GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

EPA REFERRAL FORM THIRD PARTY

Referral of a Proposal by A Third Party to the Environmental Protection Authority under Section 38(1) of the *Environmental Protection Act 1986*.

PURPOSE OF THIS FORM

Section 38(1) of the *Environmental Protection Act 1986* (EP Act) provides that any person may refer a significant proposal (one that is likely to have a significant effect on the environment) to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the EP Act. This form sets out the information requirements for the referral of a proposal by a third party.

Referrors are encouraged to familiarise themselves with the EPA's *General Guide on Referral of Proposals* [see Environmental Impact Assessment/Referral of Proposals and Schemes] before completing this form.

A referral under section 38(1) by a third party to the EPA must be made on this form. This form will be treated as a referral even though a third party may not be able to provide sufficient information on the proposal to enable to EPA to make a decision on whether or not to assess the proposal. Generally, the EPA will obtain additional project information from the proponent. The referral form and proponent information will be made available for public comment for a period of 7 days, prior to the EPA making its decision on whether or not to assess the proposal.

CHECKLIST

Before you submit this form, have you

	Yes	No
Completed all applicable questions in the form	✓	
Completed the Referror's Declaration	✓	

Following a review of the information presented in this form, please consider the following question. (A response is Optional)

DO YOU CONSIDER THE PROPOSAL REQUIRES FORMAL ENVIRONMENTAL IMPACT ASSESSMENT?

☐ YES ☒ NO ☐ NOT SURE

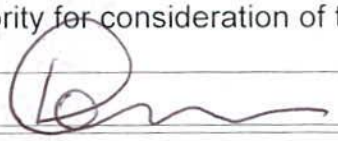
IF YES, WHAT LEVEL OF ASSESSMENT?

☐ ASSESSMENT ON PROPONENT INFORMATION

☐ PUBLIC ENVIRONMENTAL REVIEW

THIRD PARTY REFERROR DECLARATION (To be completed by the Referror)

I, David Pierre Coremans....., *(full name)* submit this referral to the Environmental Protection Authority for consideration of the environmental significance of its impacts.

Signature 	Name David Coremans
Address	4, 26 Railway Road SUBIACO WA 6008
Date	12/3/14

• Threatened Ecological Communities • Bush Forever	
Fauna • Fauna or fauna habitat • Specially Protected (Threatened) fauna	none
Rivers, creeks, wetlands and estuaries • Proximity of development to waterways	none
Significant areas and/or land features • National Park or Nature Reserve • Environmentally sensitive areas • Significant natural land features (caves, ranges, etc)	None but being referred due to the presence of an EPP lake and minor changes proposed to stormwater discharge into the lake.
Coastal zone areas • Proximity of proposed development to coastal area • Significant landforms, eg beach ridge plain • Mangroves	none
Marine areas and biota • Sensitive benthic communities, eg seagrasses, coral reefs, mangroves • Marine conservation reserves • Recreation or commercial fishing areas	none
Water supply and drainage catchments • Proclaimed groundwater or surface water protection area • Underground Water Supply and Pollution Control area • Public Drinking Water Supply Area	none
Pollution – discharge of • Noise • Vibration • Gaseous emissions • Dust • Liquid effluent • Solid waste	none
Greenhouse gas emissions	none
Contamination	none
Social surroundings • Aboriginal ethnographic or archaeological significance • Site of high public interest, eg recreation, scenic • Goods transport affecting amenity	none

1. PROPONENT, PROPOSAL AND LOCATION INFORMATION

1.1 PROPONENT

Name	LandCorp
Joint Venture parties (if applicable)	
Postal Address	Level 6 Wesfarmers House 40 The Esplanade PERTH WA 6000
Key proponent contact for the proposal • Name • Address • Phone • Email	Carl Williams Manager Activity Centres 9482 7548 Carl.williams@landcorp.com.au

1.2 PROPOSAL

Title	Claremont North East Precinct
Description	Urban Renewal

1.3 LOCATION

Name of the Shire in which the proposal is located	Town of Claremont
For urban areas – • street address • lot number • suburb • nearest road intersection	Most relevant road is Shenton Place
For remote localities – • nearest town • distance and direction from that town to the proposal site	

2. POTENTIAL ENVIRONMENTAL IMPACTS

Use the following list of environmental elements to set out your concerns in relation to the potential impacts of the proposal and in explanation of your judgement that the proposal is significant in terms of the *Environmental Protection Act 1986*:

Element of the environment	Potentially significant impact
Flora and vegetation • Clearing of native vegetation • Rare or priority flora	none

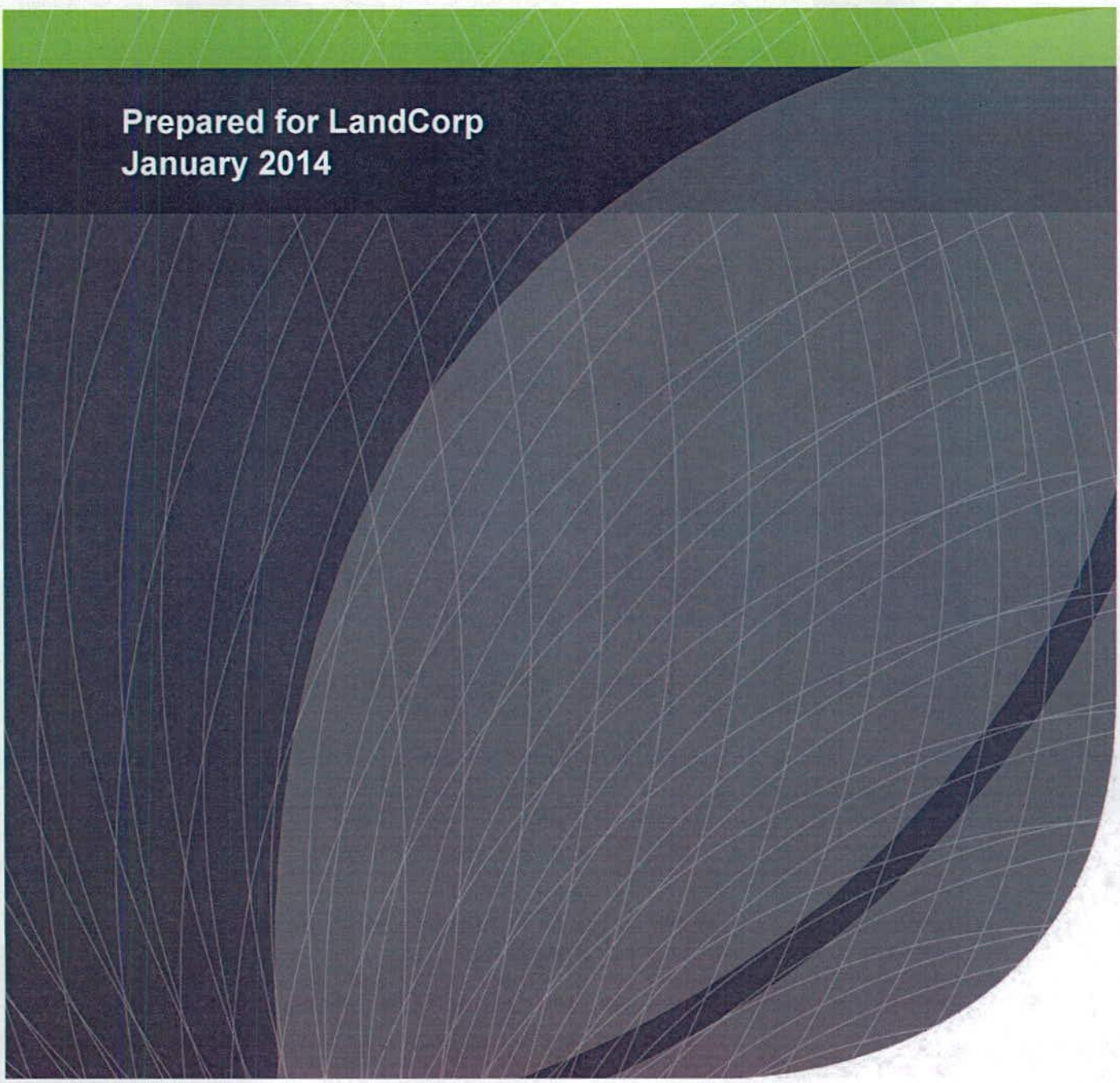
emerge ASSOCIATES
Integrated Science & Design

