event Inundation Mapping**

Project: Local Water Management Strategy
Local Structure Plan, Lots 103, 110 and 603, Picton East

Client: Harris Road Pty Ltd

Plan Number: EP12-039(01)--F38

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Date:	07/11/2019	
Checked:	ASC	
Approved:	DPC	
Date:	07/11/2019	

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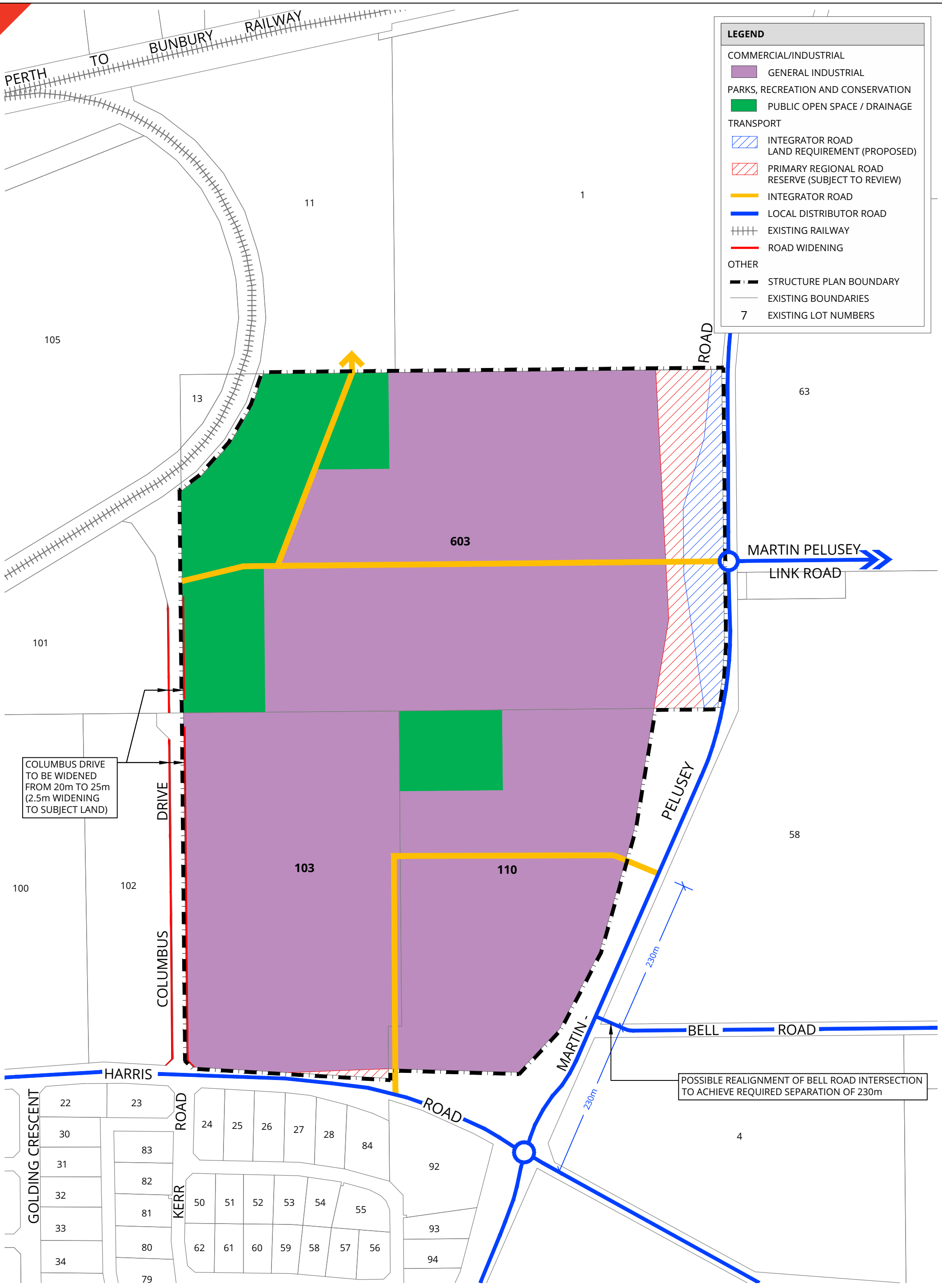
GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Local Structure Plan and Concept Plan



LOCAL STRUCTURE PLAN

LOTS 103, 110 AND 603
PICTON EAST

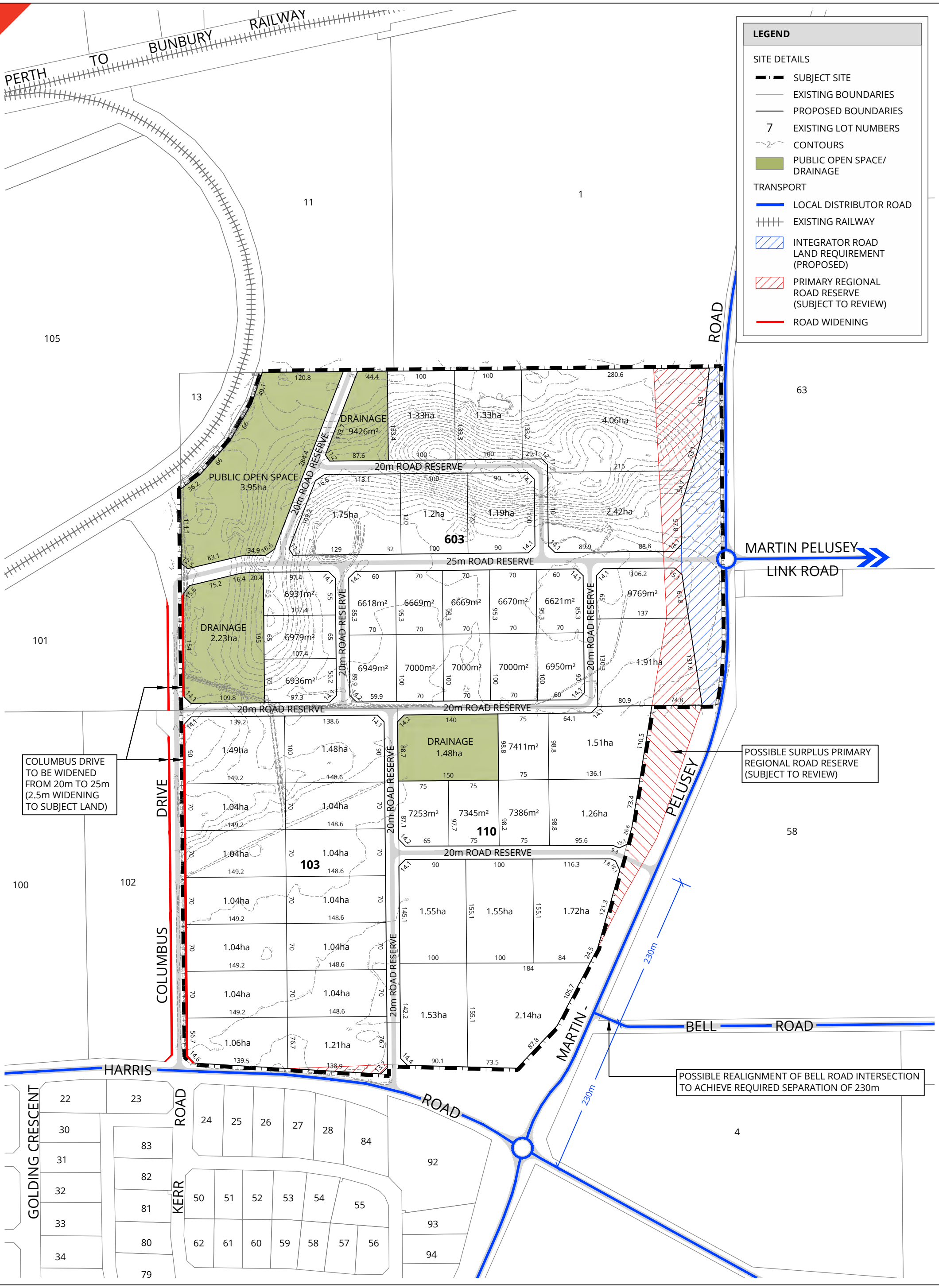
NORTH

0 125 m
SCALE @ A3: 1:5000

9013-LSP-01-G

ROWE GROUP

N:\TOWN PLANNING\9000-9999\9013\DRAFTING\CAD - WILLIAM CLEMENTS - 2019.11.12
9013_LSP01G_20191112 Picton East (LSP) - DRAWN: A. GLASKIN - DATE CREATED: 2019.11.12 - PROJECTION: MGA50 GDA94 - CADASTE: LANDGATE



CONCEPT PLAN

LOTS 103, 110 AND 603
PICTON EAST

NORTH

0 125 m
SCALE @ A3: 1:5000

9013-CON-01-E

ROWE GROUP

N:\TOWN PLANNING\9000-9999\9013\3DRAFTING\CAD - WILLIAM CLEMENTS - 2019.11.12
9013_CON01E_20191111 Picton East (Concept 1) - DRAWN: A. GLASKIN - DATE CREATED: 2019.11.11 - PROJECTION: MGA50 GDA94 - CADASTE: LANDGATE

Appendix B

Preliminary Acid Sulphate Soil Investigation

Preliminary Acid Sulphate Soil Investigation

Picton East, Shire of Dardanup, WA

Prepared for
TME Group
by Strategen

May 2010

Preliminary Acid Sulphate Soil Investigation

Picton South – Eastern Sector – Shire of Dardanup, WA

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Suite 7, 643 Newcastle Street Leederville WA
ACN: 056 190 419

May 2010

Disclaimer and Limitation

This report has been prepared for the exclusive use of the Client, in accordance with the agreement between the Client and Strategen ("Agreement").

Strategen accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any person who is not a party to the Agreement.

In particular, it should be noted that this report is a qualitative assessment only, based on the scope of services defined by the Client, budgetary and time constraints imposed by the Client, the information supplied by the Client (and its agents), and the method consistent with the preceding.

Strategen has not attempted to verify the accuracy or completeness of the information supplied by the Client.

Client: TME Group

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft Report	V1	ZC/DD	AP	1	19/5/2010
Final Report	Final	ZC/DD	AP	1	31/5/2010

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1. INTRODUCTION

The following report is a Preliminary Acid Sulphate Soil (ASS) Investigation undertaken for a land parcel (the study area) known as the Picton South site (eastern sector), which is bordered by Martin Pelusey Road, Harris Road, Columbas Drive, a section of disused railway line to the south west and the Perth to Bunbury railway line, and is located in the Shire of Dardanup, WA. The study area is proposed to be developed for light commercial use and will incorporate access roads and other services. Strategen was appointed by TME Group to undertake the investigation in order to develop an understanding of any potential ASS issues associated with excavations that may be undertaken within the study area, particularly in association with the provision of power and deep sewage services and stormwater management.

South West Chemical Services (SWCS) was sub-contracted by Strategen to carry out the Preliminary ASS field work, which was conducted on 12 May 2010. Previous investigations carried out to the south west of the study area, opposite Lot 200 Harris Road, showed some evidence of Potential Acid Sulphate Soils (PASS[1]) in a low lying area. In addition, some evidence of Actual Acid Sulphate Soils (AASS[2]) was observed in the upper soil layers and towards the Ferguson River at Lot 51 Martin Pelusey Rd, located to the south of the study area.

1.1 OVERVIEW OF STUDY AREA

The study area, as illustrated in Figure 2, comprises approximately 140 ha of low lying land split into seven lots, the majority of which has been cleared for grazing and industrial purposes. Some small pockets of lightly treed, native vegetation have been retained in slightly elevated areas associated with sandy soils. The surface levels range from 12 to 25 m Australian Height Datum (AHD).

1.1.1 Geology and soils

Geological maps for the study area show the site to be underlain by the Guildford Formation, consisting of clay, silt, sand and gravels, with the Bassendean Sands outcropping in some areas. Both the Pinjarra and Bassendean soil systems dominate the study area (Figure 1 – Department of Agriculture 2003). The Pinjarra P2 phase consists of flat to very gently undulating plains with poor to imperfectly drained, deep alkaline mottled, yellow duplex soil, which generally consist of shallow pale sand to sandy loam over clay (Department of Agriculture 2003). The Bassendean B1a phase consists of extremely low to very low relief dunes, undulating sandplain and discrete sand rises where soils are deep bleached grey sands with an intensely coloured yellow B horizon occurring within 1 m of the surface with marri and jarrah vegetation dominating the system (Department of Agriculture 2003).

[1] Potential acid sulphate soils (PASS) are soils or sediments which contain iron sulphides and/or other sulphidic minerals that have not been oxidised or exposed to air (DoE 2006).

[2] Actual acid sulphate soils (AASS) are soils or sediments which contain iron sulphides and/or other sulphidic minerals that have previously undergone some oxidation to produce sulphuric acid (DoE 2006).

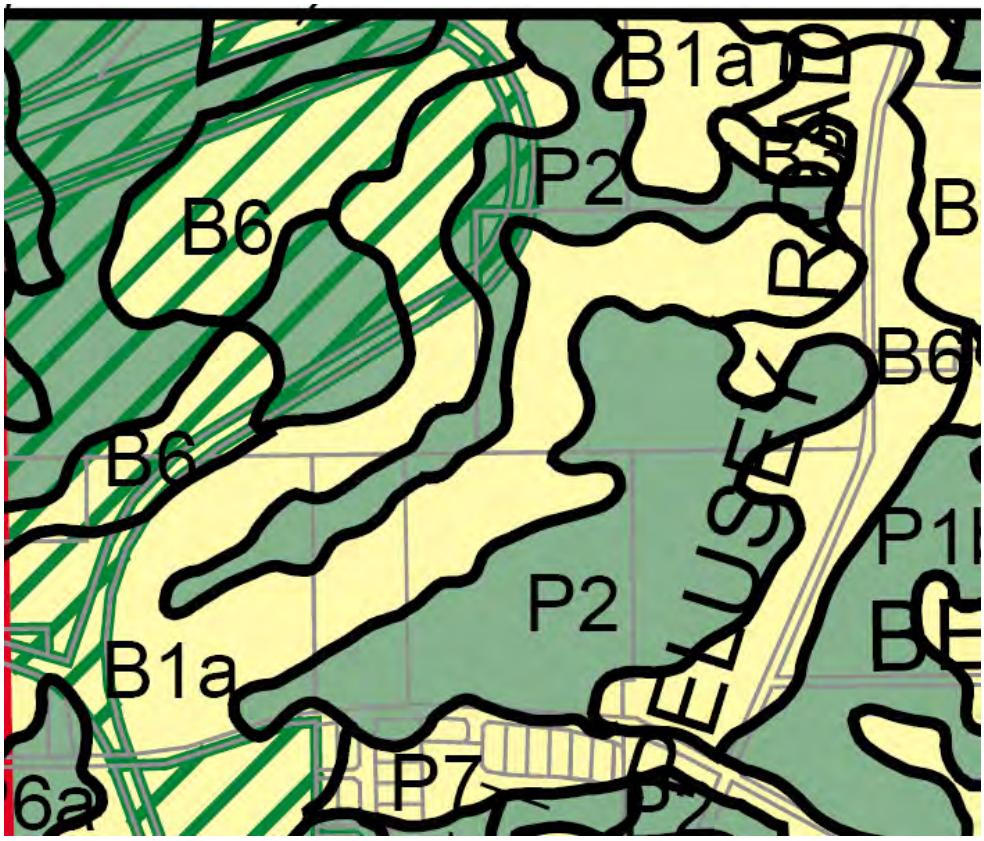


Figure 1 Soil map units within the study area

According to Western Australian Planning Commission (WAPC) Planning Bulletin 64, the site is in an area with a moderate to low risk of AASS and PASS occurring generally at depths greater than 3 m (Appendix 1).

1.1.2 Lot descriptions

The study area consists of 7 lots, comprising of:

Lot 1 – 31.6 ha of low-lying, predominantly cleared land used for horse breeding, with some moderate sized pockets of native vegetation. Part of the Lot appears to be an old sand extraction site and it has a highly modified upper soil layer consisting of predominantly fill material and builder's rubble.

Lot 11 – 11.9 ha of low-lying, predominantly cleared land used for horse breeding and training.

Lot 603 – 39.2 ha consisting of a small, cleared, low-lying area, as well as a large, slightly elevated ridge of remnant native vegetation on sandy soil.

Lot 103 – 17.1 ha of predominantly cleared, low-lying land with a small pocket of native vegetation to the north-west.

Lot 2 – 21.2 ha of almost entirely cleared, low-lying land, occupied in part by a shed used for industrial purposes.

Lot 102 – 6.3 ha of predominantly low-lying land with a slight ridge containing small amounts of vegetation.

Lot 104 – 8.6 ha of predominantly vegetated, low-lying land with areas containing piles of construction rubble.

1.2 SCOPE OF INVESTIGATION

Strategen commissioned South West Chemical Services to undertake the field work component of the Preliminary ASS Assessment of the study area. The intent of the preliminary assessment was to undertake the boring of 10 holes at pre-determined locations on the Lots using a hand auger to the depth of 2.5 m (Figure 2). Bore hole locations were considered representative of the varying elevations, soils and land types within the study area, as well as focussing on areas with a potentially higher risk of ASS. At each of the bored holes, samples were to be collected for analyses at 0.25 m vertical intervals in accordance with the Department of Environment and Conservation (DEC) *Identification and Investigation of acid sulphate soils and acidic landscapes* Guidelines (DEC 2009.

As the study area comprises approximately 140 ha, the Preliminary ASS Assessment does not constitute a full assessment in accordance with DEC Guidelines, but is intended to give an indication as to whether ASS may exist on the site. A full site assessment would entail a total of 280 holes across the full site (i.e. two holes per hectare).