CLAREMONT NORTH EAST PRECINCT

PROPOSAL REFERRAL

Project Number EP12-020

Prepared for LandCorp
January 2014



Document Control

DOC NAME	CLAREMONT NORTH EAST PRECINCT REFERRAL DOCUMENT				
DOC NO.	EP12-020(01)--001C DPC				
REVISION	DATE	AUTHOR		REVIEWER	
1	February 2013	Rachel Evans	RLE	Dave Coremans	DPC
	Initial referral document				
A	July 2013	Rachel Evans	RLE	Dave Coremans	DPC
	Referral document for submission to ToC				
B	November 2013	Rachel Evans	RLE	Dave Coremans	DPC
	Referral document for submission to ToC				
C	January 2014	Rachel Evans	RLE	Dave Coremans	DPC
	Final referral document for submission to ToC				

Executive Summary

The Claremont North East Precinct (herein referred to as 'the site'), located immediately north of the Perth to Fremantle Railway and encompassing the existing Claremont Oval, is proposed to be redeveloped for residential and commercial purposes.

This report is intended to provide a summary of the proposal, with a specific focus on the management of stormwater. The document aims to provide sufficient information to the Town of Claremont (ToC) and the Environmental Protection Authority (EPA) to be able to confirm that the proposed approach is consistent with the relevant policies and guidelines, and is in line with their expectations for the protection of Lake Claremont, which is downstream of the site.

Characteristics of the existing environment within the site have been investigated and indicate that:

- The site receives 712.3 mm on average, predominantly during June and July.
- Topography of the site is gently sloping to the north with levels ranging from 13 m AHD to 21 m Australian Height Datum (AHD). A ridge of 19-20 m AHD runs around the oval which is generally flat at 18 m AHD. The lowest point within the site is at the end of Shenton Place, at approximately 6 m AHD. Lake Claremont is downstream of the site and is at approximately 3 m AHD.
- The site is underlain by sands derived from Tamala Limestone. Infiltration capacity of the soils is approximately 8.64 m/day.
- There is 'no known risk of encountering ASS within 3 m of the surface' across the site. Lake Claremont is an area of 'High to Moderate risk of encountering ASS within 3 m of the surface'.
- Lake Claremont is downstream of the site and is listed as a Conservation Category Wetland (CCW) and an Environmental Protection Policy (EPP) Lake with an approximate catchment of 250 ha.
- The site is approximately 5 ha, and therefore represents 2 % of the Lake Claremont catchment.
- Lake Claremont and the surrounding area are listed as a Bush Forever site and an Environmentally Sensitive Area (ESA).
- Groundwater levels across the site are between 1.0 m AHD and 0 m AHD, flowing from east to west.
- While some runoff is retained within local drainage sumps, the ultimate discharge location of the surface runoff catchments in and around the site is the Public Open Space (POS) immediately adjacent to Lake Claremont. Runoff discharged to this POS would eventually discharge to Lake Claremont.

The proposed development of the site will include creation of residential, retail and commercial premises. As a part of the development, the stormwater drainage network will be required to be upgraded to provide adequate protection from surface runoff during major events, and to facilitate realigned roads within the development. These modifications will necessitate changes to the surface runoff catchments, and some minor re-routing of surface runoff.

Frequent event runoff (the 1 year 1 hour ARI event) will be treated as close to source as possible. Runoff from lots will be retained and treated within lot-scale retention (e.g. soakage structures). Runoff from road reserves will be conveyed to a bio-retention area within the golf course. Runoff to the bio-retention area will first be treated by a gross pollutant trap (GPT). Major event runoff (up to the 100 year ARI event) from within the site will be conveyed via the road network through the GPT to the bio-retention area, and when this reaches capacity it will be conveyed to Lake Claremont via a

shallow, turfed swale that will be integrated into the surrounding landscape and an existing culvert beneath the footpath.

The bio-retention area will be vegetated with native species that encourage the biological uptake of nutrients. The interaction with vegetation and infiltration through the underlying soil media will provide treatment to runoff, removing approximately 98% of sediments and pollutants.

The swale will convey flows from the end of the piped network, with initial flows being diverted to the bio-retention area for treatment. When the bio-retention area is full, additional flows will remain in the conveyance swale and continue downstream to Lake Claremont.

The additional runoff volume that will be directed to Lake Claremont through the proposed redevelopment and amended drainage design is minimal. The total catchment area for the site and road upgrade is 5 ha, which equates to approximately 2 % of the total Lake Claremont catchment area, and therefore the total runoff volumes entering Lake Claremont from the site are comparatively minor.

The stormwater management strategy detailed in this document provides an approach to water management which is consistent with a Water Sensitive Urban Design (WSUD) approach that fully considers the surrounding environment and sensitive receiving environment of Lake Claremont.

Table of Contents

Figures

Appendices

1 Introduction

1.1 Background

The Claremont North East Precinct (herein referred to as 'the site'), located immediately north of the Perth to Fremantle Railway and encompassing the existing Claremont Oval, is proposed to be redeveloped for residential and commercial purposes. The location of the proposed development is shown in **Figure 1**.

1.2 Proposed development

The proposed development of the site will include creation of residential, retail and commercial premises. The proposed development of the site is shown in **Appendix A**.

As a part of the development, the stormwater drainage network will be required to be upgraded to provide adequate protection from surface runoff during major events, and to facilitate realigned roads within the development. These modifications will necessitate changes to the surface runoff catchments, and some minor re-routing of surface runoff. It is proposed that once it has been appropriately treated, the runoff will be directed to Lake Claremont.

1.3 Policies and guidelines

The following policies and guidelines are of relevance to the proposal:

- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *State Planning Policy 2.9: Water Resources* (WAPC 2006a)
- *Statement of Planning Policy No. 3: Urban Growth and Settlement* (WAPC, 2006b)
- *Environmental Protection (Swan Coastal Lakes) Policy* (Government of WA 1992)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2007).

1.4 Purpose of this report

This report is intended to provide a summary of the proposal, with a specific focus on the management of stormwater. The document aims to provide sufficient information to the Town of Claremont (ToC) and the Environmental Protection Authority (EPA) to be able to confirm that the proposed approach is consistent with the relevant policies and guidelines, and is in line with their expectations for the protection of Lake Claremont.

2 Existing Environment

In order to provide sufficient information to determine the most appropriate approach to any modifications to the surface runoff systems which contribute to Lake Claremont, and to inform potential management measures that may be appropriate, the existing environment within and adjacent to the site has been investigated and is summarised in this section.

2.1 Sources of information

The following sources of information have been used to prepare this report:

- Climate and weather data (BoM 2012)
- Perth groundwater atlas (DoW 2012a)
- Hydrogeological atlas (DoW 2012b)
- Water register (DoW 2012c)
- WA Atlas (Landgate 2012)
- 1:50,000 Perth Geological Series (Geological Survey of WA 1986).

2.2 Climate

The site experiences a dry Mediterranean climate of hot dry summers and cool wet winters. Long term climatic averages indicate that the site is located in an area of moderate to high rainfall, receiving 712.3 mm on average annually with the majority of rainfall received in June and July (BoM 2012). The region experiences rainfall for 82 days annually (on average).