Figure 2 Lot numbers and location of auger holes within the study area

2. SOIL SAMPLING

A site visit to undertake the Preliminary ASS investigation was conducted on 12 May 2010. During the initial work it became obvious that it would not be possible to complete 10 sample holes using a hand auger due to the nature of the soils at the study site. A total of six auger holes were sampled to varying depths and soil observations were made (Table 1).

Table 1 Soil observations during hand augering

Hole No.	Lot No.	Observations
8	102	Significant groundwater observed at just less than 1 m below ground level followed by a hard hand auger impenetrable layer at 1 m. The soils generally were light brown or yellow brown of fine to medium grained sands.
9	103	Gave similar results to hole 8 with water observed at 1 m. While no refusal was encountered, the large quantity of groundwater made sample collection at greater than 1.5 m impossible. The soils were generally light brown to grey/brown of fine to medium grained sands to 1 m with clayey sands at lower depths.
5	104	Located near the disused railway line, refusal was experienced at 1 m. No groundwater was encountered but the soil and gravel was damp. The soils were generally brown to yellow /brown sands and gravel.
4	603	Attempted near the maximum elevation of the sand hill that runs across the site roughly from east to west. Samples were collected to a depth of 2.25 m as the dry sand around that depth kept collapsing into the hole and were difficult to retrieve. The soil was very dry yellow sand to the depth of 2.25 m.
2	11	Samples were yielded to a depth of 2.25 m, with groundwater encountered at 1.25 m. Samples could not be collected below 2.25 m as it became increasingly difficult to remove the hand auger. The soils consisted of light brown sand to 0.5 m followed by blue/green/grey sands to 2 m. The sample collected at 2.25 m was grey clay.
1	1	The area appeared to be an old sand extraction site consisting of fill material and builder's rubble. Sampling could not be achieved at 0.25 m due to the presence of coarse builder's rubble. A further sample site was selected but samples could only be achieved to 0.5 m. The sampled soil appeared to be a dark brown sandy top soil.

It was determined that sampling the remaining four auger holes (hole numbers 3, 6, 7 and 10) would not yield sufficiently different results to those already encountered. This was because the location of holes 7 and 10 appeared to be similar in elevation and appearance to the areas sampled at holes 8 and 9, and it was likely that groundwater would be encountered. Similarly the locations of holes 3 and 6 appeared to be similar in elevation and appearance to the areas sampled at holes 4 and 5.

Samples from each of the six auger holes were collected at 0.25 m vertical intervals and immediately placed in sealed bags on ice. The samples were then transported to the SWCS laboratory and were immediately tested for field pH (pH_f) and oxidised field pH (pH_{fox}). The samples were then dried for 48 hours at 85°C for preservation and storage. The generally negative results from the field test conducted on the six completed holes confirmed the decision not to proceed with further sampling of the remaining four holes.

3. SOIL TEST RESULTS

3.1 FIELD TESTING

Details of the field test results are presented in Appendix 2. The field test results were assessed using the following criteria:

(a) pH_f less than 4

(b) pH_{fox} less than 4 and/or

(c) the change in pH was greater than 2 (where the resultant pH_{fox} was less than 4) and/or

(d) there was a strong reaction following addition of hydrogen peroxide.

The key findings from the field test results were:

- of the 36 samples tested, there were no samples where the pH_f was 4.0 or less
- of the 36 samples there were two (2) samples where the pH_{fox} was 4 or less
- of the 36 samples there were no samples that gave a change in pH > 2 units with the pH_{fox} <4.0
- 1 sample gave a High reaction with the addition of Hydrogen Peroxide
- 3 samples gave an Extreme reaction with gas evolution and heat with the addition of Hydrogen Peroxide
- There appears to be no indication of the presence of PASS at all levels in the samples processed
- There may be an indication of Actual Acid Sulphate soils in samples collected from hole 2, hole 5 and hole 8.

3.2 DETAILED LABORATORY TESTING AND ASSESSMENT

No full laboratory assessment has been carried out at this stage.

4. CONCLUSIONS

Results of the field tests indicate a potential for AASS, particularly in the vicinity of holes 2 and 8 (Lots 11 and 102). Samples exposed to gas evolution and heat with the addition of hydrogen peroxide produced an extreme reaction in three samples at depths of 1.75 – 2.25 m for hole 2, and a high reaction in one sample at a depth of 0.75 m for hole 8. In addition, potential for AASS may also occur in the vicinity of hole 5 (Lot 104), where two surface samples (0.25 – 0.5 m) experienced a pH_{fox} of 4 or less. However, there appears to be no indication of the presence of PASS at all levels in the samples processed from these holes.

The overall results of the Preliminary ASS Investigation are limited due to the low number of samples collected using a hand auger. This outcome is the result of the soil types encountered within the study area and the presence of groundwater close to the surface in some locations. In the event that any future studies are undertaken, more accurate results at depth may be obtained using equipment such as Geoprobe boring or an excavator.

For a thorough indication of the potential for ASS within the study area, a more detailed investigation that follows full DEC guidelines is recommended for areas where field tests indicated a potential for ASS (in the vicinity of holes 2, 8 and 5), as well as areas of similar soil characteristics that weren't sampled during the site investigation. To obtain a detailed assessment of ASS potential within the entire study area, a full investigation aligning with DEC requirements (i.e. two holes per hectare across the entire site) would need to be undertaken.

5. REFERENCES

Department of Agriculture WA (2003), *AgMaps Land Profiler*, Sheet 1 – Shire of Capel, CD-ROM, Government of Western Australia.

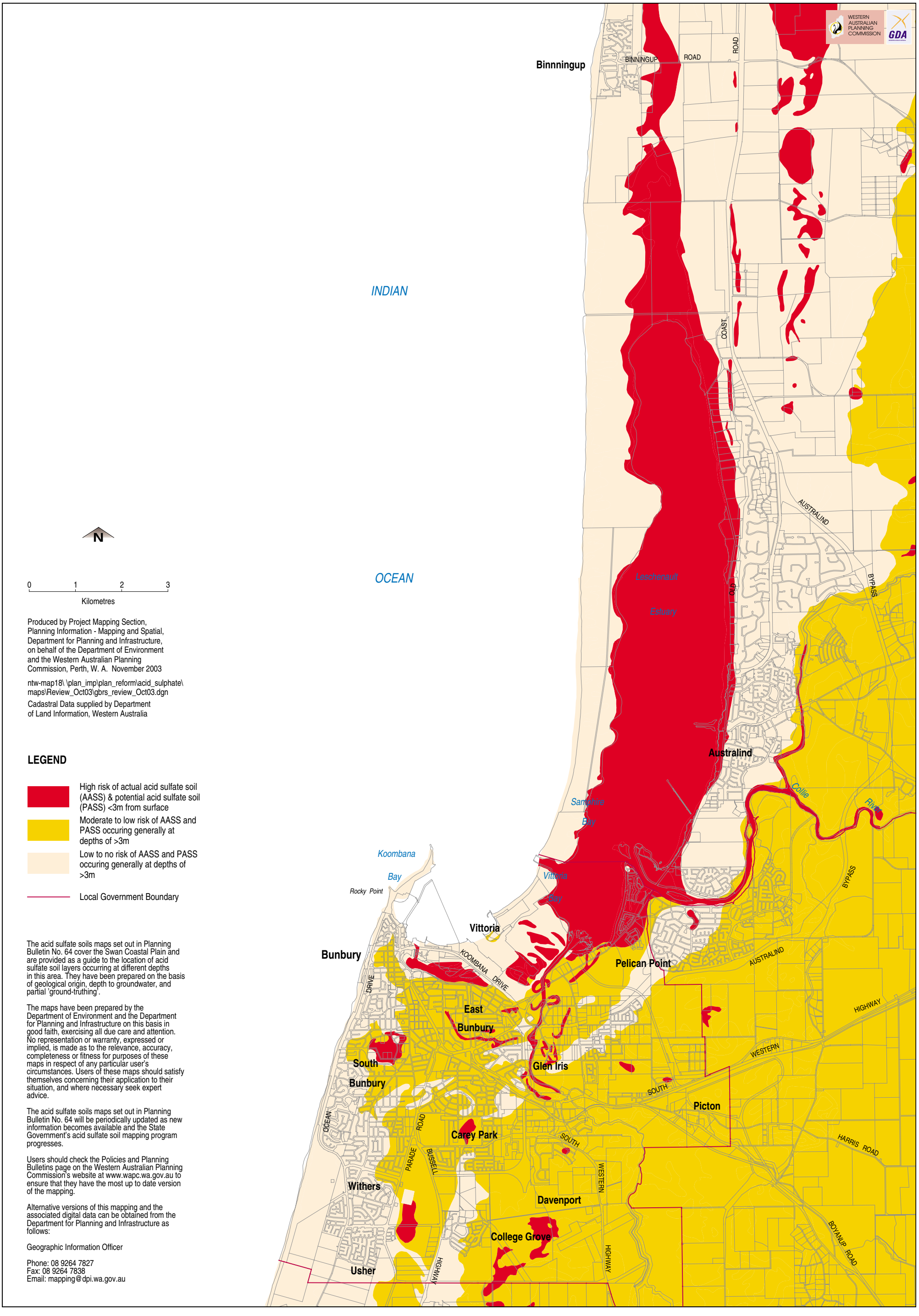
Department of Environment and Conservation (January 2009), *DRAFT Treatment and management of soils and water in acid sulphate soil landscapes*, Acid Sulphate Soils Guideline Series, Government of Western Australia.

Department of Environment and Conservation (May 2009), *Identification and Investigation of acid sulphate soils and acidic landscapes*, Acid Sulphate Soils Guideline Series, Government of Western Australia.

Queensland Department of Natural Resources, Mines and Energy (Qld NRM&E) (June 2004), *Acid Sulphate Soils, Laboratory Methods Guidelines*, Version 2.1 – Joint project of Queensland Acid Sulphate Soils Investigation Team (QASSIT), Southern Cross University (SCU), National Committee for Acid Sulphate Soils (NatCASS), Queensland Acid Sulphate Soils Management Advisory Committee (QASSMAC) and New South Wales Acid Sulphate Soils Management Advisory Committee (ASSMAC).

Western Australian Planning Commission (November 2003), *Acid Sulfate Soils*, Planning Bulletin Number 64, Figure 8: Australind – Bunbury Acid Sulfate Soils, Western Australia.

Appendix 1
Planning Bulletin Number 64: Australind – Bunbury Acid Sulphate Soils



Produced by Project Mapping Section,
Planning Information - Mapping and Spatial,
Department for Planning and Infrastructure,
on behalf of the Department of Environment
and the Western Australian Planning
Commission, Perth, W. A. November 2003

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maps\Review_Oct03\gbrs_review_Oct03.dgn

Cadastral Data supplied by Department
of Land Information, Western Australia

LEGEND

- High risk of actual acid sulfate soil (AASS) & potential acid sulfate soil (PASS) <3m from surface
- Moderate to low risk of AASS and PASS occuring generally at depths of >3m
- Low to no risk of AASS and PASS occuring generally at depths of >3m
- Local Government Boundary

The acid sulfate soils maps set out in Planning Bulletin No. 64 cover the Swan Coastal Plain and are provided as a guide to the location of acid sulfate soil layers occurring at different depths in this area. They have been prepared on the basis of geological origin, depth to groundwater, and partial 'ground-truthing'.

The maps have been prepared by the Department of Environment and the Department for Planning and Infrastructure on this basis in good faith, exercising all due care and attention. No representation or warranty, expressed or implied, is made as to the relevance, accuracy, completeness or fitness for purposes of these maps in respect of any particular user's circumstances. Users of these maps should satisfy themselves concerning their application to their situation, and where necessary seek expert advice.

The acid sulfate soils maps set out in Planning Bulletin No. 64 will be periodically updated as new information becomes available and the State Government's acid sulfate soil mapping program progresses.

Users should check the Policies and Planning Bulletins page on the Western Australian Planning Commission's website at www.wapc.wa.gov.au to ensure that they have the most up to date version of the mapping.

Alternative versions of this mapping and the associated digital data can be obtained from the Department for Planning and Infrastructure as follows:

Geographic Information Officer

Phone: 08 9264 7827
Fax: 08 9264 7838
Email: mapping@dpi.wa.gov.au

Planning Bulletin Number 64

Figure 8: Australind - Bunbury Acid Sulfate Soils

Appendix 2
South West Chemical Services – Field Test Results

South West Chemical Services
Unit 5, 4 Mummery Cres.,
Bunbury, WA, 6230
ABN 71 111 052 218
Phone/Fax 08 9721 7170
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Email admin@swchemservices.com.au

Certificate of Analysis

Client Name:	Strategen Attn: Roger Banks		
Address:	PO Box 287, Bunbury, WA 6231		
Phone No:	9792 4797	Fax:	9792 4708
Lab No:	4918	Email:	r.banks@strategen.com.au
Date samples received:	12/05/10	Report date:	14/05/10

Sample details: 36 Soil samples collected David Dodds and Zac Cockerill from 6 bore holes drilled using a hand auger at a site near the corner Harris Rd and Martin Pelusey Rd Dardanup, WA
The site is in an area of Moderate to Low risk of ASS occurring within 3 m of the natural soil surface.
Hole 1 Location GPS coordinates 50H 0382014 6309818 depth to 0.5 m
Hole 2 Location GPS coordinates 50H 0381617 6309801 depth to 2.25 m
Hole 4 Location GPS coordinates 50H 0381856 6309461 depth to 2.25 m
Hole 5 Location GPS coordinates 50H 0381146 6309216 depth to 1.0 m
Hole 8 Location GPS coordinates 50H 0381353 6308671 depth to 1.5 m
Hole 9 Location GPS coordinates 50H 0381580 6308647 depth to 1.5 m
Samples were immediately placed on ice and transferred to refrigerated storage.
A portion of the sample was removed for Field pH (pH_f) and oxidised Field pH (pH_{fox}), the remainder has been preserved by drying for 48 hours at 85°C

Scope of Work: Acid Sulphate Soils Field Tests pH_F, pH_{FOX}, Reaction rating, Fizz test
Preservation of retained samples, Interpretation of results.

Test Methods: Acid Sulphate Soils Laboratory Methods Guidelines Version 2.1 Section H:Field Tests June 2004, Queensland Government, Natural Resources, Mines and Energy.
Draft Identification & Investigation of Acid Sulphate Soils, prepared by Land & Water Quality Branch, DoE, WA May 2006
pH tested using Eutech WP pHScan BNC with Ionode Intermediate Junction pH combination electrode IJ48F calibrated according to manufacturer's instructions.

Test Results:

The field test results were assessed using the following criteria

a) pH_f less than 4
b) pH_{fox} less than 4 and /or
c) the change in pH was greater than 2 (where the resultant pH_{fox} was less than 4) and/or
d) there was a strong reaction following addition of hydrogen peroxide

Results meeting these criteria have been highlighted.

Of the 36 samples tested, there were no samples where the pHf was 4.0 or less

Of the 36 samples there were 2 sample where the pHfox was 4 or less

Of the 36 samples there were no samples that gave a change in pH > 2 units with the pHfox <4.0

1 sample gave a High reaction with the addition of Hydrogen Peroxide, 3 samples gave an Extreme reaction with gas evolution and heat with the addition of Hydrogen Peroxide.

'Actual acid sulphate soils (AASS) are soils or sediments which contain iron sulphides and/or other sulphidic minerals that have previously undergone some oxidation to produce sulphuric acid.' (DoE 2006)

'Potential acid sulphate soils (PASS) are soils or sediments which contain iron sulphides and/or other sulphidic minerals that have not been oxidised or exposed to air.' (DoE 2006)

There appears to be a no indication of the presence Potential Acid Sulphate soils at all levels in the samples processed.
There may be an indication of Actual Acid Sulphate soils in the samples collected from Hole 2 at 250 mm depth, Hole 5 at 250 mm and 500 mm depth.

All samples are being dried at 85°C for 48 hours.

If you have any further questions relating to this report and its interpretation please telephone South West Chemical Services on 08 9721 7170

David Dodds
Dip.App.Chem. A.G.Inst.Tech
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Lab No: 4918
Hole No: Bore Hole 1
Hole Depth: 0.50 metre

Date Sampled: 12/05/10
Location: 0382014E
6309818N

Hole ID	Depth m	Soil Texture	pHf	pHfox	pHf - pHfox	Reaction	Fizz Test
				pH_{H2O2}=4.95			
1	0.25	fine dark brown sandy top soil	7.45	5.85	1.60	L	N
	0.50	orange brown fine to med grained sand	7.95	6.15	1.80	M	XX

Reaction Rating N = none L = low M = medium H = high X = extreme V = volcanic
N - no visible or audible reaction, X – slight reaction, XX – moderate reaction, XXX – high reaction, XXXX – Vigorous reaction, gas evolution, heat generation

Lab No: 4918
Hole No: Bore Hole 2
Hole Depth: 2.25 metre

Date Sampled: 12/05/10
Location: 0381617E
6309801N

Hole ID	Depth m	Soil Texture	pHf	pHfox	pHf - pHfox	Reaction	Fizz Test
				pH_{H2O2}=4.95			
2	0.25	light brown fine to medium grained sand	4.95	4.40	0.55	L	N
	0.50	light brown fine to medium grained sand	5.85	4.90	0.95	L	N
	0.75	blue/grey/green and brown sand - damp	6.75	5.05	1.70	N	N
	1.00	blue/grey/green and brown sand + gravel - damp	6.75	4.75	2.00	N	N
	1.25	blue/grey/green sand - wet	6.95	6.05	0.90	L	N
	1.50	blue/green/yellow sand - wet	7.55	6.80	0.75	L	N
	1.75	blue/green/grey sand - wet	7.65	7.95	-0.30	X	N
	2.00	blue/green/grey sand - wet	7.65	7.90	-0.25	X	N
	2.25	grey clay	6.90	7.50	-0.60	X	N

Reaction Rating N = none L = low M = medium H = high X = extreme V = volcanic
N - no visible or audible reaction, X – slight reaction, XX – moderate reaction, XXX – high reaction, XXXX – Vigorous reaction, gas evolution, heat generation

Lab No: 4918
Hole No: Bore Hole 4
Hole Depth: 2.25 metre

Date Sampled: 12/05/10
Location: 0381856E
6309461N

Hole ID	Depth m	Soil Texture	pHf	pHfox	pHf - pHfox	Reaction	Fizz Test
				pH_{H2O2}=4.95			
4	0.25	brown/yellow fine sand	7.00	5.40	1.60	L	N
	0.50	yellow fine to med grained sand	7.20	5.35	1.85	L	N
	0.75	yellow fine to med grained sand	7.30	5.30	2.00	L	N
	1.00	yellow fine to med grained sand	7.25	5.25	2.00	L	N
	1,25	yellow fine to med grained sand	7.20	5.30	1.90	N	N
	1.50	yellow fine to med grained sand	7.30	5.25	2.05	L	N
	1.75	yellow fine to med grained sand	7.40	5.25	2.15	L	N
	2.00	yellow fine to med grained sand	7.35	5.25	2.10	L	N
	2.25	yellow fine to med grained sand	7.40	5.25	2.15	L	N

Reaction Rating N = none L = low M = medium H = high X = extreme V = volcanic
N - no visible or audible reaction, X – slight reaction, XX – moderate reaction, XXX – high reaction, XXXX – Vigorous reaction, gas evolution, heat generation

Lab No: 4918
Hole No: Bore Hole 5
Hole Depth: 1.00 metre

Date Sampled: 12/05/10
Location: 0381146E
6309216N

Hole ID	Depth m	Soil Texture	pHf	pHfox	pHf - pHfox	Reaction	Fizz Test
				pH_{H2O2}=4.95			
5	0.25	dark brown silty sand	4.60	**4.00**	0.60	L	N
	0.50	brown fine to med grained sand + gravel	4.95	**3.90**	1.05	N	N
	0.75	yellow/brown fine to med grained sand + gravel - damp	5.95	5.05	0.90	L	N
	1.00	yellow/brown fine to med grained sand + gravel - damp	6.30	5.15	1.15	N	N

Reaction Rating N = none L = low M = medium H = high X = extreme V = volcanic
N - no visible or audible reaction, X – slight reaction, XX – moderate reaction, XXX – high reaction, XXXX – Vigorous reaction, gas evolution, heat generation

Lab No: 4918
Hole No: Bore Hole 8
Hole Depth: 1.50 metre

Date Sampled: 12/05/10
Location: 0381353E
6308671N

Hole ID	Depth m	Soil Texture	pHf	pHfox	pHf - pHfox	Reaction	Fizz Test
				pH_{H2O2}=4.95			
8	0.25	light brown fine – medium grained sand	5.70	4.25	1.45	L	N
	0.50	light brown fine to medium grained sand	6.55	5.50	1.05	N	N
	0.75	light brown/yellow fine to medium grained sand - damp	7.10	6.60	0.50	H	N
	1.00	brown/yellow fine – medium grained clayey sand - wet	7.40	6.95	0.45	M	N
	1.25	brown/yellow fine – medium grained clayey sand - wet	7.40	6.35	1.05	L	N
	1.50	brown/yellow/grey sand - wet	7.20	6.30	0.90	L	N

Reaction Rating N = none L = low M = medium H = high X = extreme V = volcanic
N - no visible or audible reaction, X – slight reaction, XX – moderate reaction, XXX – high reaction, XXXX – Vigorous reaction, gas evolution, heat generation

Lab No: 4918
Hole No: Bore Hole 9
Hole Depth: 1.50 metre

Date Sampled: 12/05/10
Location: 0381580E
6308647N

Hole ID	Depth m	Soil Texture	pHf	pHfox	pHf - pHfox	Reaction	Fizz Test
				pH_{H2O2}=4.95			
9	0.25	light brown/grey fine – medium grained sand	6.20	4.75	1.75	N	N
	0.50	grey/brown fine to medium grained sand	7.00	5.30	1.70	L	N
	0.75	brown fine to medium grained sand - damp	6.95	5.50	1.45	L	N
	1.00	grey/brown fine – medium grained sand - damp	6.65	5.35	1.30	N	N
	1.25	orange/brown fine – medium grained clayey sand - wet	5.70	4.50	1.20	L	X
	1.50	grey clayey sand - wet	6.50	4.75	1.75	L	N

Reaction Rating N = none L = low M = medium H = high X = extreme V = volcanic
N - no visible or audible reaction, X – slight reaction, XX – moderate reaction, XXX – high reaction, XXXX – Vigorous reaction, gas evolution, heat generation

Appendix C

Surface Runoff Modelling from DWMS

3.7.3 Pre-Development Design Flows

Internal

Estimated pre-development design flows for the 1% AEP (Annual Exceedance Probability) storm event was calculated using the XPSWMM modelling package. LiDAR and site information were used to determine the boundaries of 12 catchments for the subject land (See Figure 7). Table 3 presents the design flows from each catchment and Figure 7 shows the drainage across the subject land. A detailed assessment with refined model assumptions and inputs will be required at the LWMS and UWMP stages.

Modelling assumptions include:

- A roughness coefficient ('n') of 0.4 for pervious areas, based on land cover and high responsiveness of groundwater to rainfall.
- Catchment grade determined by LiDAR data.
- Impervious area % determined by aerial photography.
- An initial loss of 10 mm assumed for all catchments to account for initial infiltration within the catchment.
- Based on LiDAR analysis, Catchments A, B and E were found to have no outlet. Stormwater generated within these catchments is currently retained on site.
- Predevelopment modelling for Catchment L was not completed as the catchment is currently constructed to final design.

The peak 1% AEP upstream flow from the Ferguson River will be reported in the DWER's DWMP. As part of the Picton South DSP, some development is proposed within the preliminary floodplain extent shown on Figure 7. However, at the LSP stage proponents will have to demonstrate that the flood regime of the general area is not detrimentally impacted. A review of the proposed stormwater management design will need to be completed as part of any future LWMSs fronting the Ferguson River.

Catchment	Area (ha)	1% AEP Impervious Area (%)	1% AEP Design Flow (m^3/s)	Receiving Waterway	Total Flow (m^3/s)
A	15.00	No outflow from Catchment			
B	9.05				
C	13.50	15	0.129	Vindictive Main Drain	0.300
D	20.75	30	0.171		
E	19.90	No Outflow from Catchment			
F	176.80	30	1.091	Picton Main Drain	2.051
G	155.40	30	0.960		
H	41.70	50	0.744	Ferguson River	2.542
I	36.85	50	0.690		
J	17.20	30	0.622		
K	36.70	35	0.486		
L	63.70	Excluded from model as catchment is constructed to final design			
Total	606.55	-	4.893	-	4.893

Table 3: Catchment Areas and 10% and 1% AEP flow rates

External

The estimated inflow from the Preston Industrial Park (Northern Precinct), north of the South Western Hwy is 0.384 m^3/s in the peak 1% AEP storm event. The report is included in the CD of Attachments.

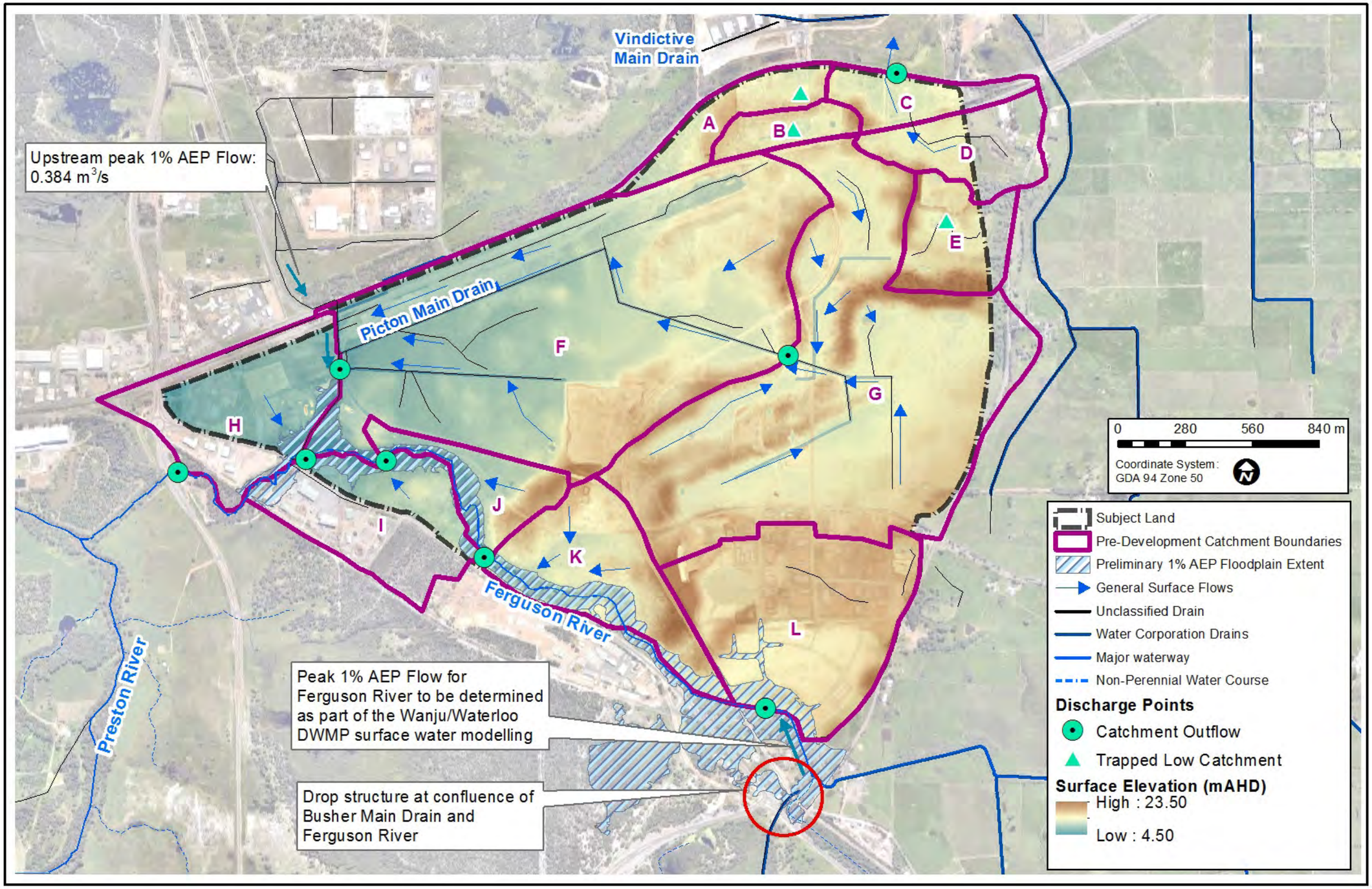


Figure 7 - Pre-Development Stormwater Modelling

4. SURFACE WATER DRAINAGE MANAGEMENT STRATEGY

The key objectives for surface water management are:

- Protection of key wetlands and waterways from the impacts of industrial runoff
- Protection of infrastructure , human life and assets from flooding and inundation

4 . 1 SURFACE WATER QUANTITY MANAGEMENT

Urbanisation results in increases impervious area. Increased rates and volumes of stormwater runoff must be managed to protect infrastructure, environment and assets from flooding and inundation. Stormwater management must also provide water treatment measures to prevent contamination of the downstream environment.

Surface water quantity design objectives are as follows:

Stormwater Flows

- Management of post-development flows to match the pre-development scenario up to the critical 1% AEP storm event.
- identified external flows to be managed within the subject land. Upstream flows within the Ferguson River will be reported with DWER's DWMP for the area. Preliminary floodplain mapping has been provided by DWER, as shown on Figure 10.
- In the post-development scenario, all trapped low catchments will merge with catchments that have an outflow connection. The peak outflow at this point will not increase as a result of the merge and will be detained to the pre-development peak 1% AEP flow rate at this point. Storages and flows across each cathcment will be sized on a pro-rata basis, determined by modelling results presented in Table 5.

Stormwater Detention and Conveyance

- A combination of detention swales and basins may be used throughout the DSP area, with outflows controlled to peak pre-development flow rates. Indicative locations are shown on Figure 10, however these may be modified or split depending on how individual lots are developed.
- The internal road network will be used to convey peak 1% AEP flows throught he subject land via overland flow, in conjunction with the pipe and swale network.
- Piped drainage within the road network will be used to convey the 10% AEP storm event.

Infrastructure Protection Measures

- Should any proportion of the proposed industrial lots be used for floodplain storage, local authorities will have to monitor and regulate surface levels as the planning process progresses.
- All finished flood levels are to be set a minimum of 300mm above the adjoining road level and flood levels generated within the LSP areas. Building pad levels are to also be a minimum 500mm above the 1% AEP flow level of the subject land's major waterways and flow channels/swales, such as the Ferguson River and Picton Main Drain.
- Industrial lots are required to retain $2m^3$ of storage per $65m^2$ of hardstand area. A piped lot connection trickle outlet may be provided to the street drainage network, with the rate of discharge assumed to be inline with maximum emptying presented in the DWER's stormwater manual, roughly 1L/s/ha. Where possible the storage area can also form part of the on lot landscaping. Local authority guidelines are provided in the CD of attachments.

Waterway and Wetland Management

- The Ferguson River consists of a small defined channel and flat surrounding floodplain with the current modelled flood extent shown on Figure 10. Final upstream peak flows within the Ferguson River will be reported in DWER's DWMP for the area.
- Modifications may be made to the Picton Main Drain and internal swale/ drainage channels, provided all modifications can be demonstrated to have no adverse impacts to the upstream or downstream environment. This may include revegetation and basic re-shaping in line with the Water Corporation's 'Drainage for livability' guidelines.
- Critical wetlands (Identified in Section 3) and the Ferguson River foreshore will be retained and rehabilitated. as part of the Picton DSP development. The extent of revegetation will be defined further in corresponding foreshore management plans. A conceptual Foreshore Management Plan has been completed and is described in Section 7.3.2.

4 . 1 . 1 Post-Development Stormwater Modelling

Indicative post-development catchment boundaries, discharge points and basin areas are shown in Figure 10. Catchment boundaries were estimated using the Picton South DSP layout, in conjunction with pre-development catchment boundaries.

Post-development modelling was completed using the XPSWMM modelling package. The peak 1% AEP allowable discharge rates presented in Table 5 were estimated based on pre-development catchment boundaries and a pro-rata analysis of interesected post-development catchments. The Columbus Drive development (Figure 10) has utilised the approved peak 1% AEP outflow rate of 0.511 m^3/s.

Indicative Detention basins for each post-development catchment were sized based on the peak 1% AEP allowable discharge rate. Subsequently the peak 10% AEP outflow rates were calculated as a result of sizing the detention storage basins.

Modelling assumptions are as follows:

- The assumed post-development land use breakdown for each catchment is 20% roads, 75% Industrial Lots and 5% drainage/ other.
- The overall peak 1% AEP flow rate has increased by 0.217 m^3/s which is wholly within the Picton Main Drain Catchment. This is due to the higher flows used within the approved Columbus Drive LWMS.
- Industrial lots are assumed to consist of 90% hardstand area.
- Industrial lots modelled with a 13.8mm initial loss, which roughly equates to $2m^3$ of storage per $65m^2$ of hardstand area.
- Roads assumed to be 90% impervious and drainage/other assumed to be 30%. Both land uses are not assumed to have an initial loss.
- Detention basins have been sized based on 1:6 side slope, 1% AEP water depth of 1.0m with the basin outlet set at the base of the basin.
- Modellling was not completed for Precinct 4 as the area has been subdivided and constructed to final design. Outflow from Precinct 4 is currently directed towards the Ferguson River and does not impact other Precincts.
- The peak 1% AEP outflow from Catchments Cat3, Cat4 and Cat5 are detained to match design inflows identified in the Lot 105 Columbus Drive LWMS of 1.16 m^3/s. This peak outflow is slightly higher than the prorata outflow identified in Section 3.