Mean temperatures range between 30.4°C and 9.7°C in February and July respectively (BoM 2012).

2.3 Topography

The topography of the majority of the site ranges between 13 m Australian Height Datum (AHD) and 21 m AHD. A ridge of 19-20 m AHD runs around the oval, which is generally flat at 18 m AHD. The highest area is along the ridge circling the oval in the north-east corner. Lots to the south of Shenton Road are generally lower than the Oval between 14 and 16 m AHD. The site has a north-west aspect. Downstream of the site, where runoff discharges to the golf course and Public Open Space (POS) surrounding Lake Claremont, the elevation is 6 m AHD. Lake Claremont has an approximate elevation of 3 m AHD.

The topography of the site is shown in **Figure 2**.

2.4 Geology and soils

2.4.1 Geology

The geomorphological classification of the site is that of a degraded surface of eolian origin within the Spearwood Dunal system. The shallow soils on the site are comprised of Sand (geological unit S7) derived from Tamala Limestone described as pale and olive yellow, medium to coarse grained, sub-angular to well-rounded quartz with traces of feldspar, moderately sorted of residual origin (Geological Survey of WA 1986).

Lake Claremont to the northwest of the site is underlain by peaty clay, dark grey and black with variable sand content of lacustrine origin (Geological Survey of WA 1986).

Preliminary geotechnical advice from Douglas Partners (Douglas Partners 2012) has been that a design permeability of 1 x 10^{-4} m/s (8.64 m/day) would be appropriate for the in situ material within the site.

The soil types in and around the site are shown in **Figure 3**.

2.4.2 Acid sulfate soils

Acid Sulphate Soils (ASS) risk mapping (DEC 2012) indicates that there is 'no known risk of encountering ASS within 3 m of the surface' across the site. There is an area of 'High to Moderate risk of encountering ASS within 3 m of the surface' around Lake Claremont (downstream of the site), coinciding with its wetland status and the underlying peat soils. The ASS risk mapping is shown in **Figure 4**.

2.5 Surface hydrology

There are a number of minor catchments within the 5 ha site. These discharge to:

- Shenton Place, The Cedus and the downstream POS area. The ultimate discharge location for runoff from these catchments is Lake Claremont.
- The existing sump located on the southern side of Shenton Road.
- The existing sump located adjacent to the oval (south eastern side).
- Claremont Oval.
- Local roads to the northeast, northwest and east of the site.

Lake Claremont is located downstream and to the northwest of the site, as detailed further in **Section 2.8**. The existing surface runoff catchments are shown in **Figure 5**.

2.6 Hydrogeology

The Perth Groundwater Atlas (DoW 2012a) indicates that the site is underlain by a layered groundwater system consisting of:

- Perth – Superficial Swan aquifer
- Perth – Yarragadee North aquifer.

Superficial groundwater levels in the region range between 1 m AHD and 0 m AHD with a general groundwater flow direction of east to west. This provides a depth to groundwater beneath the site of 12 m to 20 m. The predicted minimum and the recorded maximum groundwater contours (DoW 2012a) beneath the site are shown in **Figure 2**.

2.7 Flora and vegetation

Lake Claremont and the surrounding area immediately adjacent to the site are listed as a 'Bush Forever' Site (# 222) (Government of WA 2000). The area is considered to be an Environmentally Sensitive Area (ESA) pursuant to the *Environmental Protection (Clearing of Native Vegetation)*

Regulations 2004. The ESA boundary encroaches into a minor portion of the site in the northwest corner. The Bush Forever and ESA are shown in **Figure 6**.

Trees of various age and size line Shenton Road, Davies Road and Graylands Road, however these are all assumed to be planted and not representative of remnant vegetation. The area immediately downstream of the site has been developed as a golf course and is largely turfed, with areas of differing quality. There are some mature trees adjacent to the fairways and greens, though these are predominantly introduced species (e.g. *Pinus* sp.).

2.8 Wetlands

Lake Claremont is immediately downstream of the site and is listed in the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DEC 2012) as a Conservation Category Wetland (CCW) - Sumpland. It is also listed as an Environmental Protection Policy (EPP) lake pursuant to the *Environmental Protection Swan Coastal Plain Lakes Policy 1992* (EPA 1992). The wetland boundaries in relation to the site are shown in **Figure 7**.

The greater catchment to Lake Claremont is approximately 250 ha in size containing urban residential area, a golf course and other leisure facilities, POS and associated road network.

2.9 Summary of existing environment

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

- The site receives 712.3 mm on average, predominantly during June and July.
- Topography of the site is gently sloping to the north with levels ranging from 13 m AHD to 21 m AHD. A ridge of 19-20 m AHD runs around the oval which is generally flat at 18 m AHD. The lowest point within the site is at the end of Shenton Place, at approximately 6 m AHD. Lake Claremont is downstream of the site and is at approximately 3 m AHD.
- The site is underlain by sands derived from Tamala Limestone. Infiltration capacity of the soils is approximately 8.64 m/day.
- There is 'no known risk of encountering ASS within 3 m of the surface' across the site. Lake Claremont is an area of 'High to Moderate risk of encountering ASS within 3 m of the surface'.
- Lake Claremont is downstream of the site and is listed as a CCW and an EPP Lake with an approximate catchment of 250 ha.
- The site is approximately 5 ha, and therefore represents 2 % of the Lake Claremont catchment.
- Lake Claremont and the surrounding area are listed as a Bush Forever site and an ESA.
- Groundwater levels across the site are between 1.0 m AHD and 0 m AHD, flowing from east to west.
- While some runoff is retained within local drainage sumps, the ultimate discharge location of the surface runoff catchments in and around the site is the POS immediately adjacent to Lake Claremont. Runoff discharged to this POS would eventually discharge to Lake Claremont.

3 Lake Claremont Development

3.1 Development proposal

The Claremont North East Precinct development includes construction of streets, plazas, commercial and residential premises. The development will predominantly occur around Claremont Oval and the immediately surrounding area.

The increased impervious area due to development will increase the intensity of surface runoff following rainfall events. Due to the grading of the local road network there will be some minor changes to the catchment hydrology. This will involve removal of a drainage sump along Shenton Road and the use of a concrete pipe network to direct runoff from the lots and road reserves to the downstream discharge point.

While some of the site discharge locations will be modified, the overall catchment hydrology will be maintained. This will be achieved by local infiltration of runoff from minor events. This is an appropriate approach, as it will ensure that treatment of all runoff occurs prior to any discharge to the downstream environment. The ultimate downstream location for the development will be the golf course and POS adjacent to Lake Claremont.

Surface runoff from lots, up to the 10 year ARI event, will be retained onsite. Major event runoff will be conveyed within the site via the road network. Minor event runoff (the 1 year 1 hour ARI event) from road reserves will be treated within a bio-retention area located in downstream POS. Major event runoff will be conveyed downstream to Lake Claremont via a shallow swale that will be integrated into the surrounding landscape. This provides an approach to water management which is consistent with a Water Sensitive Urban Design (WSUD) approach. The total catchment area for the site and road upgrade works is 5 ha, which equates to approximately 2 % of the total Lake Claremont catchment area. The additional runoff volume that will be directed to Lake Claremont from the site during a major rainfall event is minimal when considered in relation to the total runoff volumes entering Lake Claremont from the greater catchment area.

3.2 Design criteria and objectives

In order to ensure all development is carried out in accordance with a WSUD approach, design criteria have been developed to which all development within the site will comply. Stormwater management includes both conveyance of water volumes and treatment of water to protect sensitive water bodies downstream.

Design criteria for the Claremont North East Precinct include:

Criteria 1 Retain up to the 10 year ARI event from lots.