Catchment	Area (ha)	1% AEP Flow (m^3/s)	1% AEP Required Storage Volume (m^3)	10% AEP Flow (m^3/s)	10% AEP Required Volume (m^3)	Receiving Waterway	Total 1% AEP Flow (m^3/s)
Cat1	37.50	0.128	20,460	0.091	13,960	Vindictive main Drain	0.300
Cat2	21.90	0.172	11,245	0.113	8,790		
Cat3	72.80	0.473	30,985	0.457	19,665	Picton Main Drain	2.270
Cat4	45.15	0.295	22,660	0.231	15,740		
Cat5	60.05	0.391	27,565	0.362	17,470		
Cat6	63.35	0.465	As per approved Lot 105 Columbus Drive LWMS				
Cat7	22.35	0.140	10,620	0.119	7,175		
Cat8	81.65	0.506	39,170	0.433	25,725		
Cat9	47.00	0.776	12,330	0.624	7,715	Ferguson River	2.54
Cat10	18.50	0.348	4,365	0.316	2,660		
Cat11	18.35	0.342	6,900	0.309	2,430		
Cat12	15.95	0.576	8,610	0.218	2,430		
Cat13	37.90	0.502	9,225	0.445	5,260		
Cat14	63.60	Constructed to final design					

Table 5: Post-Development Stormwater Management

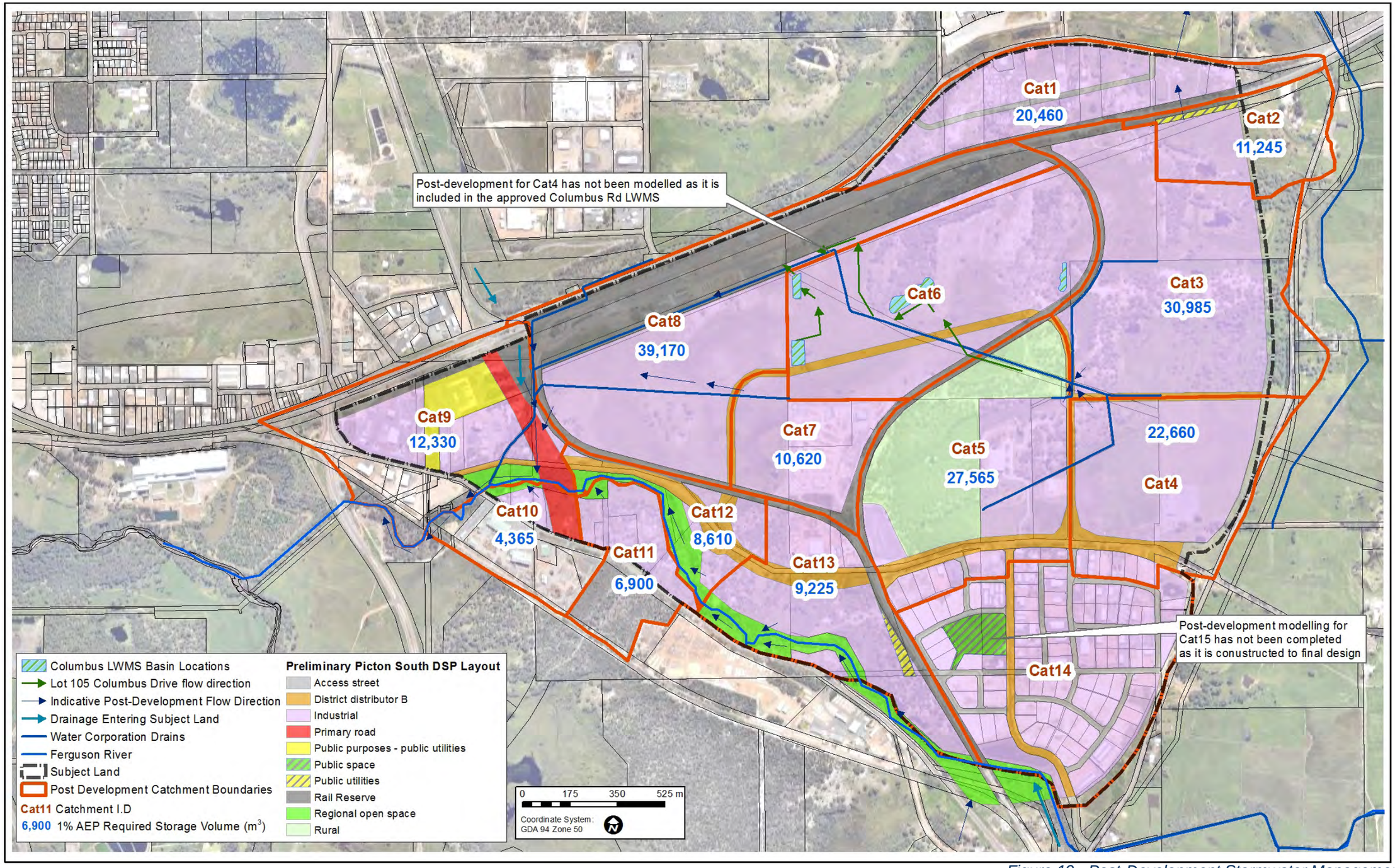


Figure 10 - Post-Development Stormwater Management

Appendix D

Lot 105 Columbas Drive, Picton East, Preliminary Servicing Strategies

LOT 105 COLUMBAS DRIVE, PICTON EAST
PRELIMINARY SERVICING STRATEGIES

DIRK VAN NOORT
CIVIL & STRUCTURAL PROJECT ENGINEER

NTRODUCTION

The subject land is located within the Preston Industrial Park presently being assessed by the Department of Planning for potential development as part of an overall structure plan for the "Southern Precinct". This report is intended to provide a preliminary overview of infrastructure requirements required to support the proposed subdivision of Lot 105 Columbas Drive. Preliminary investigations have been undertaken by the Department of Planning and it is intended that this report shall also consider the findings of those investigations.

FILLING AND DRAINAGE

Elevation of the site varies from approximately 11 metres AHD in the west to 17 metres AHD on a ridge near the eastern boundary. Much of the intermediate land is relatively flat and becomes waterlogged during the winter months. Previous use of the land has been for primary production, namely grazing.

The site is traversed by an open drain running in a westerly direction which conveys storm water into existing drainage infrastructure to the north of the site, ultimately discharging into the Preston River. This drain also provides an outlet for an upstream rural catchment of approximately 140 hectares.

It is recommended that the open drain traversing Lot 105 be replaced with a pipe drainage system following new boundaries through the proposed subdivision. It is considered that a 900mm diameter pipe shall be required to cater for the storm water runoff from the upstream rural catchment generated in a one in ten year storm event. Future development within this catchment must be required to limit its stormwater discharge to this pre existing condition.

Stormwater management within the proposed subdivision should be consistent with the water quality objectives outlined in State Planning Police 2.9 Water Resources and associated guidelines "Better Urban Water Management".

Preliminary investigations by the Department of Planning and Infrastructure identified this land as having a high water table and required to be filled in order to support the proposed industrial development. Water logging of the lower lying areas of Lot 105 was observed during the winter of 2009. Recommended fill levels required to provide sufficient separation to ground water are indicated on drawing TEE01-B-09 (1 of 2). The fill will be required to be installed with a sub soil drainage system in order to maintain ground water levels at, or close to, that which currently exists.

The mechanism of storm water management within the subdivision is detailed on drawing TEE01-B-09 (2 of 2). In general, the minor (1 in 1 year) rainfall events are entirely contained within shallow basins on site. Where roadways abut public open

space runoff from this storm event is contained within road side swales. More significant storm events (1 in 10 year) is also contained within the basins with provision for overflow into existing down stream drainage infrastructure located to the north of the site. The basins provide for overflow rates that are less than the pre-development levels.

Proposed filling of the site provides that developable areas shall be above the level of adjacent roads or public open space. Runoff generated from a major storm event (1 in 100 years) are thus conveyed along road ways or through public open space to downstream receiving waters.

Runoff from future development within the lots should be contained and recharged on site. It is usual that the local government would apply such development conditions on any future building on the lots.

ROAD NETWORK

It is anticipated that road works internal to the subdivision shall be constructed in accordance with the "Local Government Guidelines for Subdivision Development" edition 2-2009. Design in accordance with these principles should be undertaken at the time of subdivision.

Access to the site is currently provided by Columbas Drive, which links this site to the existing industrial subdivision at Harris Road.

A level crossing presently exists where Columbas Drive intersects with the railway reserve. Future control at this crossing will need to be addressed at the time of subdivision.

SEWER SERVICES

The land is located within the licence area held by the Water Corporation of Western Australia for provision of sewer services. The nearest existing sewerage infrastructure suitable to receive discharge from this development are located in Ince Road Glen Iris, approximately 5 kilometres to the west.

Should sewer services be required as a condition of the future development of this land then a sewerage pumping station will be required to be constructed in the vicinity of Lot 105. The Water Corporation at this stage have no forward planning for sewer services in this vicinity and as such it is not clear at this point exactly where the sewer pumping station would be located.

It is recommended that the Water Corporation be requested to undertake forward planning for provision of sewerage services in this vicinity as soon as possible. Detailed design of the sewer network, pumping station and pressure main will be undertaken at the time of subdivision.

WATER SERVICES

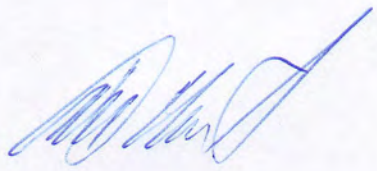
The subject land is located within the licence area held by Aqwest (Bunbury Water Board) for provision of water services. Aqwest has advised that the subdivision is serviceable from an existing 300mm diameter water main in Harris Road, approximately 800 metres to the south of the site. Detailed design of the water reticulation mains and connecting link should be undertaken at the time of subdivision.

POWER SUPPLY

The subject site is traversed by numerous overhead power lines, namely the Picton to Coolup (71) 66kV transmission line and the Picton to Worsley (81) 132kV transmission line, both located on the northern boundary. The property is also bisected by the Muja to Bunbury Harbour (81) 132kV transmission line which crosses the north western corner of the site and travels from there in a south easterly direction. Western Power have confirmed that these transmission lines may be relocated at the developers cost provided that the new alignment occurs within new gazetted road reserves or private property suitably protected by easements in favour of Western Power.

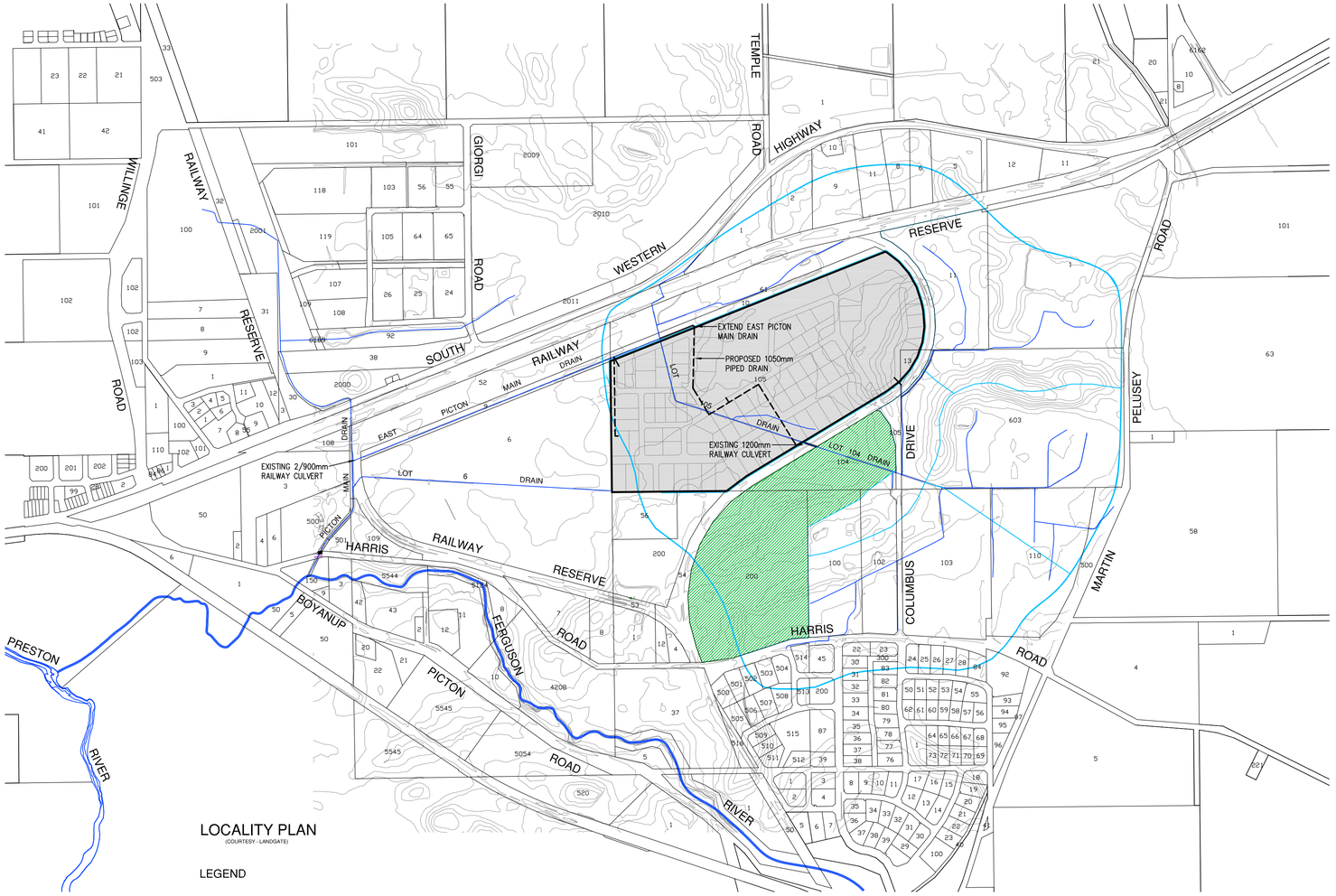
It is recommended that the Muja to Bunbury Harbour transmission line which bisects the property be relocated along the southern and western boundaries as indicated on drawing TEE01-B-09 (1 of 2). Western Power has indicated that the cost of such relocation would be in the order of $1.4 million.

Preliminary enquiries indicate that power supply for the proposed subdivision would be drawn from existing distribution lines immediately adjacent to the site. Detailed design of power supply infrastructure should be undertaken at the subdivision stage.



Dirk van Noort BE(Hons)UWA
Senior Civil Engineer

8 October 2009

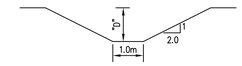


LOCALITY PLAN

(COURTESY - LANDGATE)

LEGEND

- CATCHMENT BOUNDARY – EAST PICTON MAIN DRAIN
- CATCHMENT BOUNDARY – SUB CATCHMENTS
- EXISTING OPEN DRAIN
- SUBJECT LAND
- CONSERVATION AREA



LONGITUDINAL GRADE 0.0013
DESIGN OPERATIONAL DEPTH 0.77m
CAPACITY AT DESIGN Do 1.4m³/sec
DESIGN BUNDED DEPTH 1.27m
CAPACITY AT DESIGN Db 4.4m³/sec

EAST PICTON MAIN DRAIN - DESIGN PROFILE (1984)

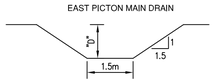
WATER CORPORATION DRAWING PWD 55383-3-1 (B)

LOCATION IMMEDIATELY U/S OF PICTON MD
CULVERT SIZE 2 x 900mm
MAXIMUM CAPACITY 4.35m³/sec

EAST PICTON MD AND CULVERT TO BE REINSTATED TO ORIGINAL DESIGN CONDITION AT THE TIME OF SUBDIVISION TO MAINTAIN DESIGN CAPACITY

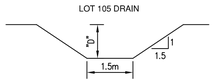
EAST PICTON MAIN DRAIN - RAILWAY CULVERT

EAST PICTON MAIN DRAIN



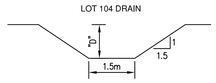
LONGITUDINAL GRADE 0.0013
MINIMUM DEPTH 1.05m
CAPACITY AT MIN "D" 2.8m³/sec

LOT 105 DRAIN



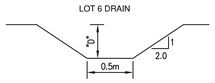
LONGITUDINAL GRADE 0.0020
MINIMUM DEPTH 0.6m
CAPACITY AT MIN "D" 1.14m³/sec

LOT 104 DRAIN



LONGITUDINAL GRADE 0.00062
MINIMUM DEPTH 0.6m
CAPACITY AT MIN "D" 0.64m³/sec

LOT 6 DRAIN



LONGITUDINAL GRADE 0.0020
MINIMUM DEPTH 0.4m
CAPACITY AT MIN "D" 0.29m³/sec

DRAIN PROFILES AS SURVEYED OCTOBER 2011

DRAINAGE OVERVIEW

EAST PICTON MAIN DRAIN WAS UPGRADED IN 1984. DESIGN DRAWINGS INDICATE A DRAIN PROFILE SHOWN ABOVE, HOWEVER SURVEYS UNDERTAKEN IN OCTOBER 2011 CONFIRM A SLIGHTLY MODIFIED PROFILE. CAPACITY OF THE DESIGN PROFILE AT THE DESIGN DEPTH OF 0.77m IS 1.4m³/sec, CAPACITY OF THE EXISTING DRAIN AT THE SAME DEPTH IS 1.5m³/sec
THE MINIMUM DEPTH OF THE DRAIN OF 1.05m OCCURS IN THE FIRST 100m. CAPACITY AT THIS DEPTH IS 2.8m³/sec.

SUBCATCHMENTS CONSIDERED IN THE ASSESSMENT OF THE DRAIN INCLUDE THE FOLLOWING AS INDICATED ON THE ADJACENT PLAN:
(1) LOT 105
(2) THE RAILWAY RESERVE AND ADJACENT AREAS NORTH OF LOT 105
(3) GRAZING AND LIGHT INDUSTRIAL AREAS TO THE SOUTH AND EAST OF LOT 105

WATER CORPORATION DESIGN CRITERIA USES A FLOW CALCULATION OF 5m³/sec PER 1000Ha AND PRODUCES THE FOLLOWING DESIGN FLOWS:

CATCHMENT	AREA	DESIGN FLOW
(1)	61Ha	0.30m³/sec
(2)	49Ha	0.25m³/sec
(3)	126Ha	0.63m³/sec
TOTAL	236Ha	1.18m³/sec

PEAK STORMWATER RUNOFF FROM THE CURRENT RURAL LAND-USE ESTIMATED FOR EACH THE SUBCATCHMENTS BASED UPON THEIR FLOW PATHS AND CRITICAL STORM DURATIONS ARE SUMMARIZED BELOW:
A RUNOFF COEFFICIENT OF 0.25 IS ASSUMED FOR THE RURAL CATCHMENTS SUBJECT TO A 1:10 YEAR ARI STORM. THE COEFFICIENT IS INCREASED BY 25% FOR THE 1:100 YEAR STORM EVENT

CATCHMENT	AREA	TRAVEL PATHS	C	T (critical)	PEAK RUNOFF (1:10yr)	PEAK RUNOFF (1:100yr)
(1)	61Ha	300m	0.25	3 HOURS	0.58m³/sec	1.07m³/sec
(2)	49Ha	300m	0.25	3 HOURS	0.46m³/sec	0.86m³/sec
(3)	126Ha	800m	0.25	8 HOURS	0.63m³/sec	1.16m³/sec

RUNOFF FLOWS FROM THE CURRENT RURAL LAND-USE AT THE POINT OF FULL CATCHMENT CONTRIBUTION BASED UPON A CRITICAL STORM DURATION OF 8 HOURS ARE ESTIMATED AT:

CATCHMENT	AREA	PEAK RUNOFF (1:10yr)	PEAK RUNOFF (1:100yr)
(1)	61Ha	0.30m³/sec	0.56m³/sec
(2)	49Ha	0.24m³/sec	0.45m³/sec
(3)	126Ha	0.63m³/sec	1.16m³/sec
TOTAL	236Ha	1.17m³/sec	2.17m³/sec

THESE RESULTS SUGGEST THAT THE WATER CORPORATION DESIGN CRITERIA REFLECTS A 1:10 YEAR STORM EVENT ON A RELATIVELY FLAT (0.1% – 0.2%) RURAL CATCHMENT.

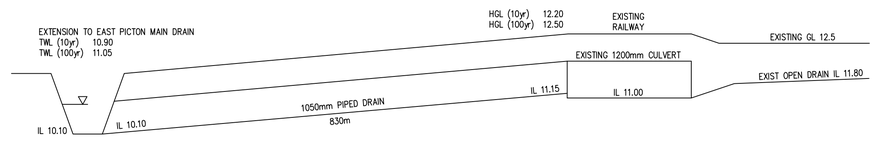
THE TOTAL ESTIMATED 1:10 YEAR RUNOFF OF 1.17m³/sec IS CONSISTENT WITH THE DESIGN CAPACITY OF THE EAST PICTON MAIN DRAIN OPERATING AT ITS DESIGN DEPTH OF 0.77m (ie 1.4m³/sec).
THE 1:10 YEAR DESIGN FLOW IN THE DRAIN TRAVERSING LOT 105 AMOUNTS TO 0.93m³/sec AND MATCHES THE CAPACITY OF THE DRAIN WHEN OPERATING AT A DESIGN DEPTH OF 0.52m.
THE 1:10 YEAR DESIGN FLOW IN THE DRAIN TRAVERSING LOT 104 AMOUNTS TO 0.63m³/sec AND MATCHES THE CAPACITY OF THE DRAIN WHEN OPERATING AT A DESIGN DEPTH OF 0.60m.
IT IS NOTED THAT FLOWS FROM EVENTS EXCEEDING THE 1:10 YEAR STORM RESULT IN OVERTOPPING OF THE DRAINS WITHIN LOTS 104 AND 105 AND LOCALIZED FLOODING IN THESE AREAS.
THE CAPACITY OF THE RAILWAY CULVERT BETWEEN LOTS 104 AND 105 IS APPROX 2.4m³/sec AND IS NOT THE CAUSE OF ANY BACK FLOODING OBSERVED WITHIN LOT 104.

THE PROPOSED DEVELOPMENT OF LOT 105 COLUMBUS DRIVE INCLUDES THE REPLACEMENT OF THE EXISTING OPEN DRAIN WITH A PIPED DRAINAGE SYSTEM. THE NEW SYSTEM IS REQUIRED TO PROVIDE TRANSMISSION OF RUNOFF FROM THE SOUTH / EAST CATCHMENT THROUGH THE DEVELOPMENT. IT IS INTENDED THAT THE EAST PICTON MAIN DRAIN BE EXTENDED EASTWARD APPROXIMATELY 130m TO CONNECT THE DOWNSTREAM END OF THE PROPOSED PIPED DRAIN. A 1050mm CONCRETE PIPE IS PROPOSED TO CONNECT THIS OPEN DRAIN TO THE EXISTING 1200mm RAILWAY CULVERT TO THE SOUTH.
THE PIPE PROVIDES A CAPACITY OF 1.05m³/sec UNDER 1:10 YEAR STORM CONDITIONS. THIS PROVIDES 25% GREATER FLOW CAPACITY TO THE UPSTREAM CATCHMENT THAN WAS AVAILABLE IN THE EXISTING OPEN DRAIN AND MITIGATES POTENTIAL FLOODING WITHIN LOT 104 UNDER THE CURRENT LAND USE ENVIRONMENT. THE INCREASED CAPACITY DOES NOT EXCEED THE CAPACITY OF THE EAST PICTON MAIN DRAIN DOWN STREAM. ASSUMING WATER LEVELS IN A 1:100 YEAR STORM EVENT ARE TO BE RESTRICTED TO 300mm BELOW THE RAILWAY, THE SYSTEM CAPACITY UNDER THESE CONDITIONS IS EXTENDED TO 1.25m³/sec.

RECENT SURVEYS OF THE EAST PICTON MAIN DRAIN INDICATE A MAXIMUM CAPACITY OF 2.3m³/sec. WHEN OPERATING AT A DEPTH OF 0.95m. (100mm FREE BOARD). PEAK OUTLET FLOWS FROM THE THREE CATCHMENTS, INCLUDING FULL DEVELOPMENT OF LOT 105 ARE ESTIMATED AS FOLLOWS:

CATCHMENT	ESTIMATED 10 YR DISCHARGE	ESTIMATED 100 YR DISCHARGE
(1)	0.30m³/sec	0.51m³/sec
(2)	0.24m³/sec	0.45m³/sec
(3)	0.63m³/sec	1.16m³/sec
TOTAL	1.17m³/sec	2.12m³/sec

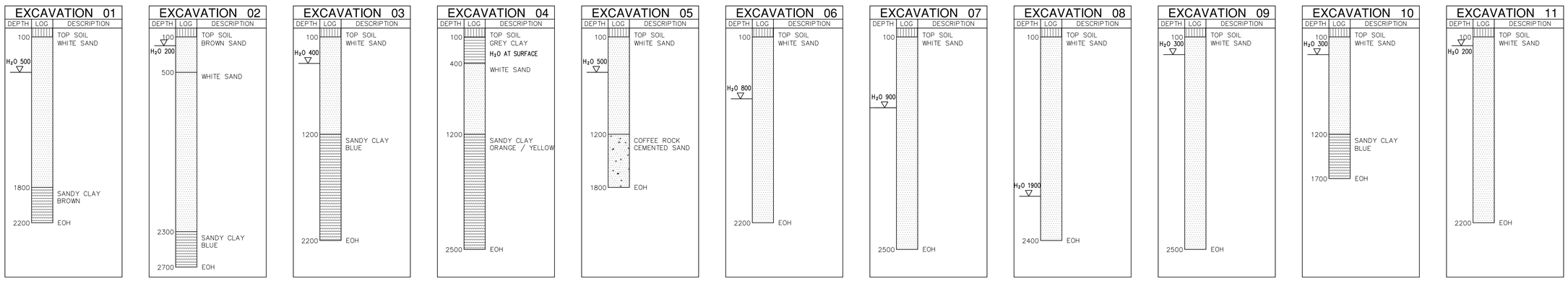
THE STORAGE REQUIRED TO ACHIEVE THE FLOW RESTRICTIONS FROM CATCHMENT 1 (LOT 105) ARE DETAILED ON SHEETS 2 AND 3. IT IS NOT ANTICIPATED THAT FURTHER DEVELOPMENT WILL OCCUR WITHIN CATCHMENT 2 AND THIS CATCHMENT WILL CONTINUE TO DISCHARGE UNDER ITS CURRENT CONDITIONS. CATCHMENT 3 WILL CONTINUE TO BECOME PARTIALLY INNUNDATED DURING STORM EVENTS EXCEEDING THE 1:10 YEAR ARI AS THE EXISTING OPEN DRAINS IN THIS CATCHMENT ARE NOT SUFFICIENT TO CARRY THESE FLOWS. FUTURE DEVELOPMENT WITHIN CATCHMENT 3 WILL REQUIRE FILLING AND CONSTRUCTION OF DETENTION BASINS TO CONTROL PEAK OUTFLOW SIMILAR TO THAT PROPOSED FOR LOT 105.



PROPOSED 1050mm TRANSMISSION PIPELINE THROUGH LOT 105

GEOTECHNICAL PIT LOGS - 22 SEPTEMBER 2011

(REFER TEST PIT LOCATIONS - SHEET 2)



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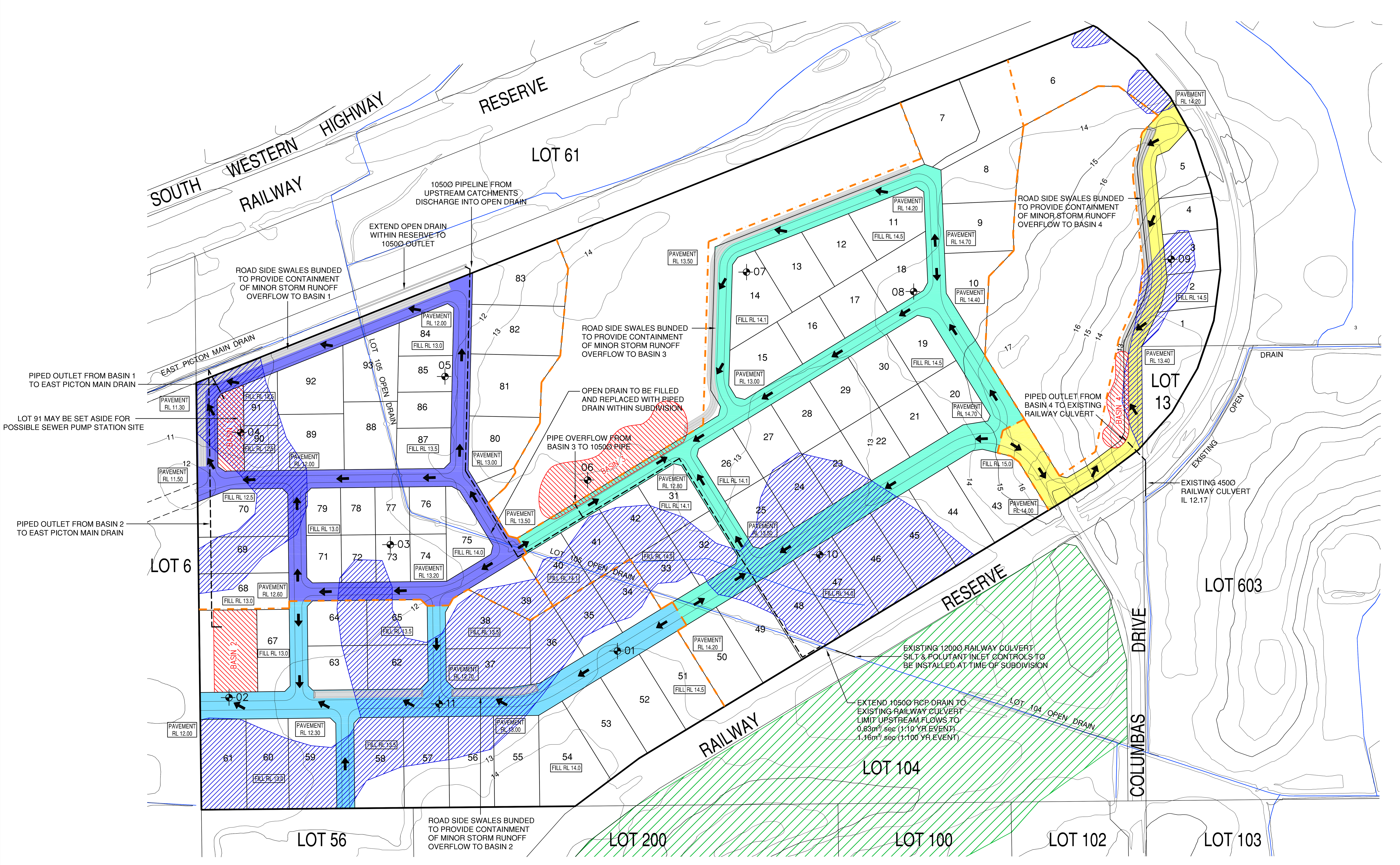
C. W. TEEDE

PROJECT No	TEE01-B-11
SHEET	1 OF 3
REVISION	D
LOCAL AUTHORITY	SHIRE OF DARDANUP
SCALE	1 : 10,000 AT A1
DATUM	AHD

REVISION DATE	No	REVISION DESCRIPTION	DESIGN	DRAWN	CHECKED	APPROVED
23 SEPTEMBER 2009	0	PRELIMINARY – NOT FOR CONSTRUCTION	DVN	DVN	DVN	
3 FEBRUARY 2010	A	ROAD HIERARCHY AMENDED	DVN	DVN	DVN	
23 SEPTEMBER 2011	B	LWMS DETAILS ADDED	DVN	DVN	DVN	
11 NOVEMBER 2011	C	DoW – REVISED SUBMISSION	DVN	DVN	DVN	
8 FEBRUARY 2012	D	DoW – REVISED SUBMISSION	DVN	DVN	DVN	

PROJECT
PROPOSED SUBDIVISION
LOT 105 COLUMBAS DRIVE PICTON

DRAWING TITLE
DRAINAGE OVERVIEW



LOCAL WATER MANAGEMENT STRATEGY

PLANNING BACKGROUND

AT ITS MEETING OF 3 NOVEMBER 2010 THE SHIRE OF DARDANUP COUNCIL RESOLVED TO INITIATE PROPOSED AMENDMENT NO. 174 TO ITS TOWN PLANNING SCHEME, WHICH INCLUDED THE PROPOSED REZONING OF LOT 105 FROM "RESTRICTED USE" ZONE TO "DEVELOPMENT" ZONE THEREBY PROVIDING A REQUIREMENT TO PROGRESS STRUCTURE PLANNING OVER THE SITE FOR FUTURE INDUSTRIAL SUBDIVISION AND DEVELOPMENT.

THE AMENDMENT WAS REFERRED TO THE EPA FOR ITS REVIEW, PURSUANT TO CLAUSE 81 OF THE PLANNING AND DEVELOPMENT ACT 2005. THE EPA RESOLVED ON 11 APRIL 2011 UNDER SECTION 48A(1)(A) OF THE ENVIRONMENTAL PROTECTION ACT 1985, THAT IT CONSIDERED THE AMENDMENT SHOULD NOT BE ASSESSED UNDER THE ACT AND PROVIDED ADVICE REQUIRING PROVISIONS BE INCLUDED IN THE SCHEME TEXT TO ADDRESS ENVIRONMENTAL ISSUES ASSOCIATED WITH PROTECTING REMNANT VEGETATION AND FAUNA. THE PROPOSAL WAS SUBSEQUENTLY RELEASED FOR PUBLIC ADVERTISING AND APART FROM COMMENTS RECEIVED BY THE DEPARTMENT OF WATER REGARDING THE REQUIREMENT TO PROVIDE A LWMS, NO OTHER SIGNIFICANT MATTERS WERE RAISED.

PREVIOUS STUDIES

NO DISTRICT WATER MANAGEMENT STRATEGY HAS BEEN PREPARED FOR THIS CATCHMENT.

CONNELL WAGNER PTY LTD ON BEHALF OF THE DEPARTMENT OF PLANNING HAVE UNDERTAKEN A GENERAL LAND CAPABILITY STUDY FOR THE PRESTON INDUSTRIAL PARK. LOT 105 FALLS WITHIN THE SCOPE OF THAT STUDY AND IS IDENTIFIED TO BE CONSTRAINED BY VEGETATION PROTECTION AREAS COVERING PART OF THE PROPERTY AND HIGH GROUND WATER LEVELS EFFECTING A LARGE PART OF THE REMAINDER. OUT SIDE OF THE VEGETATION PROTECTION AREAS, DEVELOPMENT OF THE SITE WILL REQUIRE FILLING TO PROVIDE SUFFICIENT SEPARATION TO GROUND WATER.

PROPOSED DEVELOPMENT

CURRENT LAND USE WITHIN THE SITE IS AGRICULTURAL, IN PARTICULAR GRAZING LAND. THE PROPOSED REZONING OF THIS LAND IS INTENDED TO AMEND THIS LAND USE TO LIGHT INDUSTRIAL, WITH PROTECTED VEGETATION AREAS BEING ENCOMPASED WITHIN PUBLIC OPEN SPACE. IT IS NOT INTENDED THAT ANY IMPROVEMENTS (RETICULATION ETC) BE MADE WITHIN THE P.O.S. WHICH IS PREDOMINANTLY COVERED WITH NATURAL VEGETATION.

DESIGN CRITERIA

THIS STRATEGY HAS BEEN PREPARED TO PROVIDE A FRAMEWORK OF TECHNIQUES AIMED AT ACHIEVING THE WATER QUALITY OBJECTIVES OUTLINED IN STATE PLANNING POLICY 2.9 "WATER RESOURCES" AND ASSOCIATED GUIDELINES "BETTER URBAN WATER MANAGEMENT".

WATER SUSTAINABILITY

POTABLE WATER SUPPLY

THE SITE IS LOCATED WITHIN THE WATER SUPPLY LICENSE AREA CURRENTLY HELD BY AQWEST (BUNBURY WATER BOARD). AQWEST HAS ADVISED THAT THE SITE CAN BE SUPPLIED FROM AN EXISTING 300mm WATER MAIN IN HARRIS ROAD. WATER INTENSIVE INDUSTRIES WILL NEED TO CONFIRM CAPACITY WITH AQWEST PRIOR TO ESTABLISHMENT. THE DEVELOPER SHALL PAY ALL COSTS ASSOCIATED WITH THE SUPPLY OF CONSTRUCTION WATER AT THE TIME OF SUBDIVISION.