Criteria 2 Retain and treat the 1 year 1hour ARI event from road reserves.

Criteria 3 Size the concrete piped network to convey the 5 year ARI event from the road network.

Criteria 4 Convey the 100 year ARI event within road pavement and/or swales integrated into the landscape.

Criteria 5 Manage erosion and sedimentation from surface water runoff.

4 Water Management Approach

The approach to surface water management within the Claremont North East Precinct, and the manner in which compliance with the design objectives will be achieved, is detailed in the following sections.

4.1 Lot scale detention

Runoff from lots will be retained either in soakwells located beneath lot paving or carpark areas, or by providing adequate storage within a rainwater tank. Where a rainwater tank is utilised, these must maintain a dedicated air space to ensure that the appropriate volume of runoff is retained. Whether via soakwell or rainwater tank, each lot must provide sufficient retention storage for the 10 year ARI event which equates to 28.4 L/m^2 of impervious area (i.e. roof and paved area combined). The total volume provided can potentially be reduced when accounting for infiltration loss at the base of soakwell structures. The infiltration losses will be different depending on the configuration of the infiltration devices. Should future lot development designs propose to account for infiltration and therefore a reduced volume in soakwells, this should be demonstrated via appropriate design calculations at the time of building design approval.

4.2 Gross pollutant trap

A gross pollutant trap (GPT) will be installed at the downstream end of the pipe network. GPTs are able to remove significant proportions of gross pollutants, sediments and particulate bound nutrients. The installation of a GPT will not only assist in maintaining water quality within Lake Claremont, but it will act to reduce the maintenance requirements for the bio-retention area. The location of the GPT is shown in **Appendix B**.

4.3 Bio-retention area

Runoff from the road network will be directed via the GPT to a bio-retention area located in the immediately downstream POS, north of Shenton Place. The bio-retention area will be sized to retain the overflow of runoff from the 1 year 1 hour ARI event from the road network. The bio-retention area will be planted with native vegetation to encourage biological nutrient uptake. Overflow from the bio-retention area will be directed to Lake Claremont via overland flow within the conveyance swale. The location of, and the design for, the bio-retention area is shown in **Figure 8** and **Appendix B** respectively.

4.4 Development drainage system

The development drainage system will consist of a concrete pipe network that will be sized to convey runoff for the 5 year ARI event from the connected road catchment. Runoff which exceeds the capacity of the 5 year ARI event from the road catchment (and up to the 100 year ARI event) will be conveyed via road pavement. The development drainage system will discharge to the conveyance swale discussed in **Section 4.5**. The catchments for the post-development environment and the direction of flow within these catchments are shown in **Figure 8**.

4.5 Conveyance swale

An open swale will be utilised for conveyance of runoff beyond the extent of the pipe network. The swale will be a relatively flat (1:6 side slopes) and shallow (0.3 m depth) turfed swale that will integrate with the surrounding landscape. The swale will convey runoff for all events from the terminus of road pavement and the concrete pipe network towards the bio-retention area. On intersection with the bio-retention area runoff from the 1 year 1 hour ARI event will be diverted into the bio-retention area. Runoff beyond the capacity of the bio-retention area will divert downstream via the conveyance swale. The conveyance swale will meander around the existing golf course features and established trees, before final discharge to Lake Claremont via an existing culvert. The location of the conveyance swale is shown in **Figure 8**, while the design of the swale is shown in **Appendix B**.

4.6 Demonstration of compliance

This section demonstrates that the design objectives detailed in **Section 3.2** can and will be met by the water management measures described above.

Criteria 1 Retain the 10 year ARI event surface runoff from lots

Runoff from roof areas for events up to the 10 year ARI event will be retained within private lots within either soakwells or rainwater tanks, or a combination of both, therefore no flows will be contributed to the road network during such an event.

Criteria 2 Retain and treat the 1 year 1 hour ARI event surface runoff from road reserves

Runoff from road pavements within a 1 year 1 hour ARI event will be conveyed within the concrete pipe network and discharged into the conveyance swale via the GPT. The conveyance swale will then discharge runoff for the 1 year 1 hour ARI event into the bio-retention area. There will be no runoff conveyed to Lake Claremont during a 1 year 1 hour ARI event.

Surface runoff modelling has been undertaken using XPStorm hydrological and hydraulic modelling software to determine the volume that will be required within the bio-retention area to ensure that the 1 year 1 hour ARI event will be accommodated. The design of the bio-retention area has assumed a design permeability of 7.5 m/day, which is less than the recommended rate of 8.64 m/day (Douglas Partners 2012). This reduction in the assumed infiltration rate allows for any clogging which may occur over time.

The XPStorm modelling indicates that the bio-retention area will need to provide 150 m^3 of detention. The landscape designs for the bio-retention area confirm that 150 m^3 can be retained. These designs are contained in **Appendix B**. A summary of the runoff calculation assumptions used in the XPStorm modelling is contained in **Appendix C.** The provision of XPStorm modelling results and landscape designs demonstrate that **Criteria 1** will be achieved by the proposed surface runoff system.

Criteria 3 Size piped network to convey 5 year ARI event from the road network.

The concrete pipe network will be sized to convey up to the 5 year ARI event runoff from road reserve catchments. This runoff will be discharged to the conveyance swale at the end of Shenton Place.

Criteria 4 Convey the 100 year ARI event within road pavements and/or swales integrated into the landscape.

As indicated, runoff from the road reserve for up to the 5 year ARI event will be conveyed within the concrete pipe network. For events greater than this and up to the 100 year ARI event, runoff will be conveyed within road pavements towards the golf course and Lake Claremont. This conveyance will be ensured by avoiding any trapped low points within the contributing catchment, as demonstrated in JDSI catchment drawing JDSI10448.04 SK08 RevA (see **Appendix D**).

At the end of the road pavement within Shenton Place all surface runoff will be conveyed further downstream by an open swale. Flows greater than the 1 year 1 hour ARI event will bypass the bio-retention swale and will be routed towards Lake Claremont along the conveyance swale.

The 100 year ARI event peak flow rates have been calculated using XPStorm. The calculations assume that all lots will retain up to the 10 year ARI event within the lot boundaries, but that all runoff beyond this will be conveyed as per the road reserve. The total volume that will be conveyed to Lake Claremont from the development following a 100 year ARI event is 1,253 m^3. The peak flow that will need to be conveyed by the conveyance swale will be 0.63 m^3/s. The design of the swale has been undertaken based on the peak flow determined by the XPStorm modelling.

Criteria 5 Manage erosion and sedimentation from surface water runoff.

Peak flows from a 100 year ARI event have been determined using XPStorm to be 0.63 m^3/s. Prior to any discharge to Lake Claremont, runoff from the 1 year 1 hour ARI event will be either retained within individual lots or will be directed to the bio-retention area (for runoff from road reserves). This will capture and retain up to 98% of the sediment load generated (Wong *et al* 2006), thereby providing adequate protection for the downstream environment. The design of the conveyance swale/bio-retention basin interface will also ensure that peak flows from major events bypass the basin, and this will provide protection against mobilisation of any accumulated sediments within the basin that may have accumulated from previous minor and frequent runoff events.

The conveyance of major events downstream of the paved portions of road reserves will be achieved by a turfed conveyance swale, consistent with the surrounding landscape. The peak flows identified (0.63 m^3/s) will have a maximum depth of 0.3 m, and this will not be sufficient to cause erosion of the turfed conveyance channel to Lake Claremont. The final design of the bio-retention basin and interface with the swale will be done so as to protect the bio-retention area and the conveyance swale from erosion during major runoff events.

5 Implementation plan

5.1 Roles and responsibilities

This document provides a framework that LandCorp can utilise to assist in implementing a WSUD approach that has been based upon site-specific investigations and is consistent with relevant State and Local Government policies. The responsibility for working within the framework established within this document rests with LandCorp and their contractors, although it is anticipated that future monitoring, management and maintenance actions beyond any agreed management period will be the responsibility of the ToC.