WASTE WATER DISPOSAL

THE SUBJECT SITE IS LOCATED APPROXIMATELY 5.0km FROM THE NEAREST SEWER NETWORK OPERATED BY THE WATER CORPORATION OF WA. CONNECTION TO THIS SERVICE WOULD REQUIRE CONSTRUCTION OF A SEWERAGE PUMPING STATION AND PRESSURE MAIN.

LOTS PROPOSED WITHIN THE SUBDIVISION VARY IN SIZE FROM $2500m^2$ TO 1.5Ha. ALTHOUGH THE SITE IS PRESENTLY SUBJECT TO HIGH GROUND WATER LEVELS, THE PROJECT INCLUDES SUBSTANTIAL FILLING AND PROVISION OF SUBSOIL DRAINAGE INFRASTRUCTURE WHICH WILL ULTIMATELY PROVIDE A MINIMUM SEPARATION TO GROUND WATER OF 1.2m. UNDER THESE CIRCUMSTANCES, ON SITE DISPOSAL OF WASTE WATER BY APPROVED ALTERNATE TREATMENT UNITS WITH SOIL IMPROVEMENT IS VIABLE.

THE WATER CORPORATION HAS ADVISED THAT IT PREFERS NOT TO PROVIDE A SEWER SERVICE TO INDUSTRIAL SITES WHERE POSSIBLE. SHOULD A SEWER SERVICE BE DETERMINED NECESSARY FOR THE SUBDIVISION TO PROCEED, A TEMPORARY SEWERAGE PUMPING STATION COULD BE CONSTRUCTED ON LOT 91 AT THE NORTH WESTERN CORNER OF THE SITE.

PRE DEVELOPMENT ENVIRONMENT

SITE DESCRIPTION

THE NATURAL LANDFORM WITHIN THE SUBJECT SITE RISES GRADUALLY FROM AN ELEVATION OF 11m AHD IN THE NORTH WEST TO 14m AHD IN THE SOUTH EAST. A RIDGE EXTENDING TO RL 17.1m OCCURS IMMEDIATELY INSIDE THE EASTERN BOUNDARY. GEOTECHNICAL EXCAVATIONS ACROSS THE SITE IDENTIFY A SAND SURFACE LAYER TO A MINIMUM DEPTH OF 1.2m. THE DEPTH OF SAND INCREASES IN THE MORE ELEVATED VEGETATED AREAS TO THE NORTH AND EAST TO A MINIMUM OF 2.5m. THE SAND IS GENERALLY UNDERLAIN BY A TIGHT SANDY CLAY LAYER WHICH EFFECTIVELY PERCHES GROUND WATER DURING THE WINTER MONTHS. ONLY IN A LOW LYING ISOLATED AREA IN THE NORTH WESTERN CORNER OF THE SITE WAS THE SAND OVERLAIN BY A HEAVY CLAY SURFACE LAYER.

THE PERCHED WATER TABLE RESULTS IN SEASONAL INUNDATION OF THE LOW LYING AREAS OF THE SITE DURING THE WINTER MONTHS, THE CONTROL OF WHICH REPRESENTS A SIGNIFICANT DESIGN CONSIDERATION FOR FUTURE DEVELOPMENT. AS THE PERCHED GROUND WATER INTERSECTS THE GROUND SURFACE EACH WINTER, NO GROUND WATER MONITORING BORES HAVE BEEN INSTALLED. GROUND WATER LEVELS BENEATH THE MORE ELEVATED PARTS OF THE SITE HAVE BEEN INDENTIFIED IN THE GEOTECHNICAL BORE LOGS AND ARE GENERALLY CONSISTENT WITH THE OBSERVED SURFACE WATER LEVES ON ADJACENT LOWER GROUND.

SURFACE DRAINAGE

APPROXIMATELY NINTY FIVE PERCENT OF THE SUBJECT LAND IS DRAINED BY AN OPEN WATER CORPORATION DRAIN WHICH SERVICES A PREDOMINANTLY RURAL CATCHMENT TO THE SOUTH AND EAST AND TRAVERSES THE PROPERTY IN A NORTH WESTERLY DIRECTION. THE DRAIN ENTERS THE EAST PICTON MAIN DRAIN WHICH CONTINUES WESTERLY FOR APPROXIMATELY 1.8km WHERE IT DISCHARGES TO THE FERGUSON RIVER. (REFER DRAINAGE OVERVIEW AT SHEET 1). LOT 105 IS NOT LOCATED WITHIN THE FLOODWAY OR FLOOD FRINGE OF THE FERGUSON RIVER. THE REMAINDER OF THE PROPERTY, COMPRISING THE SOUTH WESTERN CORNER, DRAINS VIA A TRIBUTARY TO THE PICTON MAIN DRAIN WITHIN LOT 6 HARRIS ROAD. IT IS PROPOSED TO DIVERT THIS FLOW TO THE EAST PICTON MAIN DRAIN.

THE WATER CORPORATION HAS ADVISED THAT THEY HAVE NO OBJECTION TO THEIR DRAINAGE NETWORK SERVICING THE PROPOSED INDUSTRIAL DEVELOPMENT PROVIDED THAT THE INTEGRITY OF THE SYSTEM IS MAINTAINED AND THE PROPOSAL DOES NOT CREAT FLOODING EITHER UPSTREAM OR DOWNSTREAM OF THE DEVELOPMENT. THE CORPORATION HAS HOWEVER ADVISED THAT THEY WOULD ONLY CONTINUE TO MAINTAIN DRAINS THAT REMAINED SUBSTANTIALLY RURAL IN NATURE. IN PARTICULAR, THEY WOULD NOT ASSUME OWNERSHIP OF THE PROPOSED 1050mm TRANSMISSION DRAIN OR EXTENSION OF THE EAST PICTOM MAIN DRAIN REQUIRED TO CONNECT IT. THE CORPORATION WILL REQUIRE THE LOCAL AUTHORITY TO TAKE RESPONSIBILITY FOR THIS INFRASTRUCTURE. THE REMAINING OPEN DRAINS WOULD CONTINUE TO BE OPERATED BY THE WATER CORPORATION WHILST ANY PART OF THEIR CATCHMENT REMAINED RURAL.

GROUND WATER

THE SITE HAS BEEN IDENTIFIED BY PREVIOUS STUDIES (CONNELL WAGNER) TO BE SUBJECT TO HIGH GROUND WATER LEVELS. INSPECTION OF THE SITE DURING THE WINTERS OF 2009 AND 2011 CONFIRMED INUNDATION OF THE GROUND SURFACE IN THE AREAS INDICATED. GEOTECHNICAL EXCAVATIONS UNDERTAKEN ON 22 SEPTEMBER 2011 CONCLUDED THAT THE INUNDATION WAS PERCHED ABOVE A FIRM SANDY CLAY SUB STRATUM APPROXIMATELY 1.2m BENEATH THE SURFACE.

ACID SULFATE SOILS

ACID SULFATE SOIL RISK MAPS PROVIDED BY THE DEPARTMENT OF ENVIRONMENT AND CONSERVATION (SEE ATTACHED PLAN) INDICATE THE SITE TO BE AT MODERATE TO LOW RISK OF ACID SULFATE SOILS WITHIN 3m OF THE SOIL SURFACE. ASSESSMENT IN ACCORDANCE WITH W.A.P.C. "ACID SULFATE SOILS – SELF ASSESSMENT FORM" AND D.E.C. DOCUMENT "IDENTIFICATION AND INVESTIGATION OF ACID SULFATE SOILS AND ACIDIC LANDSCAPES" SHOULD BE UNDERTAKEN AT THE TIME OF SUBDIVISION.

ENVIRONMANTAL WATER COURSES

NO WATER BODY OF ENVIRONMENTAL SIGNIFICANCE EXISTS ON THE SITE.

STORMWATER MANAGEMENT STRATEGY

UPSTREAM CATCHMENT

THE SUBJECT SITE IS LOCATED WITHIN A PREDOMINANTLY RURAL CATCHMENT. THE WATER CORPORATION DRAIN THAT TRAVERSES THE SITE ALSO PROVIDES A DRAINAGE OUTLET FOR AN UPSTREAM SUB-CATCHMENT OF APPROXIMATELY 126Ha. PEAK 1 IN 10 YEAR INFLOW FROM THIS AREA IS ESTIMATED TO BE 630l/s. DEVELOPMENT OF LOT 105 IS TO MAINTAIN THIS OUTLET CAPACITY VIA AN INDEPENDENTLY PIPED SYSTEM THAT TRAVERSES THE LOT TO EXISTING DOWNSTREAM INFRASTRUCTURE. ALTHOUGH THIS CREATS A SMALL BREAK IN THE TREATMENT TRAIN, IT IS PROPOSED IN ORDER THAT THE WATER QUALITY TREATMENT FACILITIES CONSTRUCTED WITHIN LOT 105 ARE DEDICATED WHOLY TO STORMWATER CREATED AT THIS SITE AND NOT DILUTED BY INCOMMING FLOWS. DOWNSTREAM INFRASTRUCTURE IS LOCATED WITHIN PUBLIC LAND WHERE A CONTINUOUS TRAIN OF WATER QUALITY TREATMENT IS POSSIBLE. DEVELOPMENT WITHIN THE UPSTREAM CATCHMENT WILL BE REQUIRED TO LIMIT ITS DRAINAGE OUTFLOW AS DETAILED IN THE OVERVIEW AT SHEET 1 AND TO MANAGE WATER QUALITY TO AN ACCEPTABLE STANDARD PRIOR TO DISCHARGE.

DOWNSTREAM CATCHMENTS

RUNOFF FROM THE PROPOSED DEVELOPMENT WILL DISCHARGE TO TWO LOWER CATCHMENTS. BASINS 1 2 AND 3 OUTLET TO THE EAST PICTON MAIN DRAIN, WHILST BASIN 4 OUTLETS TO A TRIBUTARY TO THE MAIN DRAIN IN LOT 603. PEAK PRE AND POST DEVELOPMENT FLOWS (m^3/sec) ARE SUMMARIZED BELOW:

BASIN	1:10 YEAR EVENT		1:100 YEAR EVENT	
	PRE	POST	PRE	POST
1 2 3	0.53	0.270	0.98	0.465
4	0.05	0.030	0.09	0.046

EAST PICTON MAIN DRAIN AND CULVERT STRUCTURES ARE TO BE REINSTATED TO ORIGINAL DESIGN CONDITION AT SUBDIVISION TO MAINTAIN DESIGN CAPACITY.

DRAINAGE OF PRIVATE LAND

STORMWATER RUNOFF WITHIN FUTURE DEVELOPMENTS SHALL BE RETAINED AND RECHARGED ON SITE VIA A SYSTEM OF RAIN GARDENS, SOAK WELLS AND BASINS INSTALLED IN ACCORDANCE WITH THE REQUIREMENTS OF THE LOCAL GOVERNMENT. ADOPTING A 1% FALL TOWARD SOAK WELLS IN HARDSTAND AREAS RESULTS IN MINOR PONDING ABOVE THE PAVEMENT PRIOR TO OVERFLOW VIA THE CROSSOVER DURING EVENTS THAT EXCEED THE "ON SITE" STORAGE CAPACITY. AN INFILTRATION RATE OF 432mm PER DAY HAS BEEN ASSUMED (ALLOWING FOR PARTIAL BLOCKAGE OF THE SOAK WELLS), WHICH RESULTS IN POTENTIAL OVERFLOW OF $362m^3$ PER HECTARE DURING A 1:10 YEAR ARI STORM EVENT AND $810m^3$ PER HECTARE DURING A 1:100 YEAR EVENT. ROAD PAVEMENTS ARE SET LOWER THAN THE ADJACENT LOT AND OVERFLOW FROM THESE EVENTS WILL ENTER THE ROAD RESERVE TO BE DIRECTED TOWARD AND RETAINED IN DETENTION BASINS AT THE LOWER END OF THE CATCHMENT. GROUND WATER CONTROL IS PROPOSED TO MAINTAIN A MINIMUM DEPTH TO GROUND WATER OF 1.2m (REFER GROUND WATER NOTES BELOW). THE MAXIMUM DEPTH OF SOAK WELLS SHOULD THEREFORE BE LIMITED TO 900mm.

DRAINAGE OF PUBLIC LAND

ROAD RESERVES WITHIN THE PROPOSED DEVELOPMENT ARE DIVIDED INTO THE SUBCATCHMENTS INDICATED ON THE ADJACENT PLAN AND DRAINED VIA THE SYSTEM OF SWALES AND BASINS TO THE EXISTING DOWNSTREAM INFRASTRUCTURE. TREATMENT OF THE VARIOUS STORM EVENTS IS DESCRIBED BELOW AND QUANTIFIED IN THE ADJACENT TABLES:

1:1 YEAR STORM EVENT

THE TREATMENT OF INITIAL RUNOFF FROM THE CRITICAL 1:1 YEAR STORM EVENT SHALL EMULATE THE CURRENT SYSTEM OF SLOW MIGRATION TOWARD THE EXISTING DRAINAGE INFRASTRUCTURE BY HOLDING RUN OFF WITHIN TREE PITS, ROAD SIDE SWALES AND BUNDED AREAS OF DETENTION BASINS. RUNOFF FROM MINOR STORMS SHALL BE ENTIRELY CONTAINED WITHIN THESE FACILITIES. PROVISION SHALL BE PROVIDED TO FULLY DRAIN THE BASINS TO PREVENT LONG TERM PONDING. DETAILS OF VEGETATION AND OTHER TREATMENTS SHALL BE ESTABLISHED AT SUBDIVISION STAGE.

1:10 YEAR STORM EVENT

RUNOFF FROM SIGNIFICANT STORM EVENTS (1 IN 10 YEAR ARI) INITIALLY FILL THE SWALES AND BASINS CONSTRUCTED TO CONTAIN MINOR STORM RUNOFF. THESE STRUCTURES FACILITATE ONGOING ENTRAPMENT AND SOAKAGE FOR THE DURATION OF THE STORM, THUS REDUCING NET RUNOFF INTO DETENTION BASINS LOCATED AT THE LOWER REACHES OF THE CATCHMENT (CALCULATIONS ASSUME NO SOAKAGE FROM THE DETENTION BASINS). OUTLETS FROM THE DETENTION BASINS ARE CONTROLLED TO LIMIT THE PEAK DISCHARGE FLOW TO RATES APPROPRIATE FOR DOWNSTREAM INFRASTRUCTURE AND THE BASIN SIZED TO PROVIDE SUFFICIENT STORAGE REQUIRED AS A RESULT OF THE DELAYED OUTFALL.

1:100 YEAR STORM EVENT

LOT FILLING INSTALLED TO THE LEVELS INDICATED ON THE ADJACENT PLAN ENSURE THAT PROPOSED BUILDING AREAS ARE LOCATED ABOVE ADJACENT ROAD WAYS AND THAT RUNOFF FROM MAJOR STORM EVENTS (1:100 YEAR ARI) IS RETAINED WITHIN ROAD RESERVES AND DIRECTED TOWARD DETENTION BASINS AT THE LOWER REACHES OF THE CATCHMENT. SIMILAR TO THE 1:10 YEAR SCENARIO, ENTRAPMENT OF RUNOFF IN SWALES WITHIN THE ROAD RESERVES AND STORAGE SYSTEMS WITHIN THE DEVELOPED LOTS FACILITATES ONGOING SOAKAGE FOR THE DURATION OF THE STORM, THUS REDUCING NET RUNOFF INTO DETENTION BASINS LOCATED AT THE LOWER REACHES OF THE CATCHMENT. SIMILARLY, THE DETENTION BASIN OUTLET STRUCTURES CONTROL THE PEAK DISCHARGE FLOW TO RATES APPROPRIATE FOR DOWNSTREAM INFRASTRUCTURE AND THE BASIN IS SIZED TO PROVIDE SUFFICIENT STORAGE REQUIRED AS A RESULT.

SEDIMENT CONTROL

THE CONTROL OF SEDIMENTS AND PREVENTION OF IT ENTERING DOWNSTREAM WATER COURSES THROUGH THE NEW DRAINAGE SYSTEM SHALL BE MANAGED VIA THE DRAINAGE STRUCTURES, SWALES AND BASINS INTEGRATED INTO THE DRAINAGE NETWORK. ALL ARE READILY ACCESSABLE AND MAY REQUIRE PERIODIC CLEANING DURING THE EARLY STAGES OF DEVELOPMENT.

GROUND WATER MANAGEMENT STRATEGY

NATURAL SOILS AT THE SITE COMPRISE SAND TO A MINIMUM DEPTH OF 1200mm OVERLYING A SANDY CLAY BASE. EXCAVATIONS IN THE ELEVATED AREAS OF THE SITE CONFIRMED A SAND DEPTH IN EXCESS OF 2.5m WITH A GROUND WATER LEVEL CONSISTENT WITH THE SURFACE INUNDATION OF THE LOWER LAND IMMEDIATELY ADJACENT. THE FLATTER, LOWER LAND IN THE VICINITY OF THE WATER CORPORATION DRAINS PRODUCED GROUND WATER DEPTHS OF 200–300mm, CONFIRMING A GROUND WATER GRADIENT FALLING TOWARD THESE DRAINS. IT IS APPARENT THAT THIS GRADIENT FLATTENS SIGNIFICANTLY DURING THE SUMMER.