5.2 Maintenance

The stormwater quality treatment and conveyance system will require maintenance to ensure that the system will continue to protect water quality within Lake Claremont into the future. The ongoing maintenance should be undertaken by the proponent during the maintenance period prior to management handover, and then by ToC thereafter. **Table 1** summarises the proposed maintenance regime that would be adopted.

Table 1 Ongoing management and maintenance requirements

Maintenance element	Location	Action	Timing
Gross pollutants	Gross pollutant trap	Inspect for gross pollutants	Every three months
		Remove gross pollutants	In response to inspections
	Bio-retention area	Inspect for gross pollutants	Fortnightly during rainfall season
		Remove gross pollutants	In response to inspections
Sediments/silt	Gross pollutant trap, bio-retention area	Inspect for sediments	Every three months
		Vacuum/remove sediments from GPT	In response to inspections
		Scalp/remove sediments from bio-retention area	In response to inspections
Vegetation	Bio-retention area	Inspect vegetation density/health	Annually or immediately following removal of sediments from bio-retention area

The maintenance activities will focus on the GPT and bio-retention area. The swale which conveys water downstream of the bio-retention basin will be infrequently wet, shallow sloped and turfed. There should be no additional maintenance requirements than those experienced in adjacent golf course areas provided the GPT and bio-retention area are appropriately maintained.

5.3 Reporting

The annual conditions reports will be made available to ToC and Department of Water on request, and will be submitted to the ToC at time of management handover.

5.4 Funding

The broader estate scale management strategies outlined in this document will be implemented and funded by LandCorp. Management measures to be implemented within development lots will be funded by the individual developers of each lot.

5.5 Review

It is not intended that this document be reviewed unless there are significant changes to the subdivision layout and/or the approach to the civil designs. The requirement for future stages developed by the proponent could be addressed by preparing an addendum to this document.

6 Conclusions and recommendations

This document provides a detailed summary of the relevant characteristics of the existing environment within the site and the surrounding area, including Lake Claremont. The design and ongoing management approach has been developed in response to the environmental characteristics within the site and downstream environment, and the potential risks to these characteristics. Given that the site and downstream environment will be appropriately protected by the stormwater management approach proposed, it is considered that the development is appropriate and consistent with the management aims of a CCW, and the intent of the *Environmental Protection (Swan Coastal Lakes) Policy 1992*.

7 References

Bureau of Meteorology (BoM), 2012. *Climate and weather statistics for Swanbourne WA*, available from: http://www.bom.gov.au/climate/averages/tables/cw_009215.shtml.

Department of Environment and Conservation (DEC), 2012. *Geomorphic Wetlands of the Swan Coastal Plain dataset*, Perth.

Department of Environment and Conservation (DEC), 2010. *Acid Sulphate Soil risk map, Swan coastal plain*, Perth.

Department of Indigenous Affairs (DIA), 2009. *Aboriginal Heritage Inquiry System*, available from: http://www.dia.wa.gov.au/en/Site-Search/Aboriginal-Heritage-Inquiry-System/.

Department of Water (DoW), 2012a. *Perth Groundwater Atlas*, available from: http://www.water.wa.gov.au/Tools/Maps+and+atlases/Perth+groundwater+atlas/default.aspx#1.

Department of Water (DoW), 2012b. *Hydrogeological Atlas*, available from: http://www.water.wa.gov.au/Tools/Maps+and+atlases/Hydrogeological+atlas/default.aspx#1.

Department of Water (DoW), 2012c. *Water Register*, available from: http://www.water.wa.gov.au/Tools/Maps+and+atlases/Water+Register/default.aspx#1.

Environmental Protection Agency, 1992. *Environmental Protection Swan Coastal Plain Lakes Policy 1992*, dataset available from https://www2.landgate.wa.gov.au/bmvf/app/waatlas/.

Geological Survey of Western Australia, 1986. *Perth metropolitan region 1:50 000 Environmental Geology Series: Sheet 2034 II and part of 2034 IIII and 2134 IIII*, Perth.

Government of Western Australia, 2000. *Bush Forever Final Report.*

Landgate, 2012. *WA Atlas*, available from: https://www2.landgate.wa.gov.au/bmvf/app/waatlas/.

Environmental Protection Authority (EPA) 2008. *Guidance Statement No. 33: Environmental Guidance for Planning and Development*.

This page has been left blank intentionally.

FIGURES

emerge ASSOCIATES
Integrated Science & Design

This page has been left blank intentionally.

Figure 1:	**Site Location**	Legend: Site boundary	**Plan Number: EP12-020(01)--F01**
Project:	Claremont North East Precinct		Drawn: GRO Date: 13/02/13
Client:	LandCorp		Approved: DPC Date: 15/02/13
			Checked: RLE Scale: 1:10,000@A4

0 100 200 400 Metres

emerge ASSOCIATES Integrated Science & Design

Figure 2:	Topography and Groundwater Contours
Project:	Claremont North East Precinct
Client:	LandCorp

Legend

- Site boundary
- Cadastral boundaries
- Topographic contours (mAHD)
- Groundwater contours historical max (mAHD)

Plan Number: EP12-020(01)--F02			
Drawn:	GRO	Date:	13/02/13
Approved:	DPC	Date:	15/02/13
Checked:	RLE	Scale:	1:3,000@A4

0 30 60 120 Metres

emerge ASSOCIATES
Integrated Science & Design

Sources: The following datasets were used in the production of this map: Groundwater contours historical max - DoW (2003)

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

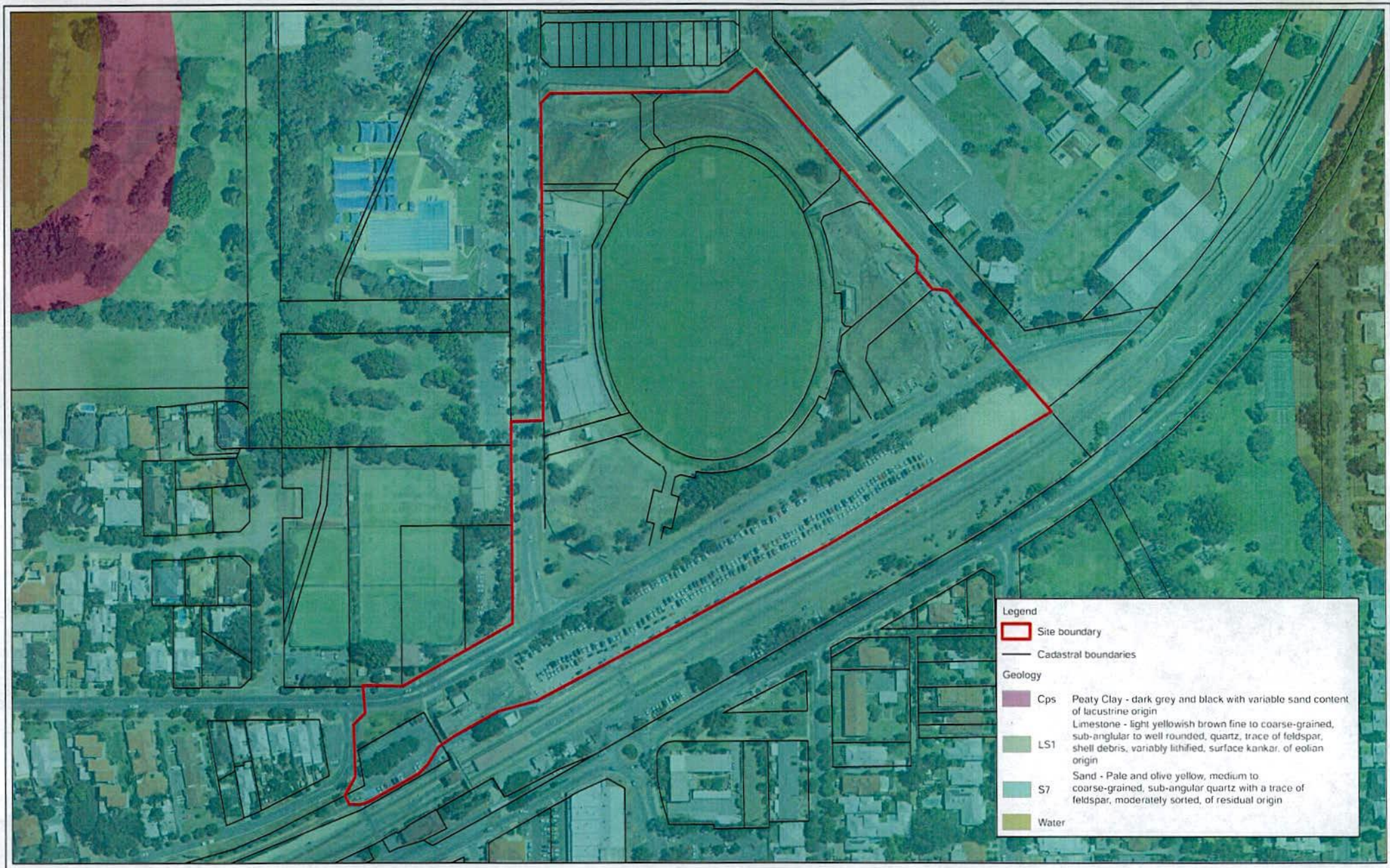


Figure 3:	Geology
Project:	Claremont North East Precinct
Client:	LandCorp

Plan Number: EP12-020(01)--F03			
Drawn:	GRO	Date:	13/02/13
Approved:	DPC	Date:	15/02/13
Checked:	RLE	Scale:	1:3,000@A4

0 30 60 120 Metres

emerge ASSOCIATES
Integrated Science & Design

Sources: The following datasets were used in the production of this map: Geology - Perth Geological Survey (1988)

Figure 4:	ASS Risk Mapping
Project:	Claremont North East Precinct
Client:	LandCorp

Legend

ASS risk

- High to moderate risk
- Moderate to low risk
- Site boundary
- Cadastral boundaries

Plan Number: EP12-020(01)--F04			
Drawn:	GRO	Date:	13/02/13
Approved:	DPC	Date:	15/02/13
Checked:	RLE	Scale:	1:3,000@A4

0 30 60 120 Metres

emerge ASSOCIATES Integrated Science & Design

Sources: The following datasets were used in the production of this map: ASS Risk - DEC (2010)

Figure 5:	Pre-development Surface Drainage Features
Project:	Claremont North East Precinct
Client:	LandCorp

Plan Number: EP12-020(01)--F05			
Drawn:	GRO	Date:	14/02/13
Approved:	DPC	Date:	15/02/13
Checked:	RLE	Scale:	1:3,000@A4

0 30 60 120 Metres

emerge ASSOCIATES
Integrated Science & Design

Figure 6:	Bush Forever Sites
Project:	Claremont North East Precinct
Client:	LandCorp

Legend

- Site boundary
- Cadastral boundaries
- Environmentally Sensitive Areas
- Bush Forever sites

Plan Number: EP12-020(01)--F06			
Drawn:	GRO	Date:	14/02/13
Approved:	DPC	Date:	15/02/13
Checked:	RLE	Scale:	1:3,000@A4

0 30 60 120 Meters

emerge ASSOCIATES
Integrated Science & Design

Sources: The following datasets were used in the production of this map: Bush Forever sites - DoP (2007), Environmentally Sensitive Areas, DEC (2012)

Figure 7:	Wetlands	Plan Number: EP12-020(01)--F07	
Project:	Claremont North East Precinct	Drawn: GRO	Date: 14/02/13
Client:	LandCorp	Approved: DPC	Date: 15/02/13
		Checked: RLE	Scale: 1:70,000@A4

0 35 70 140 Metres

emerge ASSOCIATES
Integrated Science & Design

Sources: The following datasets were used in the production of this map: EPP lakes - EPA (2010), Geomorphic Wetlands - DEC (2012)

Figure 8:	Post-development Stormwater Management Features
Project:	Claremont North East Precinct
Client:	LandCorp

Plan Number: EP12-020(01)--F08			
Drawn:	GRO	Date:	14/02/13
Approved:	DPC	Date:	15/02/13
Checked:	RLE	Scale:	1:3,500@A4

0 35 70 140 Metres

emerge ASSOCIATES
Integrated Science & Design

Sources: The following datasets were used in the production of this map: ASS Risk - DEC (2010)

APPENDIX A

emerge ASSOCIATES
Integrated Science & Design

DEVELOPMENT PLAN

This page has been left blank intentionally.

CLAREMONT NORTH EAST PRECINCT
OVERFLOW PATH & MASTERPLAN OVERLAY

PROJECT CODE : CNEP-OP
REV: A

DATE: FEB 2013
SCALE : NTS

emerge ASSOCIATES

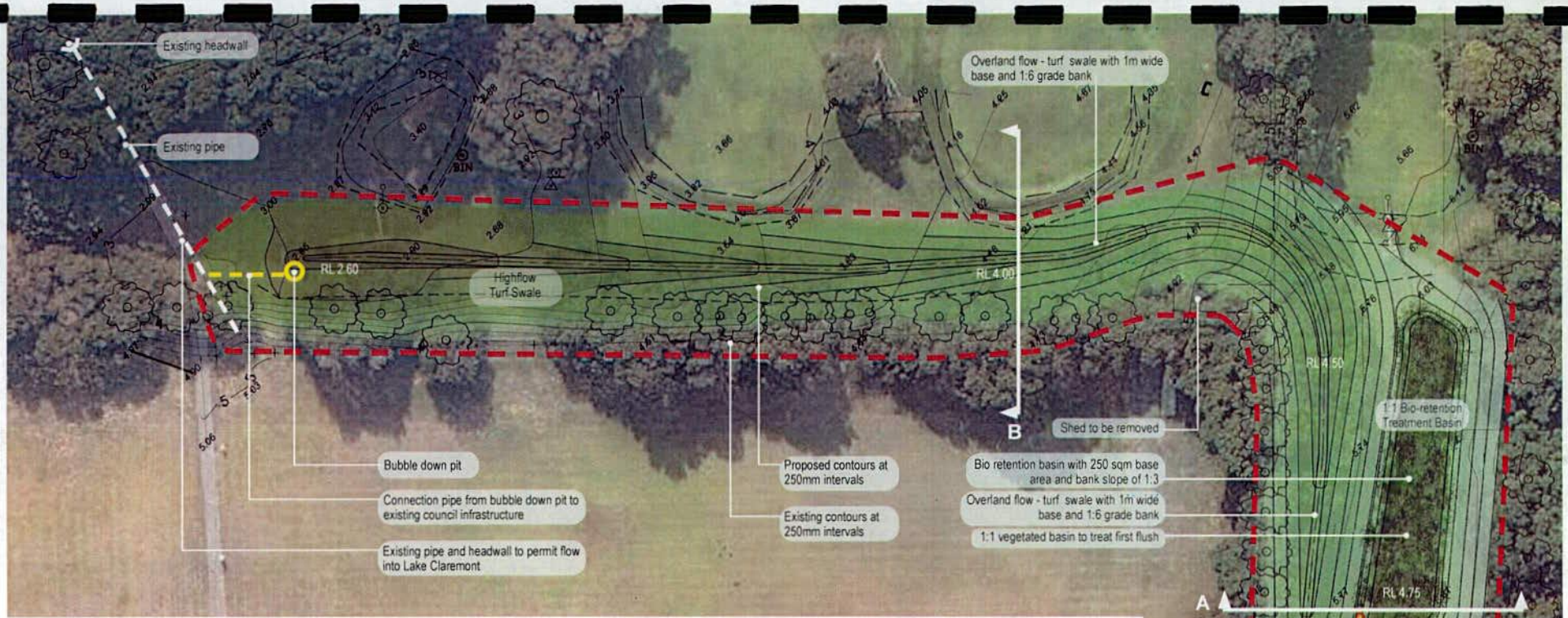
This page has been left blank intentionally.