IT IS PROPOSED THAT THE LOTS BE FILLED SUFFICIENTLY TO FACILITATE THE EFFECTIVE OPERATION OF A SUB SOIL DRAINAGE SYSTEM. THE SUBSOIL DRAINAGE SYSTEM FOR EACH LOT IS TO BE CONNECTED DIRECTLY TO THE ADJACENT ROAD SIDE DRAINAGE SYSTEM AND NOT TRAVERSE NEIGHBOURING PRIVATE LAND. IN DOING SO, THE SUBSOIL DRAINS WILL PROVIDE A DRAINAGE FUNCTION ONLY FOR THE PROPERTY IN WHICH THEY ARE SITUATED AND THERE IS NO REQUIREMENT FOR THEM TO BE PROTECTED BY EASEMENTS, THUS REDUCING POTENTIAL RESTRICTION ON FUTURE DEVELOPMENT. DETAILED DESIGN OF THE SUBSOIL DRAINAGE SYSTEM SHALL BE UNDERTAKEN AT SUBDIVISION STAGE. DRAINS ARE TO BE INSTALLED IN A CONFIGURATION SUCH THAT GROUND WATER BENEATH EACH LOT IS LIMITED TO A MINIMUM DEPTH OF 1.2m DURING A 1:10 YEAR STORM EVENT AND ACHIEVE THIS INDEPENDENTLY OF THE EFFECTS OF DRAINS IN NEIGHBOURING LOTS.

PRELIMINARY INVESTIGATIONS APPLYING RESERCH FINDINGS BY BOUWER & SCHILFGAARDE INDICATE THAT, IN THE WORST CASE SCENARION FOR THIS SITE, FILLING 1.4m ABOVE EXISTING GROUND LEVELS AND INSTALLING SUBSOIL DRAINS AT 40m CENTRES AT A DEPTH 0.4m BELOW THE EXISTING SURFACE WILL PROVIDE A MAXIMUM GROUND WATER LEVEL 1.2m BENEATH THE FINISHED SURFACE. THE EFFICIENCY OF THE DRAINAGE SYSTEM (AND HENCE THE REQUIRED DRAIN SPACING) IS EFFECTED TO A LARGE DEGREE BY THE DEPTH TO THE UNDERLYING CLAY BASE. DETAILED DESIGN TO BE UNDERTAKEN AT THE TIME OF SUBDIVISION MUST TAKE INTO ACCOUNT THE VARYING SUBSTRATUM DEPTHS AND OTHER DIMENSIONAL FACTORS EFFECTING THE DESIGN.

THE SUBSOIL DRAINAGE SYSTEMS DISCHARGE INTO THE DETENTION BASINS PROVIDED IN EACH CATCHMENT. OUTLETS ARE LOCATED ABOVE THE 1:10 YEAR DEPTH FOR EACH BASIN AND ABOVE THE TOP WATER LEVELS OF THE RECEIVING WATERS, PROVIDING A CLEAR OUTLET CONDITION.

PREPARATION FOR UWMP

ADJACENT DEVELOPMENTS

MUCH OF THE SURROUNDING LAND IS ALSO PROPOSED FOR FUTURE INDUSTRIAL DEVELOPMENT AND REMAINS AT VARYING STAGES OF THE PLANNING PROCESS. WATER CORPORATION GOVERNANCE OF THE DOWNSTREAM DRAINAGE NETWORK PROVIDES SECURITY IN RESPECT TO THE STORMWATER OUTFALL AND THE PROPOSAL CAN THEREFORE PROCEED ON A STAND ALONE BASIS. CONTINUED COORDINATION THROUGH THE PLANNING PROCESS HOWEVER WILL ENSURE INTEGRATION WITH WITH ADJACENT PROPOSALS.

DETAILED DESIGN

THE LOCAL WATER MANAGEMENT STRATEGY DOES NOT IDENTIFY ANY SIGNIFICANT FLAWS IN THE PROPOSED DEVELOPMENT WITHIN THE SCOPE OF ITS STUDY. DETAILED DESIGN IN RESPECT TO FINAL ROAD AND FILL LEVELS, DRAINAGE AND SUBSOIL DRAINAGE INSTALLATION, CONSTRUCTION METHODS AND FINISHES SHOULD BE ADDRESSED BY THE UWMP AT THE TIME OF SUBDIVISION.

LEGEND

- AREAS SUBJECT TO SEASONAL INNUNDATION
- CONSERVATION AREA
- PROPOSED DRAINAGE BASIN
- PROPOSED SWALE DRAIN
- SUB CATCHMENT BOUNDARY
- EXISTING OPEN DRAINAGE
- 1050ø PIPE TO REPLACE OPEN DRAIN
- FALL OF PAVEMENT
- PAVEMENT RL 14.40 — APPROXIMATE PROPOSED PAVEMENT LEVELS
- FILL RL 14.5 — PROPOSED LOT FILL LEVELS
- 05 — GEOTECHNICAL TEST PITS – 22 SEPTEMBER 2011 REFER PIT LOG DETAILS (SHEET 1)

STORMWATER MANAGEMENT

THE MANAGEMENT OF STORMWATER RUNOFF IS CONSIDERED FOR THE THREE STORM EVENTS:

1) MINOR STORMS, HAVING A RECURRANCE INTERVAL OF 1 YEAR ARE CONTAINED ON SITE IN STRUCTURES DESIGNED TO FACILITATE ENTRAPMENT AND FULL RECHARGE TO GROUND WATER OF THIS RUNOFF.
2) SIGNIFICANT STORMS, HAVING A RECURRANCE INTERVAL OF 10 YEARS ARE MANAGED BY CONVENTIONAL STORMWATER FACILITIES DESIGNED TO CONVEY RUNOFF SAFELY TO DOWNSTREAM RECEIVING WATERS
2) MAJOR STORMS, HAVING A RECURRANCE INTERVAL OF 100 YEARS ARE CONTAINED SUCH AS TO MINIMIZE DAMAGE TO PROPERTY WHILST DIRECTING RUNOFF TO DOWNSTREAM WATERS IN A CONTROLLED FASHION

THE FOLLOWING TABLES SUMMARIZE THE MANAGEMENT METHODS PROPOSED FOR EACH EVENT AND QUANTIFY RUNOFF RATES AND VOLUMES INVOLVED.

1:1 YEAR STORM EVENTS

WHERE FEASIBLE, ROADS ARE DRAINED BY OPEN SWALES ON THE LEAST ACTIVE SIDE OF THE ROAD (IE ADJACENT P.O.S.) WITH MINOR STORM RUNOFF RETAINED BY BUNDS CONSTRUCTED ACROSS THE SWALE. (REFER DETAILS SHEET 3). OTHER PAVEMENTS ARE DRAINED BY CONVENTIONAL PIPED DRAINAGE INFRASTRUCTURE TO DETENTION BASINS AT THE LOWER END OF THE CATCHMENT WHERE THEY ARE BUNDED BEHIND THE OUTLET PIPE. THE CRITICAL ANNUAL "FLUSHING" RUNOFF OCCURS AT THE BEGINNING OF WINTER AT WHICH TIME THE BASIN FLOORS ARE DRY AND ABLE TO RECHARGE THIS FLOW TO GROUND WATER. RUNOFF WITHIN PRIVATE LAND IS CONTAINED ON SITE IN ACCORDANCE WITH THE LOCAL GOVERNMENT REQUIREMENTS.

1:1 YEAR INTENSITY = 15mm/hr (1 HOUR STORM)

CATCHMENT 1

ROAD RESERVE AREA	= 2.83Ha
VOLUME OF 15mm RAINFALL	= $424m^3$
BASIN VOL (BUNDED OUTLET)	= $286m^3$
SWALE VOLUME	= $195m^3$
TOTAL VOLUME FOR 1:1YR	= $481m^3$
SWALE AREA	= $1600m^2$
BASIN AREA	= $1905m^2$

CATCHMENT 2

ROAD RESERVE AREA	= 2.28Ha
VOLUME OF 15mm RAINFALL	= $342m^3$
BASIN VOL (BUNDED OUTLET)	= $357m^3$
SWALE VOLUME	= $172m^3$
TOTAL VOLUME FOR 1:1YR	= $529m^3$
SWALE AREA	= $1300m^2$
BASIN AREA	= $3570m^2$

CATCHMENT 3

ROAD RESERVE AREA	= 4.18Ha
VOLUME OF 15mm RAINFALL	= $627m^3$
BASIN VOL (BUNDED OUTLET)	= $693m^3$
SWALE VOLUME	= $195m^3$
TOTAL VOLUME FOR 1:1YR	= $888m^3$
SWALE AREA	= $1600m^2$
BASIN AREA	= $6930m^2$

CATCHMENT 4

ROAD RESERVE AREA	= 1.22Ha
VOLUME OF 15mm RAINFALL	= $183m^3$
BASIN VOL (BUNDED OUTLET)	= $160m^3$
SWALE VOLUME	= $98m^3$
TOTAL VOLUME FOR 1:1YR	= $258m^3$
SWALE AREA	= $800m^2$
BASIN AREA	= $1600m^2$

1:10 YEAR STORM EVENTS

SIGNIFICANT STORMS (1 IN 10 YEAR ARI) RESULT IN OVERFLOW FROM WITHIN PRIVATE LOTS, ADDING TO THE RUNOFF FROM THE ROAD RESERVES. RUNOFF FROM THESE STORM EVENTS OVER TOP THE BUNDS CONSTRUCTED WITHIN ROAD SIDE SWALES AND DETENTION BASINS AND OUTLET TO DOWN STREAM INFRASTRUCTURE.

DISCHARGE FROM THE BASINS TO EXISTING OPEN DRAINS (UNDER THE CONTROL OF THE WATER CORPORATION) IS LIMITED BY OUTLET CONTROLS SO AS NOT TO EXCEED EITHER THE PRE-SXISTING FLOW RATES OR THE CAPACITY OF THE DOWNSTREAM DRAINS. THE BASINS PROVIDE SUFFICIENT CAPACITY TO SAFELY DETAIN RUNOFF PRIOR TO DISCHARGE. DISCHARGE RATES AND WATER DEPTHS FOR THE 1 IN 10 YEAR EVENT ARE DETAILED BELOW:

BASIN	PEAK DISCHARGE (m^3/s)	WATER DEPTH (m above outlet)
1	0.092	0.461
2	0.095	0.264
3	0.083	0.356
4	0.030	0.170

THE COMBINED PEAK DISCHARGE FROM THE 4 BASINS AMOUNTS TO $0.30m^3$/sec. PRE-EXISTING FLOWS LEAVING THE UNDEVELOPED SITE ARE ESTIMATED AT $0.30m^3$/sec.

1:100 YEAR STORM EVENTS

RUNOFF FROM MAJOR STORM EVENTS (1:100 YEAR) IS DETERMINED ON THE BASIS OF THAT WHICH OVERFLOWS RETENTION FACILITIES ON DEVELOPED LOTS AND ROAD SIDE SWALES WITHIN THE ROAD RESERVES. THESE FLOWS MAKE THEIR WAY VIA THE ROAD SYSTEM TO THE RETENTION BASINS AT THE LOWER REACHES OF THE CATCHMENT WHERE THEY ARE DETAINED AND DISCHARGED TO DOWNSTREAM INFRASTRUCTURE IN A CONTROLLED MANNER. FLOW RATES ARE LIMITED BY OUTLET CONTROLS TO REMAIN WITHIN THE CAPACITY OF DOWNSTREAM INFRASTRUCTURE AND THE BASINS SIZED TO ACCOMMODATE THE DETENTION REQUIRED.

DISCHARGE RATES AND WATER DEPTHS FOR THE 1 IN 100 YEAR EVENT ARE DETAILED BELOW:

BASIN	PEAK DISCHARGE (m^3/s)	WATER DEPTH (m above outlet)
1	0.159	0.988
2	0.151	0.519
3	0.155	0.627
4	0.046	0.352

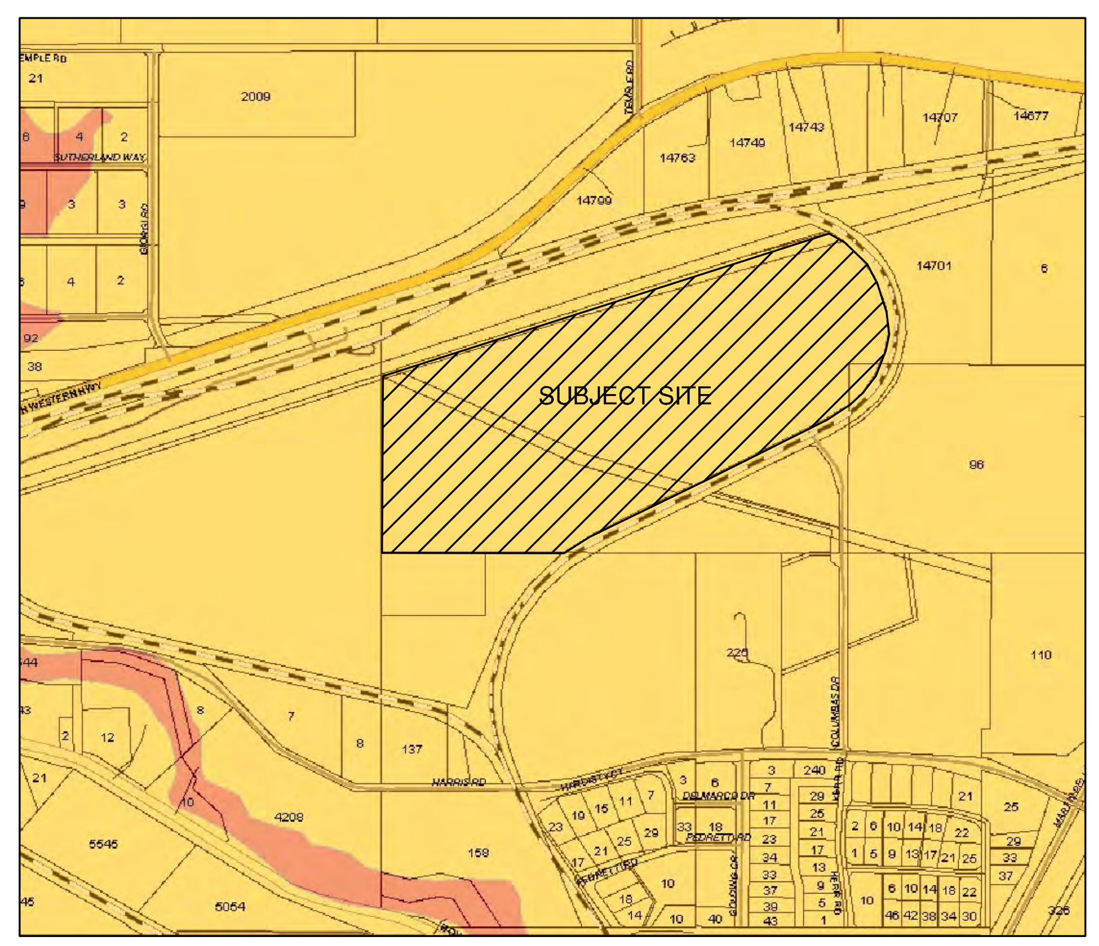
THE COMBINED PEAK DISCHARGE FROM THE 4 BASINS AMOUNTS TO $0.511m^3$/sec. PRE-EXISTING FLOWS LEAVING THE UNDEVELOPED SITE ARE ESTIMATED AT $0.56m^3$/sec.

OWNERSHIP OF DRAINAGE INFRASTRUCTURE

THE WATER CORPORATION SHALL RETAIN OWNERSHIP AND CONTROL OF THE EXISTING EAST PICTON MAIN DRAIN, THE EXISTING DRAINS WITHIN AND EAST OF LOT 104 AND THE EXISTING DRAINS WITHIN LOT 6.

THE FOLLOWING DRAINS ARE TO BE VESTED WITH THE SHIRE OF DARDANUP AS THEY ARE BEING CONSTRUCTED AS A REQUIREMENT OF URBAN DEVELOPMENT:

- THE PROPOSED EASTERLY EXTENSION OF THE OPEN DRAIN FROM THE EXISTING WATER CORPORATION EAST PICTON MAIN DRAIN TO THE DISCHARGE OF THE PROPOSED 1050 PIPED DRAIN THROUGH LOT 105 (130m).
- THE PROPOSED 1050mm TRANSMISSION DRAIN THROUGH LOT 105.
- ALL PROPOSED DRAINAGE PIPES, PITS, SWALES AND BASINS WITHIN LOT 105.



ACID SULFATE SOIL RISK MAP

COURTESY – LANDGATE (NOT TO SCALE)

- MODERATE TO LOW RISK OF ACID SULFATE SOILS WITHIN 3m OF THE SOIL SURFACE
- HIGH TO MODERATE RISK OF ACID SULFATE SOILS WITHIN 3m OF THE SOIL SURFACE

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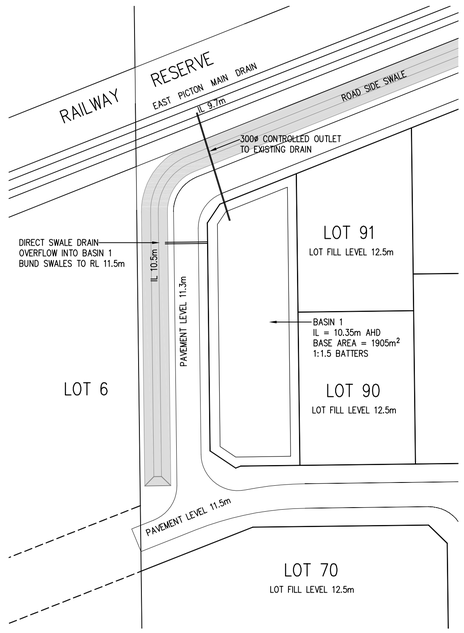
C. W. TEEDE

PROJECT No	TEE01–B–11
SHEET	2 OF 3
REVISION	D
LOCAL AUTHORITY	SHIRE OF DARDANUP
SCALE	1 : 2500 AT A1
DATUM	AHD

REVISION DATE	No	REVISION DESCRIPTION	DESIGN	DRAWN	CHECKED	APPROVED
23 SEPTEMBER 2009	0	PRELIMINARY – NOT FOR CONSTRUCTION	DVN	DVN	DVN	
3 FEBRUARY 2010	A	ROAD HIERARCHY AMENDED	DVN	DVN	DVN	
23 SEPTEMBER 2011	B	LWMS DETAILS ADDED	DVN	DVN	DVN	
11 NOVEMBER 2011	C	DoW – REVISED SUBMISSION	DVN	DVN	DVN	
8 FEBRUARY 2012	D	DoW – REVISED SUBMISSION	DVN	DVN	DVN	

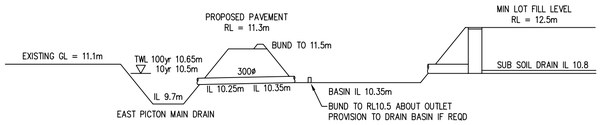
PROJECT
PROPOSED SUBDIVISION
LOT 105 COLUMBAS DRIVE PICTON

DRAWING TITLE
LOCAL WATER MANAGEMENT STRATEGY



CATCHMENTS 1A AND 1B

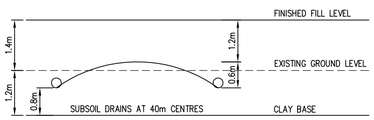
CATCHMENT AREA = 12.1Ha
RUNOFF COEFFICIENT = 0.8



DIMENSIONS - BASIN 1

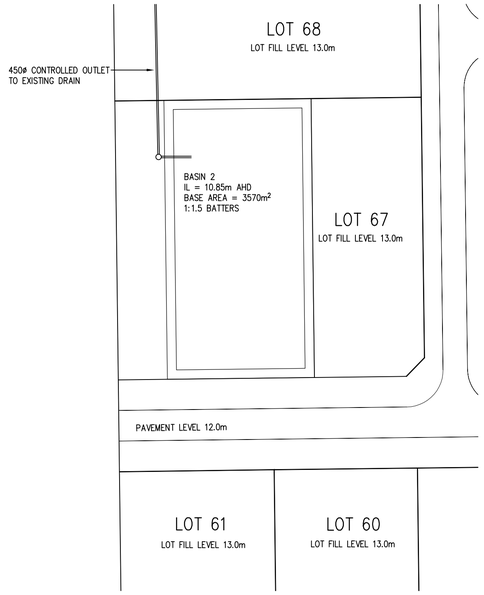
BASIN 1 DETAILS

BASIN FLOOR AREA	= 1905m²
SIDE BATTER SLOPE	= 1 : 1.5
OUTLET PIPE	40m x 300ø
1:1 YEAR STORAGE	
BUNDED OUTLET	= 286m³
SWALES (400m)	= 195m³
TOTAL	= 481m³
SWALE AREA	= 1600m²
1:10 YEAR STORAGE	
TOP WATER LEVEL	= 10.81m
MAX OUTLET FLOW	= 0.092m³/s
1:100 YEAR STORAGE	
TOP WATER LEVEL	= 11.34m
MAX OUTLET FLOW	= 0.159m³/s



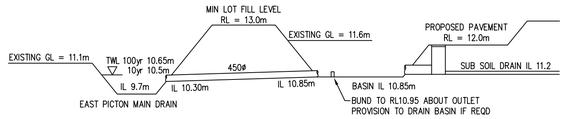
GROUND WATER CONTROL

GROUND WATER MOUNDING IN WORST CASE SCENARIO
CLAY BASE 1.2m BENEATH EXISTING SURFACE LEVEL
(DRAIN SPACING MAY BE INCREASED WHERE CLAY BASE DEPTH EXCEEDS 1.2m)



CATCHMENT 2

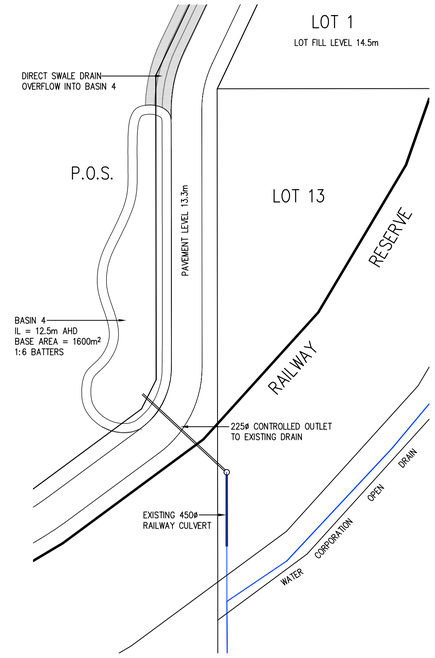
CATCHMENT AREA = 12.0Ha
RUNOFF COEFFICIENT = 0.8



DIMENSIONS - BASIN 2

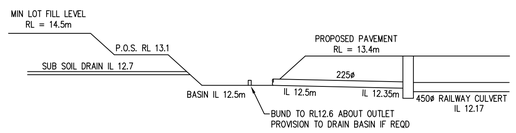
BASIN 2 DETAILS

BASIN FLOOR AREA	= 3570m²
SIDE BATTER SLOPE	= 1 : 1.5
OUTLET PIPE	290m x 450ø
1:1 YEAR STORAGE	
BUNDED OUTLET	= 357m³
SWALES (200m)	= 172m³
TOTAL	= 529m³
SWALE AREA	= 1300m²
1:10 YEAR STORAGE	
TOP WATER LEVEL	= 11.11m
MAX OUTLET FLOW	= 0.095m³/s
1:100 YEAR STORAGE	
TOP WATER LEVEL	= 11.37m
MAX OUTLET FLOW	= 0.151m³/s



CATCHMENT 4

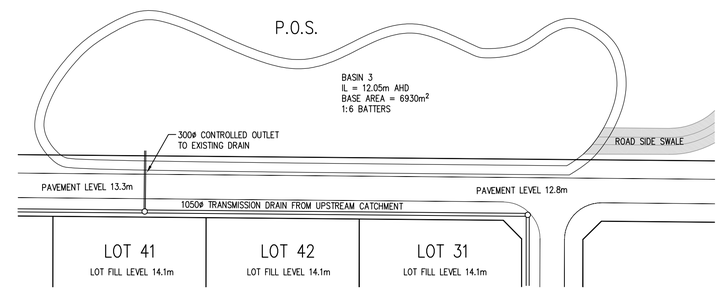
CATCHMENT AREA = 4.0Ha
RUNOFF COEFFICIENT = 0.8



DIMENSIONS - BASIN 4

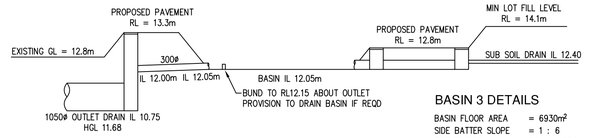
BASIN 4 DETAILS

BASIN FLOOR AREA	= 1600m²
SIDE BATTER SLOPE	= 1 : 6
OUTLET PIPE	36m x 225ø
1:1 YEAR STORAGE	
BUNDED OUTLET	= 160m³
SWALES (200m)	= 98m³
TOTAL	= 258m³
SWALE AREA	= 800m²
1:10 YEAR STORAGE	
TOP WATER LEVEL	= 12.67m
MAX OUTLET FLOW	= 0.030m³/s
1:100 YEAR STORAGE	
TOP WATER LEVEL	= 12.85m
MAX OUTLET FLOW	= 0.046m³/s



CATCHMENTS 3A AND 3B

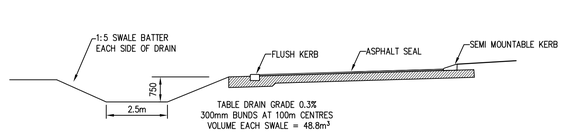
CATCHMENT AREA = 19.5Ha
RUNOFF COEFFICIENT = 0.8



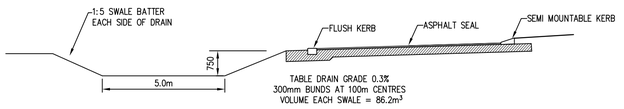
DIMENSIONS - BASIN 3

BASIN 3 DETAILS

BASIN FLOOR AREA	= 6930m²
SIDE BATTER SLOPE	= 1 : 6
OUTLET PIPE	20m x 300ø
1:1 YEAR STORAGE	
BUNDED OUTLET	= 693m³
SWALES (400m)	= 195m³
TOTAL	= 888m³
SWALE AREA	= 1600m²
1:10 YEAR STORAGE	
TOP WATER LEVEL	= 12.41m
MAX OUTLET FLOW	= 0.083m³/s
1:100 YEAR STORAGE	
TOP WATER LEVEL	= 12.68m
MAX OUTLET FLOW	= 0.155m³/s



SWALE DRAINS - CATCHMENT 1, 3 & 4



SWALE DRAINS - CATCHMENT 2

DIRK VAN NOORT
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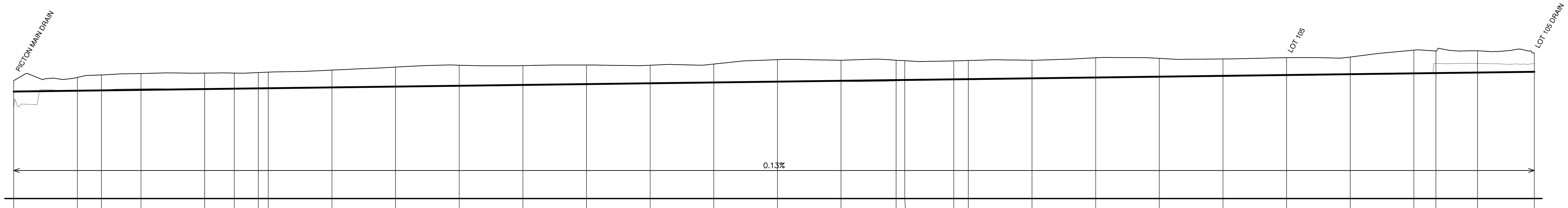
C. W. TEEDE

PROJECT No	TEE01-B-11
SHEET	3 OF 3
REVISION	D
LOCAL AUTHORITY	SHIRE OF DARDANUP
SCALE	1 : 1000 AT A1
DATUM	AHD

REVISION DATE	No	REVISION DESCRIPTION	DESIGN	DRAWN	CHECKED	APPROVED
23 SEPTEMBER 2009	0	PRELIMINARY - NOT FOR CONSTRUCTION	DVN	DVN	DVN	
3 FEBRUARY 2010	A	ROAD HIERARCHY AMENDED	DVN	DVN	DVN	
23 SEPTEMBER 2011	B	LWMS DETAILS ADDED	DVN	DVN	DVN	
11 NOVEMBER 2011	C	DoW - REVISED SUBMISSION	DVN	DVN	DVN	
8 FEBRUARY 2012	D	DoW - REVISED SUBMISSION	DVN	DVN	DVN	

PROJECT
PROPOSED SUBDIVISION
LOT 105 COLUMBAS DRIVE PICTON

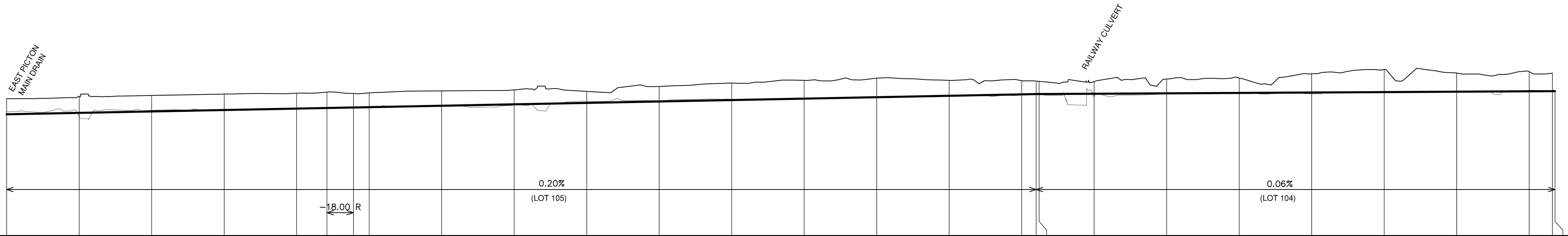
DRAWING TITLE
SWALE AND BASIN DETAILS



DEPTH TO INVERT	0.86	1.04	1.21	1.28	1.25	1.22	1.24	1.26	1.36	1.53	1.61	1.51	1.49	1.42	1.44	1.72	1.61	1.55	1.51	1.45	1.46	1.41	1.54	1.44	1.32	1.36	1.34	1.82	1.73	1.71	1.50
NATURAL SURFACE	9.26	9.51	9.70	9.81	9.84	9.85	9.89	9.92	10.08	10.32	10.47	10.43	10.48	10.46	10.55	10.90	10.85	10.85	10.81	10.80	10.83	10.85	11.05	11.01	10.96	11.06	11.11	11.65	11.58	11.60	11.45
INVERT LEVELS	8.40	8.46	8.49	8.53	8.59	8.62	8.65	8.66	8.72	8.79	8.85	8.92	8.98	9.05	9.11	9.18	9.24	9.30	9.31	9.36	9.37	9.44	9.50	9.57	9.63	9.70	9.76	9.83	9.85	9.89	9.95
CHAINAGE	0.00	50.00	68.91	100.00	150.00	173.29	192.15	200.00	250.00	300.00	350.00	400.00	450.00	500.00	550.00	600.00	650.00	693.21	700.00	738.52	750.00	800.00	850.00	900.00	950.00	1000.00	1050.00	1100.00	1117.36	1150.00	1194.68

EAST PICTON MAIN DRAIN

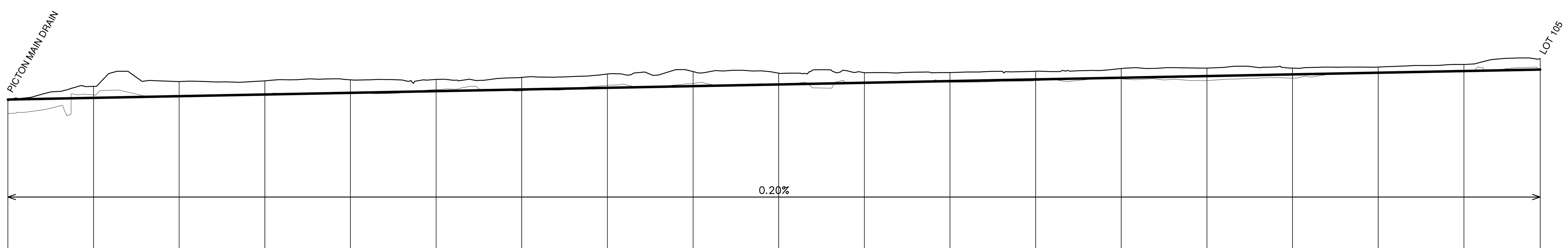
SCALES HORIZONTAL 1 : 2000
VERTICAL 1 : 200



DEPTH TO INVERT	1.08	1.13	1.10	1.10	1.06	1.10	0.97	0.99	1.03	1.00	0.80	1.04	1.17	1.26	1.32	1.06	0.94	0.90	0.88	0.84	0.99	1.03	1.30	1.56	1.29	1.36	1.24	
NATURAL SURFACE	11.48	11.63	11.70	11.80	11.86	11.94	11.84	11.88	12.02	12.09	11.99	12.33	12.56	12.75	12.90	12.75	12.72	12.70	12.68	12.66	12.84	12.91	13.20	13.49	13.25	13.35	13.24	
INVERT LEVELS	10.40	10.50	10.60	10.70	10.79	10.84	10.87	10.89	10.99	11.09	11.19	11.29	11.39	11.48	11.58	11.68	11.78	11.80	11.80	11.82	11.85	11.88	11.91	11.93	11.96	11.99	12.00	12.00
CHAINAGE	0.00	50.00	100.00	150.00	200.00	220.90	239.14	250.00	300.00	350.00	400.00	450.00	500.00	550.00	600.00	650.00	700.00	710.00	712.05	750.00	800.00	850.00	900.00	950.00	1000.00	1050.00	1066.03	1067.76

LOTS 105 AND 104

SCALES HORIZONTAL 1 : 2000
VERTICAL 1 : 200



DEPTH TO INVERT	−0.11	0.67	0.85	0.80	0.76	0.68	0.71	0.81	0.85	0.66	0.59	0.50	0.48	0.54	0.47	0.37	0.33	0.39	0.64
NATURAL SURFACE	8.79	9.67	9.95	9.99	10.05	10.07	10.19	10.39	10.53	10.44	10.47	10.47	10.55	10.71	10.74	10.73	10.80	10.95	11.29
INVERT LEVELS	8.90	9.00	9.10	9.19	9.29	9.39	9.49	9.58	9.68	9.78	9.88	9.98	10.07	10.17	10.27	10.37	10.46	10.56	10.65
CHAINAGE	0.00	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00	550.00	600.00	650.00	700.00	750.00	800.00	850.00	894.57

LOT 6

SCALES HORIZONTAL 1 : 2000
VERTICAL 1 : 200

DRAIN PROFILES AS SURVEYED OCTOBER 2011

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E-MAIL engineer@dvn.net.au

C. W. TEEDE

PROJECT No	TEE01–B–11
SHEET	ANNEXURE A
REVISION	D
LOCAL AUTHORITY	SHIRE OF DARDANUP
SCALE	1 : 2000 AT A1
DATUM	AHD

N

REVISION DATE	No	REVISION DESCRIPTION	DESIGN	DRAWN	CHECKED	APPROVED
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11 NOVEMBER 2011	C	DoW – REVISED SUBMISSION	DVN	DVN	DVN	
8 FEBRUARY 2012	D	DoW – REVISED SUBMISSION	DVN	DVN	DVN	

PROJECT
PROPOSED SUBDIVISION
LOT 105 COLUMBAS DRIVE PICTON

DRAWING TITLE
WATER CORPORATION DRAIN PROFILES