APPENDIX B

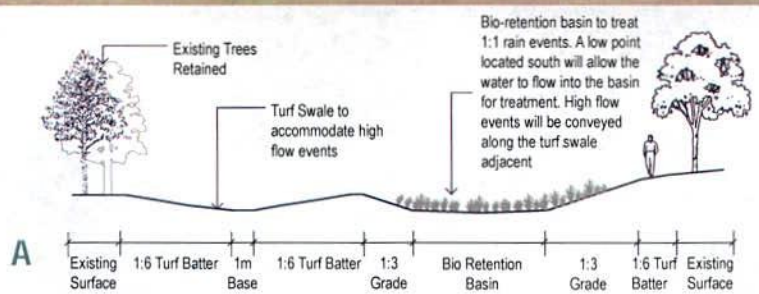
emerge ASSOCIATES
Integrated Science & Design

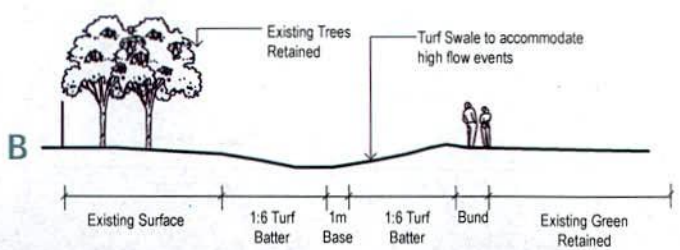
LANDSCAPE PLANS

This page has been left blank intentionally.



KEY PLAN





Note:
Water to 'bubble up' from pit located within the open space area. Water will flow towards the 1:1 bio-retention treatment basin for treatment. Events greater than 1:1 will bypass the treatment basin and are conveyed along the turf swale towards the infrastructure located on the western side of the site.

CLAREMONT NORTH EAST PRECINCT

OVERFLOW PATH CONCEPT: CONCEPT PLAN AND SECTIONS

PROJECT CODE : CNEP-OP
REV: C

DATE: JAN 2014
SCALE: 1:500 @ A3

emerge ASSOCIATES

This page has been left blank intentionally.

APPENDIX C

emerge ASSOCIATES
Integrated Science & Design

RUNOFF MODELLING ASSUMPTIONS

This page has been left blank intentionally.

Claremont North East Precinct Surface Runoff Modelling Assumptions

In order to calculate surface water runoff generated within the Claremont North East Precinct, XPStorm hydrologic and hydraulic modelling software was used. The hydrologic component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrologic model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness are based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPStorm. Virtual links (i.e. purely for model construction, not equivalent to flow paths onsite) between nodes within a sub-catchment are given the length of 10 m and a slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a 'storage' node.

An "initial loss - continual loss" infiltration model was developed to represent the post-development environment, with loss values chosen based on project team experience with similar developments. The catchment infiltration parameters used are detailed in **Table 1**.

Table 1 Post-development catchment parameters

Land Use Type	Initial Loss (mm)	Continual Loss (mm/hr)	Roughness (Mannings 'n')
Road Surface	1	0.1	0.014
Road Verge	3	0.5	0.03
Roof	15.8	0.1	0.014
Lot Impervious	15.8	0.1	0.014
Gardens	25	3.5	0.05

The assumptions utilised during the modelling include the following:

- Lots have 50% roof area, 45% paved area and 5% permeable garden/landscaped area.
- Lots fully retain the 10 year ARI event runoff on-site (e.g. in a soakwell or rainwater tank).
- Roof area and paving are assigned a 28.4 mm initial loss to represent the retention of the 10 year ARI runoff onsite.
- Garden/landscaping areas will have highly permeable soil fill.
- Road reserves consist of 60% bitumen and 40% verge.
- The bio-retention area is modelled as a 0.5 m deep square basin with 1:3 side slopes, and has been sized to fully retain the 1 year 1 hour ARI runoff from the road reserves.
- Infiltration within the bio-retention area is 7.5 m/day, which allows a clogging factor.
- Runoff from all the catchments (lots and roads combined) for events above the 1 year 1 hour ARI event is conveyed by an open swale towards Lake Claremont.
- The conveyance swale will be a vegetated natural channel.
- The 100 year ARI event critical duration is 1 hour.

The post development catchment areas were identified considering the pre-development sub-catchments and the Claremont North East Precinct structure plan. Land types within the catchments were guided by the design guidelines. The post-development catchment characteristics are summarised in **Table 2**.

Table 2 Post development catchment characteristics

Sub-Catchment	Slope	Total Area (ha)	Lot Roof (ha)	Lot Paved (ha)	Lot Garden (ha)	Road Pavement (ha)	Road Verge (ha)
Lot 1	0.013	1.962	0.981	0.883	0.098	0.0	0.0
Lot 2	0.010	0.547	0.274	0.246	0.027	0.0	0.0
Lot 3	0.006	0.638	0.319	0.287	0.032	0.0	0.0
Road	0.018	1.837	0.00	0.0	0.0	1.102	0.735
Total		4.984	1.574	1.416	0.157	1.102	0.735

The results of the modelling provide design requirements for both the bio-retention area and the conveyance swale, as well as the peak flow rates experienced within the swale during a 100 year ARI event. These are summarised in **Table 3** and **Table 4**.

Table 3 Bio-retention area design requirements

Depth (m)	Side Slopes	Bottom Surface Area (m^2)	Top Surface Area (m^2)	Volume
0.5	1:3	250	353	150

Table 4 Conveyance swale design requirements

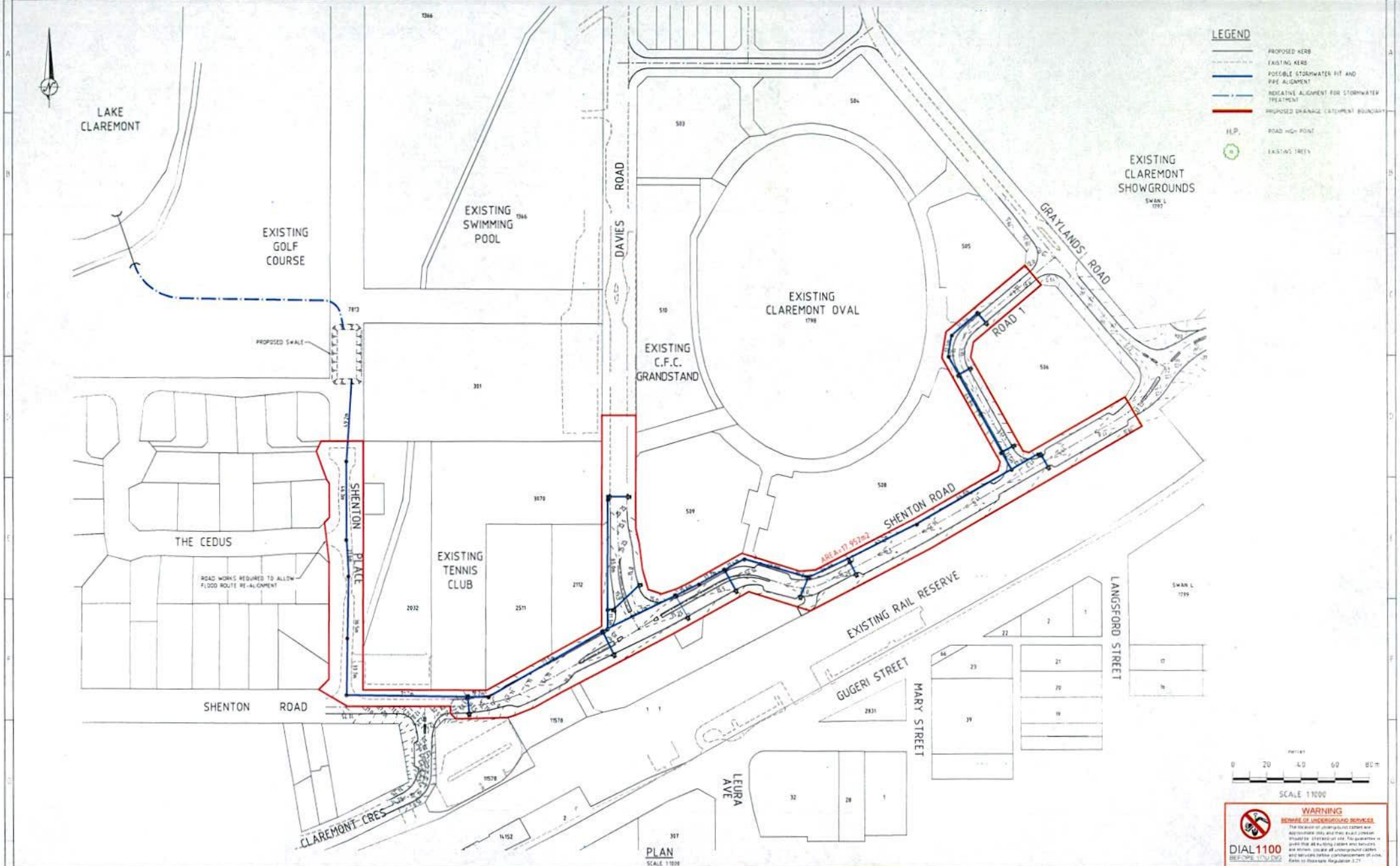
Design depth (m)	Side slopes	Mannings n	Bottom width (m)	Top width (m)	100 Year ARI Depth (m)	100 Year ARI peak flow rate (m^3/s)	100 Year ARI peak velocity (m/s)
0.3	1:6	0.025	1.0	4.2	0.26	0.868	1.28

APPENDIX D

emerge ASSOCIATES
Integrated Science & Design

JDSI ENGINEERING DRAWINGS

This page has been left blank intentionally.



PLAN
SCALE 1:1000

REV	DATE	DRAWN	CHECKED	APPROVED	
A	01.24.12	A.P.			ISSUED FOR INFORMATION

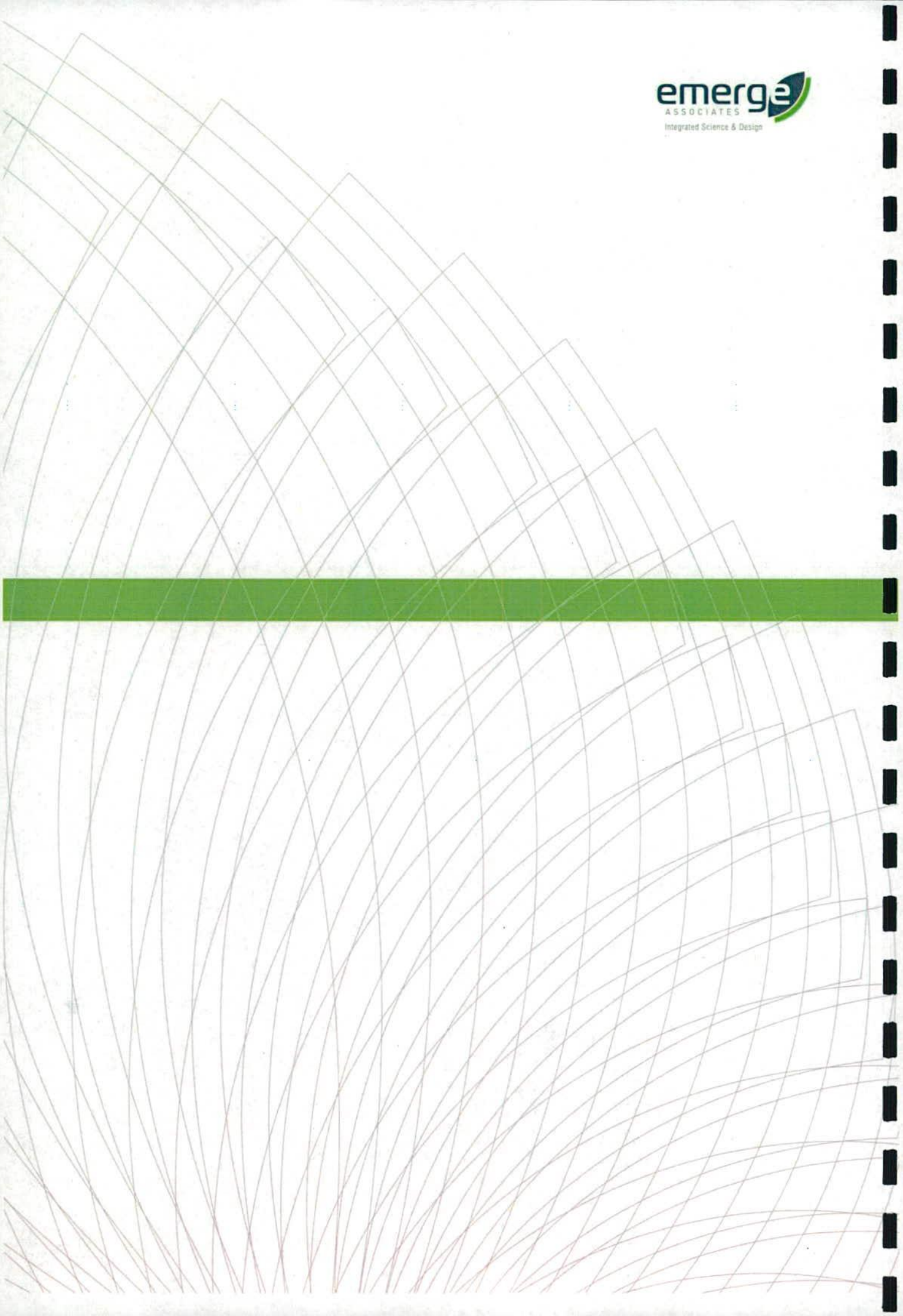
JDSi
CONSULTING ENGINEERS
3/5 Tuby Road, East Perth Western Australia 6004
P: (08) 9225 4110 F: (08) 9225 4121

CLIENT: LANDCORP

PROJECT: CLAREMONT NORTH EAST PRECINCT DEVELOPMENT

DRAWING TITLE: PROPOSED OVERALL SOUTHERN DRAINAGE PRELIMINARY LAYOUT PLAN

DRAWN: A. PANDH	MAPC No.:
DESIGNED: A. PANDH	SCALE @ A1: 1:1000
PROJECT MANAGER: D. HELLMUTH	DATUM: AHD
	CO-ORDS: NONE
JDS PROJECT No.: JDS10448.02	DRAWING No.: SK08
	REVISION: A


emerge
ASSOCIATES
Integrated Science & Design

emerge
ASSOCIATES
Integrated Science & Design

Suite 4, 26 Railway Road
Subiaco, Western Australia 6008

t - 08 9380 4988
f - 08 9380 9636

e - info@emergeassociates.com.au
w - www.emergeassociates.com.au